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# The impact of risk attitudes on entrepreneurial survival\*

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## Abstract

Risk attitudes influence the complete life cycle of entrepreneurs. Whereas recent research underpins the theoretical proposition of a *positive* correlation between risk attitudes and the *decision to become* self-employed, the effects on *survival* are not as straightforward. Psychological research posits an inverse U-shaped relationship between risk attitudes and entrepreneurial survival. On the basis of experimentally-validated data of the German Socio-Economic Panel (SOEP), we examine the extent to which risk attitudes influence survival rates in self-employment in Germany. The empirical results confirm that persons whose risk attitudes are in the medium range survive significantly longer as entrepreneurs than do persons with particularly low or high risk attitudes.

**Keywords:** Entrepreneurship, Risk Attitudes  
Survival

**JEL:** D81, J23, M13

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# 1 Introduction

Recent empirical research supports the theoretical proposition of a positive correlation between risk attitudes and the *decision to become* an entrepreneur (see, e.g., Cramer, Hartog, Jonker, and Van Praag, 2002; Caliendo, Fossen, and Kritikos, 2009). Several studies (Stewart and Roth, 2001; Hartog, Ferrer-i-Carbonell, and Jonker, 2002) further show that the population of self-employed persons tends to be less risk averse than other persons, such as those who are regularly employed. These observations lead to the crucial question addressed in this paper: Do risk attitudes also represent a defining characteristic of entrepreneurial *survival*?

Prior economic research focuses only on the questions of whether and why entrepreneurs may need to be less risk averse than other persons, such as employees (Kihlstrom and Laffont, 1979).<sup>1</sup> To the best of our knowledge, the question of the extent to which individual risk attitudes might have an impact on survival rates of entrepreneurs has not been explored in economic literature. Accordingly, empirical research does not go beyond the examination of differences in risk attitudes between the groups of self-employed and regularly employed persons.

Psychological research pays little more attention to this question, as it argues that entrepreneurs should neither take the highest nor the lowest possible but instead ‘well-calculated’ risks to remain successful. Chell, Harworth, and Brearley (1991) suggest an inverse U-shaped relation between risk attitudes and entrepreneurial survival, where low risk attitudes characterize more risk-averse persons and high risk attitudes characterize the less risk averse. However, insufficient empirical research links risk attitudes to the survival rates of entrepreneurs. In a recent survey of the relationship between personality traits and business success, Rauch and Frese (2007) conclude that the effect of risk taking on entrepreneurial success is rather small, and that this trait does not necessarily increase the success probability. However, the inverse U-shaped relationship simply has not been tested so far. A possible reason for this lack of empirical research is that reliable demographic data about individual risk attitudes were missing.

This paper aims to close the gap. We employ a representative data set, the

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<sup>1</sup>See also subsequent discussions by Evans and Jovanovic (1989), Parker (1997), Cressy (2000), Norton and Moore (2006), and Kan and Tsai (2006).

German Socio-Economic Panel which contains in the 2004 wave several questions about subjective risk attitudes and objectively measurable risk preferences which were both experimentally validated. Based on these data, we conduct a rigorous test whether the probability of entrepreneurial survival correlates with the willingness to bear certain risks. To answer this question consistently, we control for the labor status of all entrepreneurs in the sample, that is, whether they continue as self-employed or switch to an employed position or unemployment.

The rest of the paper is organized as follows: In Section 2, we discuss and illustrate the inverse U-shaped relationship between risk attitudes and entrepreneurial survival. We describe the data in Section 3, with a special focus on the various measures of risk attitudes which we use in our further analysis. In Section 4, we present the econometric approach, followed in Section 5 by a discussion of the results of our analysis. We conclude in Section 6 that risk attitudes have an impact on entrepreneurial survival. Our empirical analysis indicates that persons with medium range attitudes towards risk survive significantly more often in self-employment than persons with particularly low or high risk attitudes do.

## 2 Risk Attitudes and their Impact on Entrepreneurial Success

According to Chell et al. (1991), there should be an inverse U-shaped relation between risk attitudes and entrepreneurial survival, where low risk attitudes characterize more risk averse and high risk attitudes indicate less risk averse persons. Therefore, the hypothesis we subsequently test posits that among all entrepreneurs, persons with low or high risk attitudes have a higher exit probability from their entrepreneurial activities than are persons whose risk-taking behavior falls within the medium range.<sup>2</sup>

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<sup>2</sup>In this context, we need to clarify that risk attitudes at a medium range level are not to be set equal to risk neutral preferences. As the SOEP data reveal (see Dohmen, Falk, Huffman, Sunde, Schupp, and Wagner, 2010), most persons and also most entrepreneurs are risk averse. Among all entrepreneurs with different levels of risk aversion we form henceforth three categories: i) those who have low risk attitudes, ii) persons with a medium range of risk attitudes, and iii) persons who have high risk attitudes. Among the latter ones, we cannot exclude that a small fraction is risk neutral or even risk seeking.

As our empirical analysis concentrates on active entrepreneurs, we do not aim to explicitly discuss this hypothesis in the context of their decision to become an entrepreneur. In the spirit of behavioral models on risky choices, we aim to illustrate by a very simple model the decision of entrepreneurs to continue their activities. Given a continuous set of possible investments—each with a specific risk and expected return—we focus on entrepreneurs who have already chosen to expend initial investment into one of these possibilities. Entrepreneurs make risky investments only if these investments will lead, *ex ante*, to higher expected returns than would safe investments, as long as entrepreneurs are strictly risk averse. Accordingly, we assume that the expected returns of investments increase with their riskiness, but are subject to decreasing returns to scale if the risk level of the investment increases.<sup>3</sup>

These features of risky investments are captured by a simple model in which projects  $Pr(p; y_s)$  are characterized by the probability of success  $p \in (0; 1)$  and the payoff in case of success  $y_s > 0$  being a measure of the project scale. We further assume that all projects involve fixed investment costs which are equal to a constant fraction of the potential payoff,  $y_s/c$  and that there are only two potential outcomes, i.e., the actual net returns to the project are either  $y = y_s - y_s/c$  in case of success of the project, or  $y = -y_s/c$  in case of failure of the project. Then the expected return of a project is  $E(y) = py_s - y_s/c$ , and the variance is  $Var(y) = p(1 - p)y_s^2$ . The relationship between the expected value and the variance of  $y$  is derived as

$$Var(y) = p(1 - p) \left( p - \frac{1}{c} \right)^{-2} [E(y)]^2. \quad (1)$$

Entrepreneurs will only consider projects which satisfy  $p > 1/c$  and thus have positive  $E(y)$ . It follows that for a given success probability  $p$  these projects exhibit a risk premium in that the expected returns increase with the scale of risk ( $dE(y)/dVar(y) > 0$ ). The risk premium displays at the same time a decreasing marginal rate of increase as expected return and risk increase ( $d^2E(y)/dVar(y)^2 < 0$ ). Entrepreneurs will choose along the mean-variance dimension the scale and risk level of the project that maximizes their expected utility (see Figure 1).

INSERT FIGURE 1 ABOUT HERE

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<sup>3</sup>We cannot exclude the possibility that beyond a certain risk level of an investment, expected returns are even marginally decreasing.

As a consequence, entrepreneurs with low risk attitudes will choose less risky, i.e., smaller projects, where the marginal risk premium for an additional unit of risk is high. Entrepreneurs with high risk attitudes instead choose riskier, thus larger projects with a small marginal risk premium. Hence, the individually chosen project scale  $y_s(r)$  is a monotonically increasing function of each person's risk attitudes  $r$ . For simplification, we assume that every project lasts one period and that most entrepreneurs, instead of a lifetime decision, compare from period to period the expected income from the next entrepreneurial project with the actual opportunity cost.<sup>4</sup> As long as entrepreneurs decide to stay in business, we further assume that they conduct consecutive projects. A failure of a project does not necessarily imply that an individual stops being in business.

When a project is finished, two considerations determine whether a person starts another project or exits entrepreneurship. First, the entrepreneur compares the net expected return for the next project with the opportunity cost which is the income the person receives beyond self-employment. That might be a positive wage offer from the best possible position in dependent employment, a transfer from the social security system, or simply zero. The opportunity cost  $w^*$  may differ from period to period and is modeled as a random draw from a continuous distribution of the random variable  $w$  which can take on positive values including zero. Second, we have to note that the realized return on investment differs from the expected return. If a project fails (with probability  $1 - p$ ) and produces a loss  $l = y_s/c$ , the probability  $p_b(l)$  depicts that this loss leads to bankruptcy and consequently forces the entrepreneur to shut down the business even if he or she would have preferred to continue. An alternative explanation is provided by the prospect theory of Kahneman and Tversky (1979) according to which individuals are loss averse and might stay away from further risky investments having realized a loss  $l = y_s/c$  once. The higher the loss, the higher the probability of bankruptcy or of the probability of a reluctant individual to continue as a risk taking entrepreneur; thus,  $p_b(l)$  is increasing in loss  $l$ , which in turn increases with the project size  $y_s$ . In Figure A.1 in the Appendix, we provide a decision tree which explicitly shows the individual

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<sup>4</sup>Of course there are also some die-hard entrepreneurs who would never stop to be entrepreneurs no matter what happens. Burke, FitzRoy, and Nolan (2008) show that these are, however, a minority among all entrepreneurs.

decisions of entrepreneurs taking all continuation and exit reasons into account. The probability of starting another project, i.e., of continuing as an entrepreneur, is written as

$$\begin{aligned}
 P(\text{continue}) &= P(E(y) > w^*) (1 - (1 - p) \cdot p_b(l)) \\
 &= P\left(py_s - \frac{y_s}{c} > w^*\right) \left(1 - (1 - p) \cdot p_b\left(\frac{y_s}{c}\right)\right) \\
 &= F_w\left(y_s \left(p - \frac{1}{c}\right)\right) \left(1 - (1 - p) \cdot p_b\left(\frac{y_s}{c}\right)\right) \quad (2)
 \end{aligned}$$

where  $F_w(\cdot)$  is the cumulative probability distribution of the wage offer  $w^*$ .<sup>5</sup> It follows that the derivative of this probability of continuing with respect to risk attitudes  $r$  is

$$\begin{aligned}
 \frac{d}{dr}P(\text{continue}) &= \left(\left(p - \frac{1}{c}\right) f_w(y_s) \frac{dy_s}{dr}\right) \left(1 - (1 - p) \cdot p_b\left(\frac{y_s}{c}\right)\right) \\
 &\quad - \left(\frac{1 - p}{c} \frac{d}{dy_s} p_b(y_s) \frac{dy_s}{dr}\right) F_w\left(y_s \left(p - \frac{1}{c}\right)\right) \quad (3)
 \end{aligned}$$

As previously noted, the scale of the project increases with higher risk attitudes, i.e.,  $dy_s/dr > 0$ . Further,  $f_w(y_s) = dF_w(y_s)/dy_s \geq 0$  since  $f_w(y_s)$  is a density function, and  $p > 1/c$  (because projects otherwise would not be considered). As a consequence the first factor of the first term is positive. The second factor is also positive, as the probability of bankruptcy is always between 0 and 1. Therefore, the first term of equation (3) is positive. Turning to the second term, as argued above  $dp_b(\cdot)/dy_s$  is again positive so that the first factor of the second term is positive. As  $F_w(\cdot)$  is between 0 and 1 and because of the negative sign ahead of the second term, the second term becomes negative.

The first term reflects the relationship between returns of the projects and

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<sup>5</sup>The same model could be used to describe entry into entrepreneurship as well. As for potential entrants there is no prior project and their bankruptcy risk is zero, the equation reduces to  $P(\text{entry}) = P(E(y) > w^*) = F_w(y_s(p - 1/c))$ . Then  $dP(\text{entry})/dr = F_w(\cdot)/dy_s dy_s/dr > 0$  (since  $p > 1/c$ ) and thus, the probability of entry unambiguously increases with higher risk attitudes. The empirical results of Caliendo et al. (2009) support this implication of the model. Note that there will always be some risk averse entrepreneurs, as draws from the wage offer distribution may turn out very low or even zero if somebody cannot find a job.



opportunity costs. As higher risk attitudes  $r$  imply a larger project, we observe a higher probability that the expected return from the entrepreneurial project exceed the wage offer. This means vice versa that entrepreneurs who are tolerating only low risks are more likely to face wage offers which are above the expected return of their next entrepreneurial project. If a higher wage offer occurs, those individuals will leave entrepreneurship even if the previous project did not fail. The second term takes care of the relationship between project size and bankruptcy. With higher risk attitudes  $r$  the size of the project increases which raises the probability of bankruptcy. Thus, the second term reflects the fact that some individuals are forced to leave entrepreneurship because their project failed and they went bankrupt.<sup>6</sup>

If the cumulative probability distribution  $F_w$  of the wage offer becomes relatively large while the probability of bankruptcy  $p_b(l)$  remains to be relatively small, the result is that the probability of continuing as an entrepreneur first increases with  $r$  at low values of  $r$ , when the first term still dominates, and then decreases with  $r$  at higher values of  $r$ , when the second term starts to dominate (for a numerical example see Appendix A.2). Hence, there is an inverse U-shape relationship between risk attitudes and the probability of continuing as an entrepreneur.

Given these considerations, it becomes clear under what conditions entrepreneurs will decide to continue or finish their entrepreneurial activities. Having implicitly ordered the complete spectrum of entrepreneurs from those with the lowest risk attitudes to those with the highest, we hypothesize that very risk-averse entrepreneurs who have chosen the safest possible investments are more likely to generate returns below their opportunity costs than entrepreneurs with higher risk attitudes.<sup>7</sup> As the risk level of an investment increases step by step, its expected return will exceed with higher probability the opportunity costs, while a bankruptcy will be realized with moderate probability. Finally, if the riskiness of an investment increases far above average, we hypothesize that it becomes more and more likely that the en-

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<sup>6</sup>It should be emphasized that our model is also able to capture different exit reasons such as failures leading to bankruptcy and closures because of high opportunity costs. For further details on differences between business failure and closure, see van Praag (2003), Headd (2003) and Bates (2005).

<sup>7</sup>This expectation is also plausible from another point of view: If returns from a safe investment exceed earnings from wage income, every person would become an entrepreneur and realize sufficient income.

trepreneur falls into bankruptcy when the project fails and creates large losses.<sup>8</sup> Thus, if the complete spectrum of entrepreneurs is characterized by three risk categories, we should observe persons with low or high risk attitudes to close down their businesses with higher probability than persons with a medium level of risk attitudes.

### 3 Data Set and Risk Measurement

We base our analysis on the German Socio-Economic Panel (SOEP), an established, representative panel survey that contains detailed information about the socio-economic situation of approximately 22,000 persons living in 12,000 households in Germany.<sup>9</sup> Key to our analysis are measures of risk attitudes that were added to the SOEP in the 2004 survey wave. Several questions deal with attitudes toward risk in general and in specific contexts, including occupation, the relevant domain for employment decisions. Respondents indicate their willingness to take risks on an 11-point scale ranging from 0 (complete unwillingness) to 10 (complete willingness). Another question corresponds to conventional lottery measures and asks respondents to state how much (in categories of fifths) of 100,000 euros, which they hypothetically had won in a lottery, they would invest in a risky asset.<sup>10</sup> The question indicates that there are equal chances respondents will double the amount invested or lose half of it.<sup>11</sup> In contrast to the other risk questions which may in-

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<sup>8</sup>Recent research by Baron (2004) and Köllinger, Minniti, and Schade (2007) provides further explanations why particularly entrepreneurs with high risk attitudes might decide to start a business venture even if high negative outcomes may arise. They reveal that these persons tend to be overconfident in being capable to exclude or reduce the probability of negative returns.

<sup>9</sup>The SOEP started in 1984 as a longitudinal survey of private households and persons in West Germany and then expanded to the territory of East Germany in June 1990. The central aim of this panel study is to collect representative micro-data about persons, households, and families. It is similar to the BHPS in the United Kingdom and the PSID in the United States. A rather 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; household production; and basic orientation. For a more detailed data description, see Wagner, Frick, and Schupp (2007).

<sup>10</sup>There is a long tradition to elicit risk attitudes by lottery choices; see in particular Kahneman and Tversky (1979) or recently Fellner and Maciejovsky (2007).

<sup>11</sup>See Table A.1 in the Appendix for the original phrases included in the risk measures. With reference to footnote 2 this design also makes clear that risk neutrality would require to invest the full amount of money into the risky asset. Thus, all persons who answered that they would invest less than the complete amount into the risky asset are risk averse. Only for persons who state that

corporate both risk preference and risk perception, the lottery question holds the perception of the riskiness of a decision constant across respondents by providing explicit stakes and probabilities.<sup>12</sup>

Dohmen *et al.* (2010) validated the reliability of these survey measures of risk attitudes with a field experiment. A representative sample of 450 adults had the opportunity to make risky choices with real money at stake, and answered the general risk question from the SOEP. The authors find that answers to the general risk question were good predictors of actual risk-taking behavior in the experiment. Furthermore, the answers to the lottery question were correlated with responses to the general risk question. These findings support the validity and relevance of the survey measures of risk attitudes while at the same time they allow us to make use of a much larger panel data sample.

We use the yearly outcomes for the years 2000 to 2005 for those individuals who answered the risk question in 2004, assuming the stability of risk attitudes at least over this relatively short period of time (see Barsky, Juster, Kimball, and Shapiro, 1997, for evidence that risk attitudes remain stable over time). As in most empirical studies on entrepreneurial choice, we use self-employment as a measurable proxy of the concept of entrepreneurship.<sup>13</sup> The classification of persons as self-employed stems from a survey question about the occupational status of the respondents. If respondents are employed or self-employed in more than one position, they report their status of their primary activity. We restrict the sample to persons between 18 and 65 years of age who have been self-employed at least once during the sample period and for which we have information on the occupational risk question and whether the father was self-employed. Overall, we observe 4,731 person-year observations in which self-employed persons are *at risk* of exiting self-employment, with 569 exits actually occurring.

INSERT TABLE 1 ABOUT HERE

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they would invest the complete amount of 100,000 euros into the risky asset we cannot exclude that these are risk neutral or even risk seeking.

<sup>12</sup>Previous research indicates the potential for significant differences between (subjective) risk perceptions and (objectively measurable) risk preferences (see Palich and Bagby, 1995).

<sup>13</sup>This broad definition of entrepreneurship is frequently used in economics and psychology as well; see Stewart and Roth (2001) or Rauch and Frese (2007).

In Table 1, we provide mean values of the characteristics of those respondents who remain self-employed and those who exit. The table reveals significant differences between the groups (see the last column, which reports the  $p$ -value from a  $t$ -test of mean-equality). People exiting self-employment are more likely to be female, less educated, and younger than those who remain self-employed. The answers to the risk-related questions also differ between groups. For both kinds of risk measures, we observe that persons with a low risk profile are more likely to leave self-employment (except for people who invest nothing in the lottery question). However, to analyze the impact of risk attitudes on entrepreneurial survival, we require an econometric model that controls for relevant characteristics and covariates, as well as the duration of the self-employment, as we will present in the subsequent section.

## 4 Econometric Specification

To estimate the probability of exit from self-employment, conditional on the duration of the current spell in self-employment, we introduce a discrete time hazard rate model. We use yearly data because the interviews occur once a year, and the covariates are not available for higher frequencies.

Respondents may experience multiple self-employment spells during the observation period. Therefore, we use the discrete non-negative random variable  $T_{ik}$  to describe the duration of the  $k$ -th spell of individual  $i$ . When a spell terminates in year  $t$  (measured from the beginning of the spell),  $T_{ik}$  takes on a value of  $t$ . The hazard rate  $\lambda_{ik}(t)$  is defined as the probability that spell  $k$  for person  $i$  ends in period  $t$  (i.e., a transition occurs) conditional on survival until the beginning of  $t$ :

$$\lambda_{ik}(t|X_i(t)) = P(T_{ik} = t | T_{ik} \geq t, X_i(t)), \quad (4)$$

where  $X_{ik}(t)$  is a vector of the characteristics and covariates of individual  $i$  in interval  $t$  of spell  $k$  including the risk attitude. The probability of remaining self-employed in period  $t$  (“survival”), conditional on having survived until the beginning of  $t$ , is the complementary probability

$$P(T_{ik} > t | T_{ik} \geq t, X_i(t)) = 1 - \lambda_{ik}(t | X_i(t)). \quad (5)$$

The survivor function, which represents the unconditional probability of remaining in the current spell until the end of period  $t$ , can be written as the product of the survival probabilities in all periods before and in  $t$  (and thus a function of the conditional hazard rate which will ultimately be estimated):

$$S(t | X_i) = P(T_{ik} > t | X_i) = \prod_{\tau=1}^t (1 - \lambda_{ik}(\tau | X_i(\tau))). \quad (6)$$

Consequently, the unconditional probability of a transition in period  $t$  is the probability of survival until the beginning of period  $t$ , multiplied by the hazard rate in period  $t$  (and thus, again, is a function of the conditional hazard rate):

$$P(T_{ik} = t | X_i) = \lambda_{ik}(t | X_i(t)) \prod_{\tau=1}^{t-1} (1 - \lambda_{ik}(\tau | X_i(\tau))). \quad (7)$$

We employ the maximum likelihood method to estimate the model, which enables us to take into account completed spells as well as both left-censored and right-censored spells in the estimation. For a fully observed spell that ends with an exit from self-employment, the contribution to the likelihood function is given by equation (7). For a right-censored spell, the likelihood contribution is given by the survivor function (6), because we know only that the person “survived” until the end of the observation period, not when the spell will end. Combining these two cases, the likelihood contribution of a spell  $k$  of an individual  $i$  can be written as

$$L_{ik}^{\text{non left-censored}}(\text{parameters} | c_i, X_{ik}) = \left[ \frac{\lambda_{ik}(t_{ik} | X_{ik}(t_{ik}))}{1 - \lambda_{ik}(t_{ik} | X_{ik}(t_{ik}))} \right]^{c_{ik}} \prod_{\tau=1}^{t_{ik}} (1 - \lambda_{ik}(\tau | X_{ik}(\tau))), \quad (8)$$

where  $c_{ik}$  is a censoring indicator defined such that  $c_{ik} = 1$  if a spell is completed and 0 if a spell is right-censored.

If a spell is left-censored in the SOEP, because person  $i$  enters the panel after spell  $k$  has already lasted  $u_{ik}$  years, we must condition on survival up to the end of period  $u_{ik}$ , which means that expression (8) has to be divided by  $S(u_{ik})$ . Then the

likelihood contribution of the spell is

$$\begin{aligned} L_{ik}(\text{parameters}|c_i, X_{ik}) &= \left[ \frac{\lambda_{ik}(t_{ik}|X_{ik}(t_{ik}))}{1 - \lambda_{ik}(t_{ik}|X_{ik}(t_{ik}))} \right]^{c_{ik}} \frac{\prod_{\tau=1}^{t_{ik}} (1 - \lambda_{ik}(\tau|X_{ik}(\tau)))}{\prod_{\tau=1}^{u_{ik}} (1 - \lambda_{ik}(\tau|X_{ik}(\tau)))} \\ &= \left[ \frac{\lambda_{ik}(t_{ik}|X_{ik}(t_{ik}))}{1 - \lambda_{ik}(t_{ik}|X_{ik}(t_{ik}))} \right]^{c_{ik}} \prod_{\tau=u_{ik}+1}^{t_{ik}} (1 - \lambda_{ik}(\tau|X_{ik}(\tau))) \end{aligned} \quad (9)$$

Note that this more general notation includes equation (8) for spells that are not left-censored ( $u_{ik} = 0$ ). In the SOEP, the retrospective employment history questions enable us to recover  $u_{ik}$  for self-employment spells and thereby deal with left-censoring.

The overall likelihood contribution of an individual  $i$  equals the product of the likelihood contributions of the  $K_i$  spells that the person experienced in the observation period. The sample likelihood function is the product of the individual likelihood contributions:

$$L(\text{parameters}|c, X) = \prod_{i=1}^N \prod_{k=1}^{K_i} L_{ik}. \quad (10)$$

The log-likelihood function is

$$\begin{aligned} \log L(\text{parameters}|c, X) &= \sum_{i=1}^N \sum_{k=1}^{K_i} \log L_{ik} \\ &= \sum_{i=1}^N \sum_{k=1}^{K_i} c_{ik} \log \left[ \frac{\lambda_{ik}(t_{ik}|X_{ik}(t_{ik}))}{1 - \lambda_{ik}(t_{ik}|X_{ik}(t_{ik}))} \right] \\ &\quad + \sum_{i=1}^N \sum_{k=1}^{K_i} \sum_{\tau=u_{ik}+1}^{t_{ik}} \log[1 - \lambda_{ik}(\tau|X_{ik}(\tau))] \end{aligned} \quad (11)$$

We define a new binary transition indicator variable  $y_{ik\tau} = 1$  if person  $i$  completes spell  $k$  in period  $\tau$ , and 0 otherwise. The  $y_{ik\tau}$  correspond to dummy variables that equal 1 if an exit out of self-employment is observed between  $\tau$  and  $\tau + 1$ , and 0 otherwise. Effectively adding some zeros to the sum, it can be written

$$\begin{aligned}
\log L(\text{parameters}|y, X) &= \sum_{i=1}^N \sum_{k=1}^{K_i} \sum_{\tau=u_{ik}+1}^{t_{ik}} y_{ik\tau} \log \left[ \frac{\lambda_{ik}(\tau|X_{ik}(\tau))}{1 - \lambda_{ik}(\tau|X_{ik}(\tau))} \right] \\
&+ \sum_{i=1}^N \sum_{k=1}^{K_i} \sum_{\tau=u_{ik}+1}^{t_{ik}} \log[1 - \lambda_{ik}(\tau|X_{ik}(\tau))] \\
&= \sum_{i=1}^N \sum_{k=1}^{K_i} \sum_{\tau=u_{ik}+1}^{t_{ik}} (y_{ik\tau} \log[\lambda_{ik}(\tau|X_{ik}(\tau))] \\
&+ (1 - y_{ik\tau}) \log[1 - \lambda_{ik}(\tau|X_{ik}(\tau))]) \quad (12)
\end{aligned}$$

The last expression has exactly the same form as the standard log-likelihood function for a binary regression model in which  $y_{ik\tau}$  is the dependent variable and the data are organized in person-period format, where  $\tau$  is measured from the beginning of the current self-employment spell and thus measures its duration (cf. Jenkins, 1995).

The functional form of the hazard rate is specified as a logistic hazard model:

$$\lambda_{ik}(t|X_{ik}(\tau)) = \frac{\exp(f(\tau) + X_{ik}(\tau)\beta)}{1 + \exp(f(\tau) + X_{ik}(\tau)\beta)}, \quad (13)$$

where the function  $f(\tau)$  represents the dependence of the hazard rate on the spell duration  $\tau$  (baseline hazard), specified as a polynomial function of the third degree. This model is consistent with an underlying continuous time model in which the within-interval durations follow a log-logistic distribution (Sueyoshi, 1995).

The cumulative transition probability, or exit function, is the complementary probability of the survival probability in equation (6):

$$F(t|X_{ik}) = 1 - S(t|X_{ik}) = 1 - \prod_{\tau=1}^t (1 - \lambda_{ik}(\tau|X_{ik}(\tau))). \quad (14)$$

This function is of special interest in this context because it describes the probability that a person exits self-employment during the first  $t$  years of self-employment.

## 5 Estimation Results

To test the main hypothesis of this paper, the inverse U-shaped relationship between risk attitudes and entrepreneurial survival, we employ two risk measures (occupational risk and lottery investment) and estimate different specifications (dummies, linear, quadratic). As outcome variable we consider the employment status throughout the analysis: a continuation as self-employed represents the survival measure, whereas a transition to regular employment or unemployment constitutes an exit of self-employed persons (with exits defined as the sum of failures and closures).<sup>14</sup> As the dependent variable takes on 1 if an exit is observed and 0 otherwise, a positive sign of a coefficient and marginal effect indicates that a variable increases the probability of exit and thus decreases the probability of remaining self-employed. For the risk measures we start with dummy variable specifications, before we apply linear and quadratic estimations.

Full estimation results are available in Table A.3 in the Appendix. In our baseline estimation (see column (0) of Table A.3), we initially test the influence of several basic socio-demographic and business characteristics—which showed already in previous research to influence entrepreneurial survival—without including any risk measures. Beginning with the socio-demographic variables, we observe gender and age effects showing that women and younger persons have significantly lower probabilities of remaining self-employed. A self-employed father has a positive effect on survival. This is in line with previous research showing that having a self-employed father increases the probability to become self-employed (see, e.g., Dunn and Holtz-Eakin, 2000; Caliendo et al., 2009). With respect to education and previous working experience, we find several well-known effects. Specifically, a university degree and lifetime working experience have significantly positive effects, whereas years of unemployment experience before the start of the current self-employment spell has a negative influence on the probability of remaining self-employed. We also find an interesting wealth effect: Although wealth has a positive impact on the probability of business creation (see, e.g., Blanchflower and Oswald, 1998), this effect disappears when it comes to business survival: Capital income, which is used as an indicator

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<sup>14</sup>Unfortunately, in our empirical analysis we are not able to differentiate between voluntary and involuntary exits.



for wealth here,<sup>15</sup> has no significant influence on the probability of remaining self-employed. Finally, as described in Section 4, the discrete hazard rate model takes into account the state (or duration) dependence which describes the fact that being in one labor market state in one period itself (causally) increases the probability of being in the same labor market state in the next period. Since Caliendo and Uhendorff (2008) show that neglecting state dependence in self-employment may lead to misleading conclusions, our econometric model includes the tenure of the current self-employment spell in linear, quadratic and cubic terms as explanatory variables. It can be seen that longer tenure decreases the exit probability.<sup>16</sup> All these control variables are also included in our estimations in columns (1)-(6) where we test the influence of different risk measures on survival.

As described in Section 3, respondents indicate on a scale from 0-10 the extent to which they are willing to take risks in occupational choices. This kind of risk measure portrays the subjective risk attitudes of entrepreneurs. In addition to the subjective question about occupational risk attitudes, entrepreneurs also respond to a lottery question by dividing a fixed amount between a safe and a risky investment with a given success probability. This question thus reveals objectively measurable risk preferences. For the occupational risk measure and the lottery measure we start with dummy variable specifications, before we use the occupational risk measure in a continuous way.

In our first estimation (column (1)) we present the influence of the occupational risk measure on entrepreneurial survival for each possible answer between 0 and 10, whereas in column (2), we consolidate answers 0-2 in low risk, 3-7 in medium risk, and 8-10 in high risk categories. In our third estimation (column (3)) we analyze the results of the lottery question. Then we proceed with more parametric specifications and treat the willingness to take risk in occupational choices as a continuous variable, testing a linear (column (4)) and quadratic (column (5)) influence on the exit rate.

INSERT TABLE 2 ABOUT HERE

Table 2 presents marginal effects of the risk measures for the first three esti-

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<sup>15</sup>Wealth is only observed in one year of our observation period. Therefore we decided to use capital income—which is observed yearly—as an indicator.

<sup>16</sup>This so called liability of newness is consistent with previous findings, see e.g., Henderson (1999) and for German data Fritsch, Brixey, and Falck (2006).

mations, which can be interpreted straightforwardly: A decrease (increase) in the probability of staying self-employed occurs if the marginal effect is positive (negative). The marginal effect of one of the discrete risk categories is the difference in the predicted yearly exit probability for a discrete change of this category's dummy variable from 0 to 1, where the other risk category dummies are set to 0 and the remaining explanatory variables to their mean values. Thus, the marginal effect always indicates the difference in the exit probability between a certain risk category and the base category, which corresponds to the lowest risk attitude. We also interpret the economic impact of these changes in relation to the mean yearly exit rate which is 10.7% in the sample (see Table 1).

Always using the lowest risk category as the base category (i.e. no or low risk for occupational choices in columns (1) and (2); no risky investment in column (3)), we test the influence of these two risk measures on entrepreneurial survival. In column (1), we observe that in comparison to persons who are not willing to take occupational risks at all, persons willing to take higher risks have a higher probability of remaining self-employed in a given year. The difference is statistically significant for the risk levels 2 and 5-8. Persons with values of 9 or 10 for occupational risks reveal no significantly higher probability of entrepreneurial survival (compared to the base category). From an economic point of view, we emphasize that the largest increase in the probability of remaining an entrepreneur emerges for medium risks. A risk attitude of 5 or 6 on the 11-point scale increases the probability of survival as self-employed by about 5 percentage points. As the predicted exit probability is approximately 12.5% in the base category (i.e. complete unwillingness to take occupational risk) at the mean values of the remaining explanatory variables, the economic impact of occupational risk attitudes in the 5 or 6 point range is remarkable: Exit rates among these persons decline by 40% to about 7.5%. Overall, the estimation results confirm the hypothesized inverse U-shape depicting the relationship between risk attitudes and survival rates.

We confirm these observations in column (2) in which we consolidate the answers to the occupational risk questions into three categories. In comparison to entrepreneurs with a low willingness to take risks in occupational choices (base category), the survival rates of entrepreneurs with medium risk attitudes is significantly

higher, while the exit rate for entrepreneurs with high risk attitudes in their occupation is not significantly different. This again reflects an inverse U-shape between risk attitudes and survival.

The analysis in column (3) reveals similar and complementary effects, such that higher exit rates provide the significant characteristic. Although people who decide to make medium-risk investments (between 40,000 and 80,000 Euros) do not suffer a higher exit probability than those in the base category, the less risk-averse (who put all their money into the risky investment) and more risk-averse respondents (who put only 20,000 Euros into the risky investment) suffer a significantly higher exit probability as entrepreneurs. The highest marginal effect emerges for persons who choose the highest risk in the lottery. For them, the exit probability from self-employment increases by 8 percentage points, doubling from 8% (in the base category) to 16%. Overall, the results of this specification again point to a U-shaped relationship between risk preference and exit rates.<sup>17</sup>

INSERT TABLE 3 ABOUT HERE

The U-shape found in the flexible specifications suggests that the relationship between risk attitudes in occupation and survival rates is best described by a parabola. Table 3 shows the estimated logit coefficients for a linear and a quadratic functional form assumption. The quadratic term in column (5) is significantly different from 0, such that the linear specification in column (4) is rejected ( $p$ -value of Wald test: 0.0071). We also tested a third degree polynomial, but the results were insignificant and its inclusion did not increase the log likelihood.<sup>18</sup> The quadratic estimation in column (5) is thus preferred, and these results further support the U-shape relationship. The minimum exit probability is reached at a risk tolerance level of 6. Figure 2 shows how the exit probability changes with risk attitudes on the scale from 0-10 for an individual with otherwise average characteristics, according to the estimates in (5).

INSERT FIGURE 2 ABOUT HERE

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<sup>17</sup>The finding that people who invest the lowest amount possible (20,000 Euros) have a higher exit probability than those who invest nothing certainly represents a surprising kink in this shape, however.

<sup>18</sup>Results are available upon request from the authors.

As the duration models discussed so far are estimated only for the sample of self-employed, non-random selection into self-employment could be an issue. To address this problem, we estimate in column (6) a model with selection (cp. Heckman, 1979). We employ the sample selection model for binary dependent variables suggested by Van de Ven and Praag (1981) which considers the exit from self-employment as a binary outcome. The model estimates a reduced-form probit equation, which describes selection into self-employment. It is estimated on the pooled sample including not only the self-employed, but also persons being in dependent employment, and the unemployed/inactive (55,856 person-year observations between 2000-2005). The hazard rate of exit from self-employment is specified as a probit model instead of a logit model given in equation (13).<sup>19</sup> This allows modeling the error terms of the latent selection and hazard rate equations to follow the bivariate normal distribution with correlation  $\rho$  as well as estimating the two equations jointly using the Full Information Maximum Likelihood estimator.<sup>20</sup> The results in Table 3 show that the estimated probit coefficients of the linear and square terms of the occupational risk attitude have the same signs and significance levels as the logit coefficients in the baseline column (5). The probit coefficients can be multiplied by 1.6 for an approximate comparison with the magnitudes of the logit coefficients (Amemiya, 1981). The resulting estimates for the level term (-0.122) and the square term (0.018) are not significantly different from the logit estimates in (5), given their standard errors. Thus, not accounting for sample selection does not significantly bias the results in this setting.<sup>21</sup>

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<sup>19</sup>We use the estimation results from column (5) for an assessment of differences. It turns out that the estimated effects and significance levels of the occupational risk attitude (and of its square) which result from the probit model, are only slightly (but statistically not significant) different from those of the logit model. This is due to the similarity of the normal and the logistic distributions. The results are available from the authors upon request.

<sup>20</sup>In the selection equation we use all explanatory variables included in the hazard rate equation, except for the duration terms. For better identification, we additionally include the secondary schooling level of the respondent's father and mother in the selection equation. This information is excluded from the hazard rate equation. The parents' schooling is expected to influence their children's occupational choice, but not the success and the exit rate once an adult has decided to be self-employed. The parents' schooling levels are measured by dummy variables indicating if the parents obtained the higher secondary school degree (Abitur), which qualifies for university admission in Germany. Both variables turn out to have a positive and highly significant influence on selection.

<sup>21</sup>Notwithstanding, an LR test rejects the hypothesis that  $\rho = 0$  and thus indicates that the selection and the hazard rate equations are not independent ( $p$ -value=0.049).

Figure 3 shows the predicted hazard rates of exit out of self-employment conditional on different durations of self-employment for entrepreneurs with different risk attitudes (based on estimation results in column (2)), evaluated at the mean values of the remaining explanatory variables. As expected, the conditional exit probability is largest during the first years of self-employment and decreases with spell duration when the initial hurdles are taken. This general shape is found for all three types of entrepreneurs. The figure also shows the U-shaped relationship between risk attitudes and the hazard rates. Using the estimated hazard model based on the same specification, we further calculate the cumulative exit probabilities over several years according to the cumulative exit function of equation (14) (see Figure 4), again evaluated at the mean values of the variables. The high exit rate of young entrepreneurs is reflected in the steep growth of the cumulative exit probability during the initial years of self-employment. Figure 4 shows that the relationship between risk attitudes and the cumulative exit rates remains consistently U-shaped, regardless of the self-employment duration. Entrepreneurs who are willing to take medium-level risks have lower cumulative exit probabilities than their counterparts with low or high risk attitudes.

INSERT FIGURES 3 AND 4 ABOUT HERE

Putting together the test results of our different estimations in columns (1)-(6), we can derive a straightforward conclusion with respect to our main hypothesis: There is an inverse U-shaped relationship between risk attitudes and the survival rates of entrepreneurs.

**Sensitivity Analysis:** We tested the sensitivity of our results with respect to various dimensions. Table A.4 and Table A.5 present the coefficients of different measures of risk attitudes based on additional specifications. Table A.4 refers to dummy variable representations of the risk attitudes and additionally shows marginal effects, while Table A.5 refers to quadratic specifications and additionally includes standard errors.<sup>22</sup> The tables reveal that using different risk measures (i.e. the willingness to take general risks or risks on financial matters instead of occupational matters) do

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<sup>22</sup>Detailed estimation results are available on request by the authors.

not change the result of a U-shaped relationship between the risk attitude and the conditional exit probability, no matter whether dummy variables or quadratic specifications of risk attitudes are used. A different classification of the three categories for low-, medium-, and high-level risk attitudes (e.g. by changing the categories from 0-2, 3-7, 8-10, to 0-3, 4-6, 7-10) does not make a significant difference either (Table A.4). To assess whether early retirement decisions influence the results, we repeat the estimations of columns (2) and (5) on a sample restricted to people up to 55 years, and again we find the U-shape. Moreover, in a competing risk model where we distinguish between self-employment exits to dependent employment and to unemployment, the U-shaped relationship is observed for exits to dependent employment (349 transitions), whereas we do not observe a significant influence for the smaller number of transitions into unemployment (220 transitions).

Another sensitivity check consists of a variation of the functional form for the baseline hazard, which captures the duration dependence. Instead of the polynomial function of the third degree, we specify the baseline hazard as a piecewise constant function of duration in self-employment. We define 6 intervals (up to 1 year duration of self-employment, 2-3, 4-6, 7-10, 11-15, and more than 15 years). We choose shorter intervals for the first years in self-employment and larger intervals for longer durations because the yearly exit probability is expected to change (decline) rapidly during the initial years of self-employment and then smoother in later years. Again, the estimated relationship between risk attitudes in occupation and the conditional exit probability turns out to be robust both for the dummy variable and for the quadratic specifications of risk attitudes. In all sensitivity tests, the standard errors reported in Table A.5 show that the point estimates for the coefficients of the linear and square terms are not significantly different from the point estimates in the estimation in column (5). Lastly, the relationship remains stable in a single-risk model allowing for unobserved heterogeneity, where we specify an individual effect with an arbitrary discrete probability distribution with two mass points.

While we argue that risk preferences are stable over time (at least for the short time interval we use), one concern might be that most observed exits from self-employment occur before the risk questions were posed in the 2004 wave and that our results might possibly be an artifact of reverse causality. To check this, we use

repeated information on general risk attitudes—which were asked once again in the 2006 wave of the SOEP—and directly estimate the effect of exiting self-employment on (the change in) risk attitudes after the exit (see Jaeger, Dohmen, Falk, Huffman, and Sunde, 2010, for a similar test of risk stability in the context of migration). To be more specific we estimate the influence of exiting self-employment between 2004 and 2006 on the change in willingness to take risk between 2004 and 2006. We find that the fact of leaving self-employment in this period does not significantly affect the observed change in risk attitudes. Given the strength of this evidence we therefore conclude that risk attitudes are a determinant of exiting self-employment and not vice versa.

## 6 Conclusions

In this study, we empirically analyze whether the risk attitudes of active entrepreneurs have an impact on their survival probability. For this analysis, we employ an experimentally-validated questionnaire that was part of the 2004 wave of the German Socio-Economic Panel (SOEP). Respondents were asked in two different ways about their willingness to take risks, revealing their subjective risk attitudes in occupational choices and their objectively measurable risk preferences. As we know from prior research, it is important to control for both kinds of risk measures. Moreover, the same survey indicates the occupational choices of all persons who answered the risk-related questions.

The aim of this paper is to determine whether risk attitudes have an influence on entrepreneurial survival. So far, only their impact on business creation has been analyzed. For this reason, we adopt an approach from psychological research, which hypothesizes that we should expect an inverse U-shaped relationship between risk attitudes and survival rates, with low (high) risk attitudes characterizing more (less) risk-averse persons. Our results confirm this hypothesis: Persons with particularly low or particularly high risk attitudes survive as entrepreneurs less often than do persons with a medium-level risk attitude. This result notably holds for all kinds of risk measures. It relativizes the approach of Kihlstrom and Laffont (1979) who argue that there should be a cut-off value with more risk averse persons being in

employed positions and less risk averse persons being entrepreneurs. We show that there is no such relationship when it comes to entrepreneurial survival.

Our analysis further reveals that the economic impact of this variable is fairly strong. Specifically, the exit rates of medium-level risk takers drop by about 40% compared to those not willing to take any risk, whereas entrepreneurs with high risk attitudes are not significantly different from those with low risk attitudes. We conclude that risk attitudes *ceteris paribus* are a defining characteristic of entrepreneurship. Whereas previous research suggests that these attitudes have a significant impact on the decision to become an entrepreneur, we extend existing knowledge by showing that attitudes have a similarly strong impact on the survival rates of already active entrepreneurs. Furthermore, while the correlations between risk attitudes and business creation are consistently positive, we show that the relationship between risk attitudes and entrepreneurial survival is inversely U-shaped.



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## Tables and Figures

Table 1: Mean Characteristics of Self-Employed/Exits from Self-Employment and t-Test of Equal Means

	Remaining in Self-Employment	Exiting from Self-Employment	p-value
Female	0.334	0.533	0.000
Highschool Degree	0.425	0.378	0.032
Apprenticeship	0.353	0.404	0.017
Higher Technical College	0.299	0.262	0.064
University	0.371	0.279	0.000
Age (in years)	45.88	43.50	0.000
Lifetime Work Experience (in decades)	2.072	1.661	0.000
Lifetime Unemployment Experience (in decades)	0.038	0.074	0.000
Disability	0.035	0.037	0.824
German Nationality	0.954	0.930	0.012
Father Self-Employed	0.172	0.109	0.000
Capital Income (in 1,000 Euros)	6.324	4.198	0.119
With Children	0.715	0.831	0.008
Married	0.688	0.694	0.771
Divorced	0.106	0.090	0.230
<b>Risk Measures</b>			
Occ. Risk Low (0-2)	0.175	0.213	0.029
Occ. Risk Medium (3-7)	0.635	0.605	0.156
Occ. Risk High (8-10)	0.190	0.183	0.694
Lottery 0€	0.575	0.542	0.131
Lottery 20k€	0.160	0.211	0.002
Lottery 40k€	0.152	0.165	0.416
Lottery 60k€	0.075	0.048	0.016
Lottery 80k€	0.020	0.011	0.116
Lottery 100k€	0.017	0.023	0.270
Person-Year-Observations	4,731	569	

*Source:* SOEP 2000-2005, own calculations.

*Note:* The numbers indicate the fractions in the sample for which the variable is true (unless stated otherwise). *p*-values refer to t-tests of mean equality in the variables between both groups. See Tables A.1 and A.2 for a detailed description of the variables.

Table 2: Exit Probability from Self-Employment: Logit Estimation Results - Marginal Effects<sup>(a)</sup>

	Spec. 1	Spec. 2	Spec. 3
Occupational Risk 0 (Reference)			
Risk 1	-0.039 (0.024)		
Risk 2	-0.048** (0.021)		
Risk 3	-0.031 (0.021)		
Risk 4	-0.033 (0.022)		
Risk 5	-0.053** (0.018)		
Risk 6	-0.054** (0.019)		
Risk 7	-0.041** (0.019)		
Risk 8	-0.052** (0.020)		
Risk 9	-0.013 (0.027)		
Risk 10	-0.031 (0.028)		
Occ. Risk Low (0-2, Reference)			
Occ. Risk Medium (3-7)		-0.017* (0.010)	
Occ. Risk High (8-10)		-0.012 (0.013)	
Lottery 0€ (Reference)			
Lottery 20k€			0.019* (0.010)
Lottery 40k€			0.005 (0.010)
Lottery 60k€			-0.016 (0.013)
Lottery 80k€			-0.017 (0.025)
Lottery 100k€			0.078* (0.041)
Control Variables <sup>(b)</sup>	Yes	Yes	Yes
PY-Observations	5,300	5,300	5,354
Pseudo- $R^2$	0.103	0.1	0.1
Log Likelihood	-1620.695	-1626.385	-1654.817

Source: SOEP 2000-2005, own calculations.

Notes: \*\*\*/\*\*/\* indicates significance at the 1%/5%/10% levels, standard errors are in parentheses.

<sup>(a)</sup> The marginal effect of one of the discrete risk categories is the difference in the predicted yearly exit probability for a discrete change of this category's dummy variable from 0 to 1, where the other risk category dummies are set to 0 and the remaining explanatory variables to their mean values. Thus, the marginal effect always indicates the difference in the exit probability between a certain risk category and the base category, which corresponds to the lowest risk attitude.

<sup>(b)</sup> See Table A.3 for a full list of included explanatory variables.

Table 3: Exit Probability from Self-Employment: Logit Estimation Results for Linear and Quadratic Specifications - Coefficients

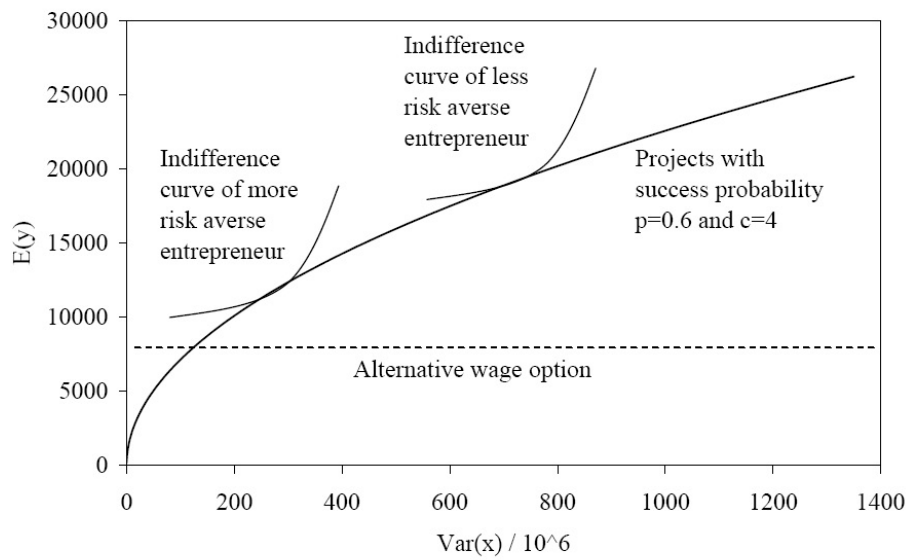
	Duration Models		Heckit
	(4)	(5)	(6)
Occ. Risk. Linear	-.029 (0.018)	-.177** (0.058)	-0.076** (0.034)
Occ. Risk. Squared		.016** (0.006)	0.012*** (0.003)
Control Variables <sup>(a)</sup>	Yes	Yes	Yes
PY-Observations	5,300	5,300	55,856
(Pseudo-)R <sup>2</sup>	0.099	0.101	0.084
Log Likelihood	-1627.758	-1624.224	-16144.893

*Source:* SOEP 2000-2005, own calculations.

*Notes:* \*\*\*/\*\*/\* indicates significance at the 1%/5%/10% levels, standard errors are in parentheses.

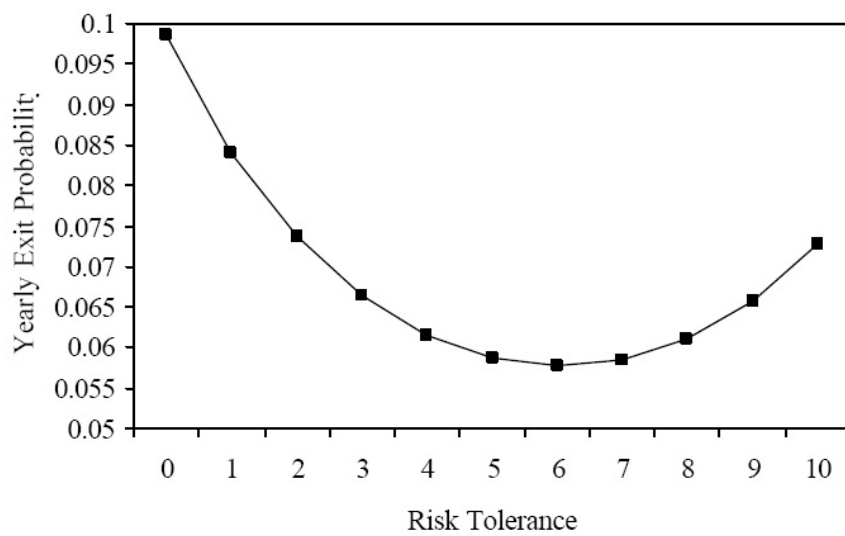
<sup>(a)</sup> See Table A.3 for a full list of included explanatory variables.

Figure 1: Utility Maximizing Choices of Risk-averse Entrepreneurs (Example)



*Note:* The curved line shows the relationship between means and variances of the returns to projects with success probability  $p = 0.6$  and a fixed costs parameter of  $c = 4$  (see text). Indifference curves of two entrepreneurs with different degrees of risk aversion are tangent to this line and illustrate that less risk averse entrepreneurs will choose larger projects with higher mean and variance of the returns.

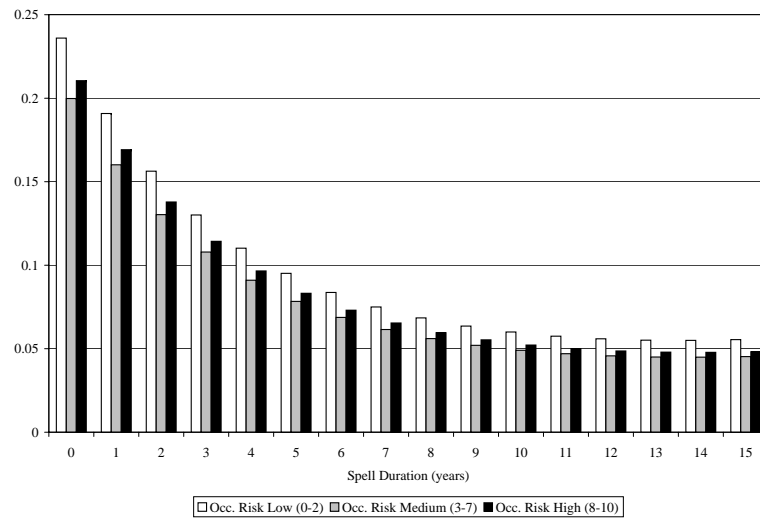
Figure 2: Estimated Relationship Between Risk Tolerance in Occupation and Yearly Exit Probability for an Entrepreneur with Average Characteristics (Quadratic Specification)



*Note:* The figure shows the predicted yearly probability of exit from self-employment as a function of the risk attitude for a self-employed person with otherwise average characteristics. The estimations are based on the quadratic specification in column (5) of Table A.3.

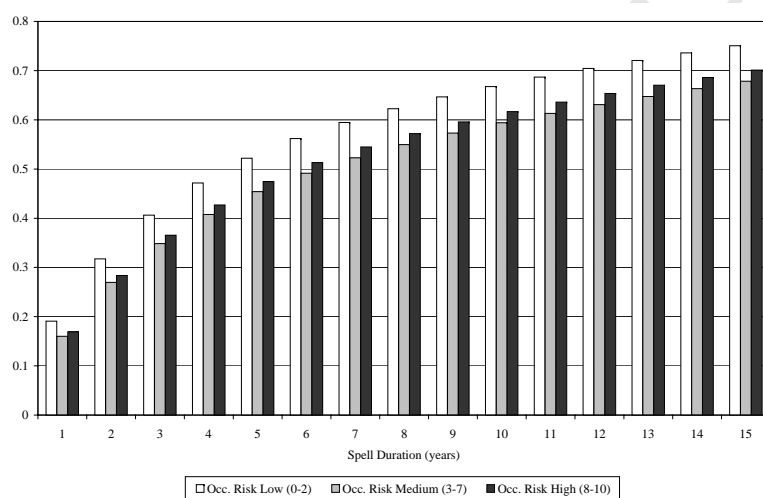


Figure 3: Conditional Hazard Rate of Exit for Entrepreneurs with Different Risk Attitudes



*Notes:* The figure shows the predicted yearly hazard rates of exit out of self-employment conditional on different durations of self-employment for entrepreneurs with different risk attitudes (based on the estimation in column (2) of Table A.3), evaluated at the mean values of the remaining explanatory variables.

Figure 4: Cumulative Exit Probabilities for Entrepreneurs with Different Risk Attitudes



*Notes:* The figure shows how the cumulative probability of exit increases over the duration of self-employment for entrepreneurs with different risk attitudes (based on the estimation in column (2) of Table A.3), evaluated at the mean values of the remaining explanatory variables.

## A Additional Tables

Table A.1: Detailed Description of the Risk Measures

Variable Label	Description
<b>Hypothetical risky investment after winning 100 thousand Euros in the lottery<sup>(a)</sup></b>	
Lottery 0€	Dummy for individuals who would invest nothing. Omitted category.
Lottery 20k€	Dummy for individuals who would invest 20 thousand Euros.
Lottery 40k€	Dummy for individuals who would invest 40 thousand Euros.
Lottery 60k€	Dummy for individuals who would invest 60 thousand Euros.
Lottery 80k€	Dummy for individuals who would invest 80 thousand Euros.
Lottery 100k€	Dummy for individuals who would invest 100 thousand Euros.
<b>Willingness to take risks in occupation<sup>(b)</sup></b>	
Occ. Risk Low (0-2)	Dummy for individuals who indicated 0-2 on 11-point scale, omitted category.
Occ. Risk Medium (3-7)	Dummy for individuals who indicated 3-7 on 11-point scale.
Occ. Risk High (8-10)	Dummy for individuals who indicated 8-10 on 11-point scale.

<sup>(a)</sup> The original SOEP question for the hypothetical investment is: *Please consider what you would do in the following situation:*

*Imagine that you had won 100,000 Euros in the lottery. Almost immediately after you collect the winnings, you receive the following financial offer from a reputable bank, the conditions of which are as follows: There is the chance to double the money within two years. It is equally possible that you could lose half of the amount invested. You have the opportunity to invest the full amount, part of the amount or reject the offer.*

*What share of your lottery winnings would you be prepared to invest in this financially risky, yet lucrative investment? 100.000 Euros, 80.000 Euros, 60.000 Euros, 40.000 Euros, 20.000 Euros, Nothing, I would decline the offer.”*

<sup>(b)</sup> The original SOEP questions for the risk attitude in occupation is: *People can behave differently in different situations. How would you rate your willingness to take risks in the following areas? Please tick a box on the scale, where the value 0 means: ‘risk averse’ and the value 10 means: ‘fully prepared to take risks’.*

*How is it in your occupation?*

Table A.2: Detailed Description of the Variables

Variable Label	Description
female	Dummy for females
east	Dummy for individuals who live in East-Germany
highschool	Dummy for individuals who finished higher secondary school with the terminal degree of a university entrance qualification (“Fachhochschulreife” or “Abitur”)
apprenticeship	Dummy for individuals who finished an apprenticeship with a terminal degree (“Lehre”)
highertechncol	Dummy for individuals who finished a higher technical college, a health care school, or civil service training with a terminal degree
university	Dummy for individuals who graduated from a university with a terminal university degree
age	Age of individual
agesqr	Age squared
workexp10 <sup>(a)</sup>	Years of work experience, divided by 10.
unemexp10 <sup>(a)</sup>	Years of unemployment experience before having entered self-employment, divided by 10.
disabled	Dummy for handicapped / physically challenged individuals
german	Dummy for German nationality
nchild	Number of children under 17 in the household
married	Dummy for married and not separated individuals. Omitted category for marital status is “single”/“widowed”
separated	Dummy for married, but separated individuals
divorced	Dummy for divorced individuals
fatherse	Dummy for individuals whose father was self-employed when the respondents were 15 years old
capitalinc	Income from interests, dividends and renting out in $t - 1$ (reported retrospectively in $t$ ) in 1000 Euros
duration <sup>(a)</sup>	Tenure of the current self-employment spell in years. For left-censored spells, the duration since the last job change is used, which may be shorter than the overall self-employment spell if somebody switched jobs within self-employment before having entered the panel.
duration-sq	duration <sup>2</sup>
duration-cu	duration <sup>3</sup>

<sup>(a)</sup> Uses information from the lifetime employment history in the SOEP.

*Notes:* Dummy variables equal 1 if condition holds and 0 otherwise.

Table A.3: Exit Probability from Self-Employment: Estimation Results - Coefficients

Variables	Baseline without	Risk Measures as Dummy			Risk Measure as Continuous		
	Risk Measure	Variables in columns (1)-(3)			Variable in columns (4)-(6)		
	(0)	(1)	(2)	(3)	(4)	(5)	(6)
female	0.544***	0.53***	0.535***	0.553***	0.524***	0.530***	0.122
highschool	-0.075	-0.057	-0.07	-0.078	-0.063	-0.059	0.070
apprenticeship	0.188	0.175	0.184	0.2	0.191	0.186	0.003
highertechncol	-0.076	-0.072	-0.078	-0.052	-0.071	-0.072	-0.015
university	-0.334**	-.341**	-.332**	-.276**	-0.329**	-0.333**	-0.134*
age	-0.082**	-.082**	-.082**	-.094**	-0.082**	-0.082**	-0.008
agesq	0.001**	0.001***	0.001***	0.001***	0.001**	0.001**	0.000
workexp10	-0.440***	-.438***	-.439***	-.429***	-0.436***	-0.435***	-0.191***
unemexp10	1.204***	1.250***	1.232***	1.260***	1.218***	1.246***	0.446
disabled	-0.022	-0.077	-0.033	-0.029	-0.026	-0.06	-0.168
german	-0.234	-0.226	-0.233	-0.173	-0.249	-0.216	-0.144
fatherse	-0.327**	-.324**	-.326**	-.312**	-0.331**	-0.316**	0.037
capitalinc	-0.001	-0.0007	-0.0006	-0.0005	-0.001	-0.001	0.001
nchild	0.028	0.033	0.023	0.019	0.027	0.023	0.040
married	0.325**	0.344**	0.336**	0.355**	0.319**	0.349**	0.132
separated	0.540*	0.564*	0.548*	0.527*	0.545*	0.550*	0.382**
divorced	0.212	0.248	0.235	0.222	0.226	0.25	0.148
d2001	-0.374**	-.366**	-.369**	-.414**	-0.368**	-0.365**	-0.183**
d2002	-0.210	-0.193	-0.202	-0.248	-0.203	-0.194	-0.103
d2003	-0.290*	-.269*	-.283*	-.287*	-0.280*	-0.272*	-0.097
d2004	-0.239	-0.225	-0.232	-.287*	-0.226	-0.226	-0.058
d2005	-0.401**	-.386**	-.395**	-.433***	-0.389**	-0.389**	-0.147*
constant	0.742	1.199	0.912	0.912	0.93	1.119	-1.505*
Duration Dependence							
duration	-0.286***	-.284***	-.284***	-.288***	-0.285***	-0.283***	-0.127***
duration-sq	0.015***	0.015***	0.015***	0.015***	0.015***	0.015***	0.007***
duration-cu	-0.000***	-0.002***	-0.002***	-0.002***	-0.000***	-0.000***	-0.000**
Occupational Risk 0 (Reference)							
Risk 1		-.412					
Risk 2		-.544**					
Risk 3		-.322					
Risk 4		-.344					
Risk 5		-.612***					
Risk 6		-.626***					
Risk 7		-.448**					
Risk 8		-.594***					
Risk 9		-.128					
Risk 10		-.323					
Occ. Risk Low (0-2, Reference)							
Occ. Risk Medium (3-7)				-.213*			
Occ. Risk High (8-10)				-.147			
Lottery 0€ (Reference)							
Lottery 20k€				0.231*			
Lottery 40k€				0.062			
Lottery 60k€				-.232			
Lottery 80k€				-.249			
Lottery 100k€				0.76**			
Occ. Risk Linear					-0.029	-0.177**	-0.076**
Occ. Risk Squared						0.016**	0.012***
PY-Observations	5300	5300	5300	5354	5300	5300	55856
(Pseudo-)R <sup>2</sup>	0.099	0.103	0.099	0.1	0.099	0.101	
Log Likelihood	-1628.982	-1620.695	-1627.463	-1654.817	-1627.758	-1624.224	-16144.893

Source: SOEP 2000-2005, own calculations.

Notes: \*\*\*/\*\*/\* indicates significance at the 1%/5%/10% levels. In columns (0)-(5) we estimate duration models (logit) without sample selection; in column (6) we estimate a probit model with sample selection. The estimation results for the selection equation are available from the authors upon request.

Table A.4: Summary of the Sensitivity Analysis - Coefficients and Marginal Effects<sup>(a)</sup>

	Coefficient	Marg. Effect
(1) Exit Probability from Self-Employment - Different Risk Measures		
Financial Risk Low (0-2, Reference)		
Fin. Risk Medium (3-7)	-.172*	-.013*
Fin. Risk High (8-10)	.209	.019
General Risk Low (0-2, Reference)		
Gen. Risk Medium (3-7)	-.316**	-.027**
Gen. Risk High (8-10)	-.270	-.024
(2) Exit Probability from Self-Employment - Different Occ. Risk Categories		
Occupational Risk Low (0-2, Reference)		
Occ. Risk Medium (3-7)	-.213*	-.017*
Occ. Risk High (8-10)	-.147	-.012
Occupational Risk Low (0-3, Reference)		
Occ. Risk Medium (4-6)	-.265**	-.021**
Occ. Risk High (7-10)	-.143	-.012
(3) Exit Probability from Self-Employment - Aged Below 56 Years		
Occupational Risk Low (0-2, Reference)		
Occ. Risk Medium (3-7)	-.295**	-.026**
Occ. Risk High (8-10)	-.255	-.023
(4) Competing Risk Specification		
(4a) Exit Probability to Dependent Employment		
Occupational Risk Low (0-2, Reference)		
Occ. Risk Medium (3-7)	-.312**	-.017**
Occ. Risk High (8-10)	-.154	-.009
(4b) Exit Probability to Unemployment		
Occupational Risk Low (0-2, Reference)		
Occ. Risk Medium (3-7)	-.040	-.001
Occ. Risk High (8-10)	-.135	-.003
(5) Exit Probability from Self-Employment		
Different Specification of Survival Function (Piecewise-constant)		
Occupational Risk Low (0-2, Reference)		
Occ. Risk Medium (3-7)	-.207*	-.016*
Occ. Risk High (8-10)	-.142	-.011
Control Variables <sup>(b)</sup>	Yes	Yes

Source: SOEP 2000-2005, own calculations.

Notes: \*\*\*/\*\*/\* indicates significance at the 1%/5%/10% levels.

<sup>(a)</sup> The marginal effect of one of the discrete risk categories is the difference in the predicted yearly exit probability for a discrete change of this category's dummy variable from 0 to 1, where the other risk category dummies are set to 0 and the remaining explanatory variables to their mean values. Thus, the marginal effect always indicates the difference in the exit probability between a certain risk category and the base category, which corresponds to the lowest risk attitude.

<sup>(b)</sup> See Table A.3 for a full list of included explanatory variables.

Table A.5: Summary of the Sensitivity Analysis - Coefficients for the Quadratic Specifications

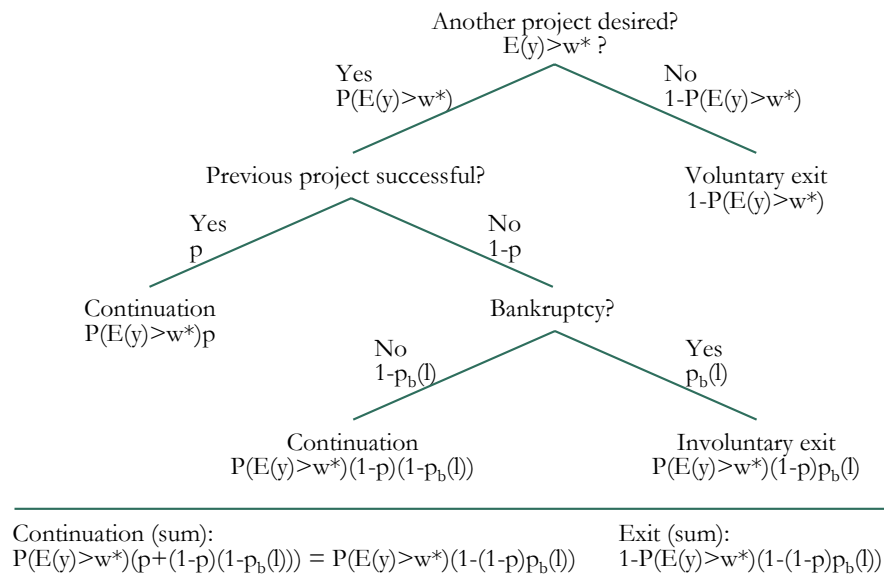
	Coefficient	Standard Error
(1) Exit Probability from Self-Employment - Different Risk Measures		
(1a) Financial Risk		
Linear	-0.147**	(0.059)
Squared	0.018**	(0.008)
(1b) General Risk		
Linear	-0.152**	(0.076)
Squared	0.014**	(0.007)
(3) Exit Probability from Self-Employment - Aged Below 56 Years		
Occ. Risk Linear	-0.191**	(0.065)
Occ. Risk Squared	0.016**	(0.007)
(4) Competing Risk Specification		
(4a) Exit Probability to Dependent Employment		
Occ. Risk Linear	-0.215**	(0.071)
Occ. Risk Squared	0.020**	(0.007)
(4b) Exit Probability to Unemployment		
Occ. Risk Linear	-0.121	(0.089)
Occ. Risk Squared	0.011	(0.009)
(5) Exit Probability from Self-Employment		
Different Specification of Survival Function (Piecewise-constant)		
Occupational Risk Low (0-2, Reference)		
Occ. Risk Linear	-.177***	(0.058)
Occ. Risk Squared	.016***	(0.006)
Control Variables <sup>(a)</sup>	Yes	Yes

Source: SOEP 2000-2005, own calculations.

Notes: \*\*\*/\*\*/\* indicates significance at the 1%/5%/10% levels.

<sup>(a)</sup> See Table A.3 for a full list of included explanatory variables.

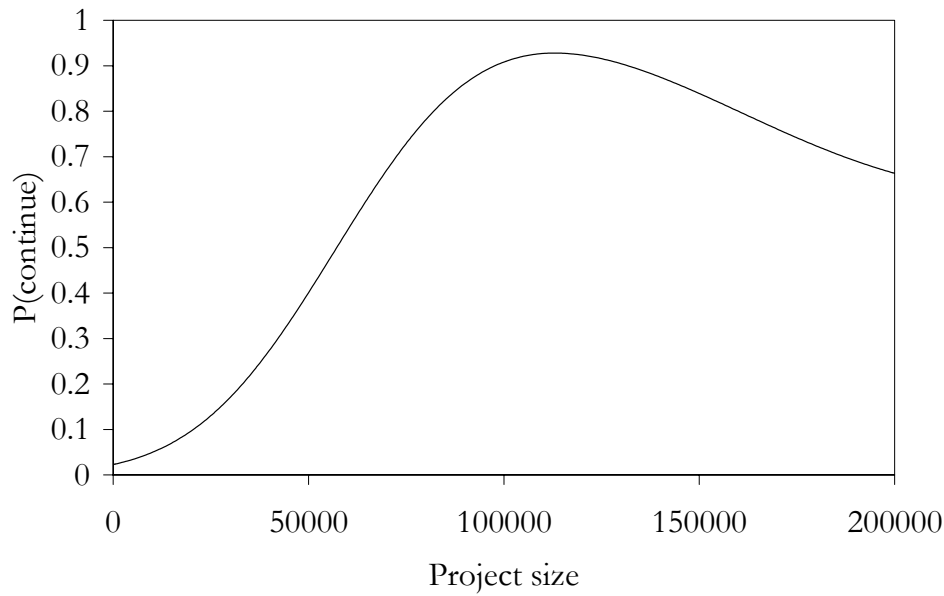
Figure A.1: Decision Tree



*Note:* After the completion of a project, an entrepreneur decides whether to start another project, i.e. to continue as an entrepreneur, or to exit entrepreneurship. The decision tree shows how this decision is taken in our model setup. At the branches of the tree and at the endpoints, the probabilities defined in the model are given. Below the tree, the overall probabilities of continuing and exiting are derived.



Figure A.2: Probability of Continuing as an Entrepreneur as a Function of the Project Size



*Note:* As an example for our model of the probability of continuing as an entrepreneur, we specify the wage offer  $w$  to be normally distributed with mean 20,000 and a standard deviation of 10,000. The probability of bankruptcy  $p_b(l)$  is specified as the cumulative distribution function of a normal distribution with mean 40,000 and a standard deviation of 10,000. We keep  $p = 0.6$  and  $c = 4$ , as in Figure 1. This Figure A.2 depicts the probability of continuing as an entrepreneur as a function of the project size  $y_s$  which is inversely U-shaped. First, when projects become larger, the probability of going on as an entrepreneur increases because the expected returns from the entrepreneurial project will exceed the wage offer with increasing probability while the case of bankruptcy does not yet play a significant role for this project size. After a turning point, the probability of continuing as an entrepreneur decreases. When projects become still larger, the increasing bankruptcy hazard kicks in. As the project size is a monotonically increasing function of the risk attitudes, as derived before, the probability of continuing as an entrepreneur is also an inversely U-shaped function of his/her risk attitudes.