Risk Aversion or Risk Management?: How Measures of Risk Aversion Affect Firm Entry and Firm Survival

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Abstract

The link between measured risk aversion and the decision to become an entrepreneur is well established, but the link between risk aversion and entrepreneurial success is not. Standard theoretical models of occupational choice under uncertainty imply a positive correlation between an individual's degree of risk aversion and the expected return from an entrepreneurial venture at the time of entry. Because the expected return is the risk neutral equivalent value, a higher expected return implies a higher survival probability, and so more risk averse entrepreneurs should survive more frequently than their less risk averse counterparts. We test that prediction using successive entry cohorts of young entrepreneurs in the National Longitudinal Survey of Youth 1979 (NLSY79). The empirical results soundly reject the prediction: the most successful entrepreneurs are the least risk averse. This surprising finding calls into question the interpretation of common measures of risk aversion as measures of taste for risk. Instead, measured risk attitudes perform as if they are indicators of entrepreneurial ability– the least risk averse are apparently those who can best assess and manage risks. Indeed, our interpretation is consistent with the work of recent experimental studies that find that the less risk averse have higher cognitive ability.

Key words: entrepreneurship, firm survival, risk aversion, human capital, hazard rate
JEL Classifications: L24, J24, M1, D81

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1. Introduction

Numerous studies have shown that measured risk aversion affects occupational and human capital investment decisions. Less risk averse individuals are more likely to pick private sector jobs (Pfeifer, 2008). Less risk averse individuals are also more likely to become entrepreneurs (Van Praag and Cramer, 2001; Hartog et al., 2002; Cramer et al., 2002; Ekelund et al., 2005; Kan and Tsai, 2006; Ahn, 2009). Similarly, less risk averse individuals are more likely to enter occupations and educational investments characterized by higher earnings variances (Orazem and Mattila, 1991; Shaw, 1996; Bonin et al., 2007; Isphording, 2010).

A missing element in these empirical analyses of the effects of risk aversion on occupational or educational decisions is whether those risk aversion also affect the outcomes of those decisions.[1] For example, if risk attitudes affect the decision to become an entrepreneur, they should also affect the riskiness of the venture conditional on becoming an entrepreneur. More risk averse entrepreneurs should select safer ventures while less risk averse entrepreneurs should opt for riskier firms. As a consequence, holding constant observable skills, more risk averse entrepreneurs should survive more frequently than their less risk averse counterparts. This paper shows that in theory, there is a positive correlation between an individual's degree of risk aversion and the expected return from an entrepreneurial venture at the time of entry. Because the expected return is the risk neutral equivalent value, higher expected return implies a higher survival probability. From that proposition, we posit a hypothesis that more risk averse entrepreneurs have higher survival probability than their less risk averse counterparts. We test the hypothesis using successive entry cohorts of young entrepreneurs in the National Longitudinal Survey of Youth 1979 (NLSY 79). We

[1] Exceptions include Rauch and Frese (2007) and Caliendo et al. (2010) which will be discussed below.

show that the prediction is soundly rejected: the most successful entrepreneurs are the least risk averse.

This surprising finding calls into question the interpretation of common measures of risk aversion such as those used in the NLSY as measures of taste for risk. Instead, these measures perform as if they are indicators of entrepreneurial skill – the least risk averse are apparently those who can best assess and manage risks. Indeed, this interpretation is consistent with recent experimental evidence presented by Frederick (2005), Benjamin et al. (2006), Burks et al. (2009) and Dohmen et al. (2010) who find that the least risk averse have superior cognitive ability measured by IQ. This suggests an alternative interpretation: agents with the lowest measured risk aversion may have unusually high endowments of unmeasured ability, and it is this human capital advantage that leads them to become entrepreneurs, private sector employees, and entrants into occupations and education choices with greater earnings variance.

The next section derives the theorized positive relationship between risk aversion and probability of business success conditional on entrepreneurial entry. Section 3 presents an empirical methodology that will test the role of measured risk aversion on entrepreneurial survival by entry cohort. Section 4 reviews the sample selection process and the measure of risk aversion. Empirical results that solidly reject the hypothesized relationship between measured risk aversion and entrepreneurial success are presented in section 5.

2.1 Theoretical motivation

Pratt (1964) defined a risk premium as the difference between the expected return and the certainty equivalent return. The higher required risk premia make it less likely that more risk averse agents will choose to become entrepreneurs. However, the more risk averse individuals who nevertheless enter self-employment should invest in ventures with greater expected return and less risk compared to entrepreneurs who are less risk averse. This section demonstrates that these predictions follow from a standard theoretical model of occupational choice under uncertainty.

2.2 Theory

Agents engage in choosing one of several alternative occupations. The individual's utility depends on the monetary and hedonic returns to occupational entry, $U(y_j, \alpha_j)$, where y_j is the present value of earnings and α_j is a positive or negative hedonic return from an occupation j. The utility function is concave and strictly increasing in earnings so that it can reflect an individual's risk aversion. Assuming additive separability, the utility can be described as

$$U_j = u(y_j) + \alpha_j \tag{1}$$

where u is an increasing and strictly concave function in y_j, $u' > 0$ and $u'' < 0$.

For simplicity, suppose that there are two occupations, entrepreneurship (e) and wage work (w). We assume that the present value of income from wage work is known but that the return from entrepreneurship is uncertain.[2] However, the distribution of entrepreneurial earnings is assumed to have known mean and variance. We also assume that the hedonic return from all occupations is known with certainty.[3]

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[2] The theory is for a point in time occupational decision subject to expected earnings in the occupation at that time. We do not consider occupational reswitching, although any planned reswitching could be incorporated into the expected earnings stream at that point in time.

[3] We get similar implications if the returns to wage work are uncertain but have lower variance than returns to entrepreneurship, but the derivation is more complicated. Our derivation is consistent with

The expected utility of choosing entrepreneurship can be approximated by the second order Taylor series expansion of (1) around mean of earnings, μ_e:

$$EU_e = u(\mu_e) + u'(\mu_e)E(y_e - \mu_e) + \frac{1}{2}u''(\mu_e)E((y_e - \mu_e)^2) + \alpha_e$$

$$= u(\mu_e) + \frac{1}{2}u''(\mu_e)\sigma_e^2 + \alpha_e \qquad (2)$$

where $\mu_e = E(y_e)$ and $\sigma_e^2 = Var(y_e)$.

An individual will enter the risky occupation *e* if his expected utility in the risky job (*e*) is greater than that in the safe job (*w*): $EU_e > EU_w$. The agent is indifferent between the two alternatives when $EU_e = EU_w$,[4]

or

$$u(\mu_e) + \frac{1}{2}u''(\mu_e)\sigma_e^2 + \alpha_e = u(y_w) + \alpha_w \qquad (3)$$

Dividing both sides of (3) by $-u'(\mu_e)$ and rearranging yields

$$\frac{1}{2}\gamma\sigma_e^2 = \frac{u(\mu_e) - u(y_w) + \alpha_e - \alpha_w}{u'(\mu_e)} > 0 \qquad (4)$$

where $\gamma = -\frac{u''(\mu_e)}{u'(\mu_e)} > 0$ is the Arrow-Pratt coefficient of absolute risk aversion (ARA).[5] [6]

We need to establish how an increase in risk aversion affects the required return

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using the variance in wage work as a baseline variation. Hamilton (2000) found that the standard deviation of earnings from self-employment 2-4 times larger than the standard deviation of earnings from wage work. In the NLSY, the coefficient of variation of log hourly earnings from self-employment is 67% to 89% larger for self-employment than wage work.

[4] Recall that we have imposed $\sigma_w^2 = 0$ and $\mu_w = y_w$.

[5] Alternatively, we could assume relative risk aversion, which generates the same result as ARA does. See Appendix1 for the derivation.

[6] Notice that as the known hedonic return from entrepreneurship increases relative to the hedonic return from wage work, the required gap in expected income, $u(\mu_e) - u(y_w)$ necessary to leave the individual indifferent between *e* and *w* gets smaller. This is consistent with Hamilton's (2000) conclusion that entrepreneurs accept lower pay in order to have their own businesses.

in the risky job in order to keep an individual indifferent between *e* and *w* for any given risk, σ_e. The answer depends on the expected return from *e* at the time individuals are choosing an occupation. Taking the partial derivative of μ_e with respect to γ in (4) yields

$$\frac{\partial \mu_e}{\partial \gamma} = \frac{\frac{1}{2}\sigma_e^2 [u'(\mu_e)]^2}{[u'(\mu_e)]^2 - u''(\mu_e)[u(\mu_e) - u(y_w) + \alpha_e - \alpha_w]}$$

$$= \frac{\frac{1}{2}\sigma_e^2 u'(\mu_e)}{u'(\mu_e) - u''(\mu_e)\frac{[u(\mu_e) - u(y_w) + \alpha_e - \alpha_w]}{u'(\mu_e)}}$$

$$= \frac{\frac{1}{2}\sigma_e^2 u'(\mu_e)}{u'(\mu_e) + \gamma[u(\mu_e) - u(y_w) + \alpha_e - \alpha_w]} > 0 \qquad (5)$$

$\frac{\partial \mu_e}{\partial \gamma} > 0$ because $u' > 0$ due to the concavity of *u*, $\gamma > 0$, and $u(\mu_e) - u(y_w) + \alpha_e - \alpha_w > 0$ from equation (4). The positive sign indicates that as an individual becomes more risk averse, he requires a higher expected return from *e* to be as well off in the risky occupation *e* as in the safe occupation *w*.

If risk aversion affects the required expected return from entrepreneurship at the time of entry, it should also affect the probability of entrepreneurial survival. The expected return is the risk neutral equivalent present value of entering entrepreneurship, and so requiring an even higher expected return implies a higher survival probability.

To formalize this proposition, let $T_i \geq 0$ denote the duration of the firm's existence so that if an entrepreneur *i* exits a business t_i years after start-up, $T_i = t_i$. T_i has a cumulative distribution function, $F(t_i) = \Pr(T_i \leq t_i)$, which is the probability of firm failure by time t_i. The associated probability density function is $f(t_i)$.

An entrepreneur decides to shut down his business if the realized present value of the monetary and hedonic returns from operating the business exceeds the operating cost of time which equals the present value of the stream of pecuniary and hedonic returns from wage work at t_i. The realized return is decomposed into expected return and unexpected return:

$$\pi^R_{i,e,t} + \alpha_e < y_{w,t}(x_i) + \alpha_w \tag{6}$$

$$\pi^R_{i,e,t} = \mu_e(\gamma_i) + \xi_{i,e,t} \tag{7}$$

where $\pi^R_{i,e,t}$ denotes *i*'s realized present value of returns from the entrepreneurial venture at time *t*. We decompose the realized return to entrepreneurship into two parts: μ_e: the return expected at the time of start-up which is a function of *i's* degree of risk aversion; and $\xi_{i,e,t}$: a random negative or positive shock to the expected stream of returns to entrepreneurship that is realized as of time *t*. The shock $\xi_{i,e,t}$ is drawn from the distribution $g(\xi_{i,e,t})$.

The i^{th} entrepreneur will survive in business unless they receive a sufficiently bad draw on $\xi_{i,e,t}$ that the expected present value of pecuniary and hedonic returns to the venture fall below the entrepreneur's opportunity costs of time. In (6), the opportunity costs are represented from the present value of pecuniary and nonpecuniary returns from wage work. That would include $y_{w,t}(x_i)$ which is the present value of anticipated wages which are based on *i*'s human capital and socioeconomic background designated by the vector x_i; plus the hedonic return from wage work, α_w.

The cumulative distribution function of T_i can be specified by the probability of failure at time t_i:

$$F(t_i) = \Pr(T_i \le t_i)$$

$$= \Pr(\pi^R_{i,e,t} + \alpha_e \le y_{w,t}(x_i) + \alpha_w)$$

$$= \Pr(\mu_e(\gamma_i) + \xi_{i,e,t} + \alpha_e \le y_{w,t} + \alpha_w)$$

$$= \Pr(\xi_{i,e,t} \le y_{w,t}(x_i) - \mu_e(\gamma_i) + \alpha_w - \alpha_e)$$

$$= \Pr(\xi_{i,e,t} \le a_i^*) = G(a_i^*) \qquad (8)$$

where $a_i^* = y_{w,t}(x_i) - \mu_e(\gamma_i) + \alpha_w - \alpha_e$ denotes the reservation profit level at which the entrepreneur is indifferent between shutting down and staying in business; and G is cumulative distribution function of $\xi_{i,e,t}$.

The reservation profit is decreasing in risk aversion because of (5), which means that more risk averse entrepreneurs have a lower reservation profit:

$$\frac{\partial a_i^*}{\partial \gamma_i} = -\frac{\partial \mu_e}{\partial \gamma_i} < 0 .$$

The probability that an entrepreneur exits is given by

$$\eta = \int_{-\infty}^{a^*} g(\xi_{iet}) d\xi = G(a_i^*) \qquad (9)$$

Assuming the profit shocks $\xi_{i,e,t}$ are *iid* random expectation errors, the expected duration in business before receiving a bad draw is:

$$\frac{1}{\eta} = \frac{1}{G(a_i^*)} = S(t_i) = 1 - F(t_i) \qquad (10)$$

where $S(t_i)$ the probability that the firm survive until time t_i. Equation (10) indicates that because $G(a_i^*)$ is decreasing in γ_i, the expected length of time in business is increasing in γ_i. As a result, conditional on having entered entrepreneurship, the most risk-averse agents have to have the lowest probability of exit because they required the highest expected returns from the venture at the time of entry.

Our theoretical predictions contrast with a theory advanced in psychology that the most successful entrepreneurs have medium levels of risk aversion. Atkinson and Birch (1978) argue that entrepreneurs are motivated by conflicting motivations to achieve success and to avoid failure. In effect, their model assumes utility is the product of probability of success, *P,* and probability of failure, *1-P*. Utility is maximized at *P*= 0.5 which they interpret as entrepreneurs with intermediate risk preferences. Meredith et al. (1982) present a similar theory that successful entrepreneurs are moderate risk-takers. They argue that entrepreneurs like to challenge themselves with difficult tasks because they get satisfaction by accomplishing difficult tasks. On the other hand, entrepreneurs want to avoid disutility from failure. As a consequence, successful entrepreneurs pick projects of intermediate risk that offer reasonable probability of success and at least some moderate challenge. These theories fail to incorporate expected returns into their models which lead them to confuse the riskiness of the projects undertaken with the risk preferences of the entrepreneurs. By emphasizing project survival rather than anticipated or realized return on investment, they devalue high risk and high reward ventures. Nevertheless, their prediction that intermediate risk preferences are most successful can be tested against the data as we examine our prediction that success is highest among the most risk averse.

3. Empirical methodology

In order to investigate the extent to which risk aversion affects firm failure, we incorporate a hazard regression variant of the exit probability $F(t_i) = \Pr(\xi_{i,e,t} \le a_i^*) = G(a_i^*)$ in (8). The hazard rate at which spells are completed at duration *t* conditional on surviving up to t_i is defined as

$$h(t_i) = \frac{f(t_i)}{1 - F(t_i)} = \frac{f(t_i)}{S(t_i)} \quad , \tag{11}$$

where $S(t_i)$, $f(t_i)$, and $F(t_i)$ are as defined in equation (10). Assuming the survival time t_i has a Weibull distribution, the hazard function and survival function at time t_i for individual *i* are given by

$$h(t_i, \beta, \delta \mid \gamma_i, a_i^*) = \exp(a_i^* \beta + \delta\gamma_i)\, p t_i^{p-1} \tag{12}$$

$$S(t_i, \beta, \delta \mid \gamma_i, a_i^*) = \exp\{-\exp(a_i^* \beta + \delta\gamma_i) t_i^p\} \tag{13}$$

where *p* is an ancillary shape parameter to be estimated from the data, γ_i is a categorical variable indicating attitudes toward risk with higher levels representing greater acceptance of risk, and a_i^* is composed of human capital and other socioeconomic variables that set the entrepreneur's pecuniary ($y_{w,t}(x_i)$) and nonpecuniary (α_e and α_w) costs of time. We include education, previous labor market experience, age, and parental self-employment/management experience in the x_i. For our measures of the relative hedonic returns from self-employment and wage work, α_e and α_w, we include marital status and number of children. Such family variables may be affect the relative enjoyment in the two occupations. Additional controls include regional and industry dummies to account for sectoral and regional macroeconomic conditions. Definitions and descriptive statistics of the variables employed in our econometric analysis are presented in Table 1.

The sign on δ reveals whether decreasing levels of risk aversion (i.e., increasing levels of willingness to take risk) increase the hazard of firm failure, consistent with the theoretical requirement that more risk averse entrepreneurs must have higher expected returns from selecting e at the time of entry. This test implicitly assumes that expectation errors are not systematic, meaning that entrepreneurs' forecasts are rationale given information at the time of entry. Then, taking expectations across multiple entry cohorts, expected and realized returns to entrepreneurship converge to the same mean value.

Although we control for entrepreneurs' observed characteristics, there may be unobserved factors that affect the entrepreneurial survival or failure in addition to the observed regressors. Hence, a frailty model is used to account for the presence of unobserved heterogeneity among individuals. Because frailty (λ) is not directly estimated from the data, we assume that it has unit mean and finite variance (θ) where θ is estimated from the data. Assuming λ is drawn from an inverse Gaussian distribution, the survival function conditional on the frailty is defined as[7]

$$S_{\theta}(t_i, \beta, \delta, \theta \mid \lambda) = \int_0^{\infty} \{S(t_i, \beta, \delta)^{\lambda} g(\lambda) d\lambda$$

[7] λ is introduced as a multiplicative effect on the hazard, $h(t|\lambda)=\lambda h(t)$. So λ represents the cumulative effect of omitted covariates. Exploiting the relationship between cumulative hazard function and survival function, the survival function conditional on the frailty is given as follows:

$$S(t \mid \lambda) = \exp\{-\int_0^t h(u \mid \lambda) du\} = \exp\{-\lambda \int \frac{f(u)}{S(u)} du\} = \{S(t)\}^{\lambda}$$

$$= \exp\{\frac{1}{\theta}(1-[1-2\theta \ln\{S(t_i,\beta,\delta)\}]^{1/2})\} \quad (14)$$

where $g(\lambda)$ is probability density function of λ and the subscript θ indicates the dependence of $S(t_i)$ on θ.

The log-likelihood function can be written as

$$L(\beta,\delta,\theta \mid a_i^*,\gamma_i) = \sum_{i=1}^{n}\{d_i \ln f_\theta(t_i,\beta,\delta,\theta) + (1-d_i)\ln S_\theta(t_i,\beta,\delta,\theta)\} \quad (15)$$

where d is a binary indicator defined such that $d=1$ if the entrepreneur exited from his business and 0 otherwise; $f_\theta(t_i,\beta,\delta,\theta) = -\frac{d}{dt}S_\theta(t_i,\beta,\delta,\theta)$ is probability density function of survival duration *t*.

If we select an inappropriate baseline hazard function, unreliable estimates can result (Heckman and Singer, 1984). As an alternative, we use a semiparametric Cox proportional hazard model which requires no assumption about the baseline hazard function in order to examine the robustness of our findings to alternative assumptions about the error process.

Definition of survival and failure, and creation of entry cohorts

In order to construct the log-likelihood function in (15), we need to define business survival and failure. We require a common window of time over which to judge a venture's success. Our first step is to pick a sample of first-time entrepreneurs who entered business in the same year. By analyzing entrepreneurial success from startup, we avoid left-censored entrepreneurial spells that have already selected out the most prone to failure. Setting a common starting point also insures that all ventures in the cohort are subject to the same macroeconomic environment.

We define entrepreneurial success as remaining in business at least 6 years after startup and business failure as closing the business within the first 6 years. Two-thirds of U.S. firms close within 6 years of entry, and so firms that survive at least 6 years have performed well above average (Dunne et al., 1988; Knaup and Piazza, 2007).[8]

The data for the analysis is drawn from the National Longitudinal Survey of Youth 1979 (NLSY79). The first year the respondent reported self-employment is assumed to be their startup year. In order to create successive cohorts by entry year, we identify those who started their business in 1992, 1994, 1996, 1998, 2000 and 2002.[9] Those who remain self-employed as of the wave of the survey conducted 6 years after entry are treated as survivors. All others in the cohort are treated as failures. The exit year is measured as the middle year between the last reported self-employment year and the year of new employment status. For example, if the respondent reported self-employment in 1994 but paid-employment in 1996, then we use 1995 as the self-employment exit year.

We can stack these 6 cohorts into a series of overlapping sample windows of 6 years each. Figure 1 shows cohorts differentiated by entry years and their related six year window with individual cases labeled as success or failure. Dummy variables for year of entry control for the common macroeconomic environment shaping the expectations of each entry cohort. The 2002 cohort is the last one considered due to the required six year sample window. The last year for which data are available in the NLSY79 is 2008.

4. Sample selection

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[8] Dunne et al. (1988) found that 62% of manufacturing firms exited within five years following startup. Knaup and Piazza's (2007) examination of the 1998 cohort of new firm entrants found that about two-thirds of firms exited by the sixth year in each of the 10 industries examined.

[9] The NLSY79 conducted survey annually from 1979 through 1994 and biennially thereafter. Due to the biennial survey over the period we are interested in, we assume that the startup is in an even year.

The NLSY79 includes 12,686 individuals who were 14-22 years old in the initial survey year. Focusing on our entrepreneurship entry cohorts between 1992 and 2002, our sample of self-employed individuals will be initiating their ventures between ages 27 and 37, and deciding to continue the venture or shut down between the ages of 28 and 45. Because this study is interested in entrepreneurial survival, we include only those who had a first-time startup in one of the 6 even years between 1992 and 2002. The self-employed are identified by using the "class of worker" category in the NLSY79. We consider respondents to be self-employed if at least one job is reported as self-employment among five possible jobs listed.

Unfortunately, not all the respondents were interviewed in each survey year. For the missing case of "class of worker" we tracked down their employment status by looking at job tenures before and after the missing year. For instance, if a respondent's job tenures on self-employment increased by four years over two consecutive surveys (i.e., 1994, 1998), we consider him as self-employed in the year when he was not interviewed (i.e., 1996). When multiple spells of entry and exit are reported, only the first entry and exit are included. We drop entrepreneurs from the sample if they enrolled in school at the time of startup. We also drop individuals with incomplete information on individual attributes at the time of start-up as we need to keep our vector of covariate controls exogenous to the progress of the business over the next six years.[10] The final sample includes 588 entrepreneurs.

The survival and exit rates by entry cohort are summarized in Table 2. Average exit rate varies from 49% to 71% across entry cohorts. The 2000 entry cohort has the lowest exit rate while the 1992 entry cohort has the highest exit rate. Overall,

[10] For example, if marital status is not known in the year of start-up but the individual is listed as married or divorced over the next six years, it is plausible that the marital status is affected by the success of the business.

59 % of the self-employed exited their business within six years of start up, close to the 65% exit rate reported in national analyses of firm survival.

Risk aversion in the NLSY is elicited using questions closely related to the simple occupational choice model presented in section 2. Respondents are presented a series of hypothetical occupations with different expected lifetime income levels and variances. The individual is asked to choose between a 'safe' job paying a fixed income and a second 'risky' job that will double the 'safe' income with 50% probability or else pay only a fraction of the 'safe' income with 50% probability.[11] The degree of risk aversion is measured by the degree to which the respondent is willing to accept downside risk, measured by the amount that pay could be reduced in the 'risky' job relative to the 'safe' job.

The lifetime income gamble questions are asked in 1993, 2002, 2004, and 2006 in the NLSY79. Because the 2002 entry cohort is the last one considered based on the window of 6 years, we employ the risk aversion measured in 1993 in order to avoid having measures of risk aversion that follow the business entry decision and reflect the success or failure of the enterprise.

Based on their responses to these questions in the 1993 wave of the NLSY, we place our entrepreneurs into one of four risk preference categories ranging from the most risk averse (category1) to the least risk averse (category4).[12] The risk preference categories are constructed as follows:

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[11] See Appendix 2 for the original questions.

[12] For more detailed elicitation, see Barsky et al. (1997) who find that survey-based risk aversion derived by eliciting responses to hypothetical choices are correlated with risky behaviors such as smoking, drinking, failing to have insurance, and holding stocks.

$$
Risk\ index = \begin{cases} 1\ if \quad reject\ \ 1/3\,cut\ \&\ reject\ \ 1/5\,cut & ;the\ most\ risk\ averse \\ 2\ if \quad reject\ \ 1/3\,cut\ \&\ accept\ \ 1/5\,cut & \\ 3\ if \quad accept\ \ 1/3\,cut\ \&\ reject\ \ 1/2\,cut & \\ 4\ if \quad accept\ \ 1/3\,cut\ \&\ accept\ \ 1/2\,cut & ;the\ least\ risk\ averse \end{cases}
$$

The distribution of the measured risk aversion for our entrepreneurial entry cohorts is presented in Table 3. Overall, 40% of the entrepreneurs fall into the most risk averse category and 28 % fall into the least risk averse group. There is no apparent systematic pattern to the distribution of the measured risk aversion across cohorts, with the 2002 and 1992 cohorts having similar variation in risk attitudes. These distributions indicate that there is considerable variation in measured risk attitudes in all the entry cohorts included in our sample.

5. Estimation results

The results of the failure hazard models applied to the 6 stacked entry cohorts of young entrepreneurs in the NLSY79 are reported in Table 4 Panel A. For robustness, we show various specifications implying different assumptions about the nature of the error terms and individual unobserved heterogeneity. The estimate of θ is statistically different from zero and a likelihood ratio test for the presence of heterogeneity is statistically significant, which confirms the existence of unobserved individual traits that affect probability of business failure. The estimated shape parameter p is greater than 1 and statistically significant, which means that the hazard of failure increases with time.[13] The significant estimates of θ and p suggest that the Cox model is misspecified.[14] We will therefore focus our discussion on the frailty

[13] Notice that this is the shape of individual hazard function. When frailty is significant, the population hazard function will tend to begin fall past a certain point (i.e., inverse U-shape) regardless of individual hazard function. This is because more frail entrepreneurs exit earlier and more homogeneous population of survivor will be left as time passes (Gutierrez 2002).

[14] Note that because the hazard changes nonlinearly with firm age, mixing different firm entry cohorts

model results, although none of our qualitative conclusions is sensitive to the specification choice.

We report our results in terms of their implied hazard ratio: i.e. the proportional shift in the failure hazard function due to one unit change of the covariate, holding fixed all other factors including the unobserved frailty. The control measures perform as in earlier studies of firm longevity. In line with Holtz-Eakin et al. (1994), Cressy (1996) and Taylor (1999), age has a significant effect on the hazard of failure. The probability of business failure is quadratic in age, decreasing initially and then increasing past a certain age (i.e., 37 in our data). Previous labor market work experience plays an important role in lowering the hazard of firm failure, consistent with Taylor's (1999) analysis. An additional year of previous experience cuts the hazard of failure by 10%. Education (in years of schooling) has no significant impact on firm hazard rate. This suggests that academic success is a poor indicator of entrepreneurial ability (Taylor, 1999). Apparently, practical intelligence acquired from work experience is more important (Sternberg, 2004). Finally, our results show that gender, race and marital status have little effect on hazard rate. Having self-employed parents also does not have a significant impact on business failure although it is found to increase probability of becoming self-employed in the previous literature (e.g., Lentz and Laband, 1990; Dunn and Holtz-Eakin, 2000).

Turning to our main concern, the first column reports the effect of risk attitudes on firm exits when risk is the only regressor. Recall that the risk index goes from most (1) to least (4) risk averse. We have the unexpected result that as the entrepreneur becomes less risk averse, as measured by standard measures of risk aversion, the

can confound the error structure of the hazard model. That further supports our sample strategy of picking entrepreneurial entry cohorts with fixed sampling windows which implicitly holds fixed the hazard trajectory for members of each entry cohort.

likelihood of failure decreases. This is the exact opposite of the predicted relationship between risk aversion and firm survival.

It is possible that the unexpected result is attributable to a correlation between risk attitudes and individual human capital and demographic variables that are known at the start of the entrepreneurial spell. However, when we add these measures in Column 2 the impact of risk attitudes on entrepreneurial hazard of failure is almost identical to that in the first column. The next column adds controls for industry. Technically these measures are endogenous as the entrepreneur picks the sector at the time of entry, and so these sectoral dummies should be excluded. Nevertheless, they are commonly found to affect firm survival (Taylor, 1999) due to sector specific shocks that may differentially affect profitability for firms in the same cohort. The most risk averse are still the most likely to fail with a similar hazard ratio, although the estimate loses precision.

Overall, the results from the four specifications suggest that less risk aversion results in a lower hazard and therefore a longer survival time. More precisely, a unit increase in risk acceptance index (i.e., increase in willingness to take risks) is associated with a 14% decrease in the hazard of failure. As a result, we soundly reject the hypothesis that more risk aversion increases the probability of entrepreneurial survival. Our finding is also inconsistent with the psychological models that argue the most successful entrepreneurs have moderate risk aversion. In order to check the psychological argument, we test for the intermediate risk attitudes against the most and the least risk using risk attitudes dummies. To do so, we generate three risk attitude dummies: willingness to take low, medium, and high risk. We use willingness to take low risk as base category. As shown in Panel B of Table 4, we do not observe the predicted nonlinear relationship between risk aversion and hazard of firm failure.[15] Instead, the hazard ratio drops progressively as willingness to take risk increases. Indeed, the most successful entrepreneurs are the least risk averse as before.

Our findings differ from the few previous studies relating risk aversuib and entrepreneurial success. The meta analysis of past studies of risk aversion and entrepreneurial success by Rauch and Frese (2007) reported a positive but relatively small correlation. Hence, they conclude that risk attitudes have little effect on entrepreneurial success. However, differences in risk and success measures across studies make it hard to generalize findings. A more recent study by Caliendo et al. (2010) reported a U-shaped relationship between risk attitudes and entrepreneurial failure which they offered as support for the psychological theories.[16] One difficulty with their study is the reliance on nonstandard measures of risk aversion that do not fit the required context of selecting risky occupations.[17] A further problem is that risk attitudes were measured after startup for most respondents and so their measure of risk attitudes may reflect business success or failure. However, the most important problem common to past studies is the failure to focus on the decisions of an entry cohort but rather on business survival of entrepreneurs who have already managed to survive many years prior to the survey. The longer a firm survives, the more likely it

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[15] The results are not sensitive to different classification of risk dummy variables. See the Appendix 3 for the estimation results.

[16] It is likely that Caliendo et al. (2010) misinterpret the psychological theory of achievement motivation as an inverse U-shaped relationship between risk preferences and survival. Atkinson and Birch (1978), among others, argue that higher achievement is positively related to propensity to take an intermediate risk. But this does not necessarily mean an inverse U-shaped relationship between risk preferences and achievement. In their theoretical model, Caliendo et al. (2010) assume that less risk aversion is associated with higher expected payoff in the case of success, which yields the odd implication that the most risk averse pick projects with the lowest return conditional on success, regardless of variance. In addition, they did not model utility explicitly.

[17] Two sets of questions are used to measure respondent's risk aversion. One set of questions asks respondents if they are risk averse. The other asks respondents how they would invest lottery winnings, a context that could elicit very different risk preferences than one where they are allocating earned income, and one that confuses risk preferences with portfolio allocation.

will continue to survive (Knaup and Piazza, 2007), and so the risk attitudes of entrepreneurs that already failed before the survey are not incorporated into the analysis. That selection problem biases any interpretation of the relationship between risk aversion and firm survival.

Sensitivity analysis

We first test sensitivity of the results with respect to the time windows over which business survival and failure are defined. The estimation results are summarized in Table 5 Panel A. For brevity, we report only the estimates of risk attitudes in the four specifications. The baseline estimation results are redisplayed in the first row of Table 5 for reference. The second row represents the results when we define the survival as remaining in business at least 4 years after startup. The third row is the case when we consider firm survival as remaining in business at least 8 years after entry.[18] The regression results remain stable in all the specifications. The negative relationship between risk attitudes and hazard of failure holds for both the windows of 4 and 8 years although the estimates based on 4 years become insignificant.

One concern we raise with past studies is the use of measures of risk aversion that are taken after the respondent has already been in business. We illustrate the potential bias of using endogenous risk preference measures in Panel B of Table 5. We re-estimate the hazard regression with risk attitudes measured in 2002, 2004, and 2006. While the coefficient is still negative, the estimate is never statistically significant. It appears that the bias from using risk aversion elicited after startup is to lessen evidence that the most risk averse are the least successful.

Because our own results rely on the NLSY's 1993 elicitation of risk attitudes, it

[18] We have to adjust the sample as we change the survival window. We lose the 2002 cohort when we apply a window of 8 years because the NLSY 2010 wave was not yet available. With the four year window, we gain the 2004 entry cohort.

is possible that we should have excluded the 1992 entrepreneurship cohort. Our findings above suggest that inclusion of the 1992 cohort may have biased our results. We refit the hazard regression without the 1992 entry cohort. The results are summarized in Table 5 Panel C. In all cases, the finding that the most risk averse are most likely to fail strengthens compared to the estimates in the first row of Table 5, consistent with our assessment that endogenously elicited risk aversion bias the estimates toward zero.

Lastly, rather than using entry cohorts, we use a sample of surviving entrepreneurs as of 2002, a sample comparable to the type used in previous studies. Such samples should be biased by the exclusion of the least successful entrepreneurs. We add a control for firm tenure along with the other individual characteristics used before. As shown in Panel D of Table 5, all coefficients on risk attitudes are now positive and insignificant, consistent with the theoretical effect of risk aversion of entrepreneurial success. Selection bias from inappropriately excluding unsuccessful entrepreneurs appears to bias upward coefficients on risk attitudes.

Our conclusion that entrepreneurs with the lowest measured risk aversion are the most successful holds up well. When researchers use selected samples or endogenous measures of risk aversion, these findings are compromised. We believe our results are more reliable than past studies because of our use of risk attitudes elicited before startup and our inclusion of all members of each entrepreneurial entry cohort in the analysis.

Risk aversion or Risk management?

Our surprising finding that the most risk averse entrepreneurs are the most likely to fail calls into question the interpretation of common measures of risk aversion such as those used in the NLSY as measures of attitudes toward risk.[19] Our measured risk attitudes perform as if they are indicators of entrepreneurial ability: utilizing information and making intelligent decision under uncertainty. In other words, the less risk averse are apparently those who are better able to assess and manage risks. Although previous studies have found that greater willingness to take risk increases probability of entrepreneurship, it is likely that the least risk averse agents may have unusually high endowments of entrepreneurial talent and it is this human capital advantage that leads them to become entrepreneurs. Indeed, this interpretation is consistent with the recent evidence presented by experimental studies that find that the least risk averse are those who have superior cognitive ability. These experimental studies elicited risk aversion using choices between a lottery and a safe payment.

Frederick (2005) investigates how cognitive ability is related to risk attitudes using U.S. undergraduate students. To do so, he developed intelligence test called "Cognitive Reflection Test (CRT)" that measures respondents' cognitive ability. He finds that individuals in the high CRT-score group are less risk averse than those in the low CRT-score group.[20] He states that, "the relation is sometimes so strong that the preferences themselves effectively function as expressions of cognitive ability (p.26)." Similarly, Benjamin et al. (2006) investigate whether variation in risk attitudes is related to variation in cognitive ability measured by Scholastic Assessment Test (SAT). They find that students with higher SAT score in Chilean high school show greater

[19] Panel Study of Income Dynamics (PSID) includes the same hypothetical gamble questions as NLSY does. The only different feature of PSID from NLSY is that PSID offers one more gamble question (i.e., income cut by 75%), so it allows us to order individuals into six categories. Using NLSY79 (Ahn, 2009) and PSID (Kan and Tsai, 2006; Brown, 2008), it is shown that less risk averse individuals are more likely to choose entrepreneurship.

[20] Frederick (2005) also uses American College Test (ACT), the need for cognition scale (NFC), the Wonderlic Personnel Test (WPT) in order to check correlation of each measure. He shows that all measures correlate positively and significantly with one another.

willingness to take risk. They suggest that measured risk attitudes may not fully reflect tastes for risk due to cognitive limitations.

More recently, Dohmen et al. (2010) assess the relation between risk attitudes and cognitive ability using representative German data. They discover that less risk averse individuals are those who have higher cognitive ability as measured by tests of word fluency and symbolic logic. They concluded that cognitive ability conveys information about risk aversion.

There is modest support for a link between risk acceptance and cognitive ability in the NLSY sample. The Armed Forces Qualifying Test (AFQT), a widely-used proxy for measures of skill, was administered to all individuals in the NLSY79. The correlation between measured risk acceptance and the AFQT score is 0.04 for those who were self-employed in 1993 and 0.03 for those who ever had start-ups between 1992 and 2002. In contrast, the correlation between AFQT score and risk acceptance is negative in the population of wage workers.[21]

As a simple test of the comparative static relationship between cognitive ability and risk acceptance, we regress measured risk attitudes on AFQT score, controlling for the other individual characteristics we included as measures of opportunity cost of time. Because of the possible nonlinear measures of risk attitude index, we also incorporate ordered probit model. The regression results are reported in Appendix 4. In both models, AFQT score has a statistically significant and positive effect on risk acceptance index. We also report marginal and discrete changes in probabilities for each outcome of risk attitudes in Appendix 5. The probability change is associated with a standard

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[21] The NLSY79 participants were recruited to take the Armed Services Vocational Aptitude Battery (ASVAB) test in 1980. ASVAB consists of ten sections measuring skills related to academic and vocation. Four of the ten sections comprise the AFQT. The results are consistent with those with ASVAB.

deviation increase in the corresponding independent variable centered on the mean. The effect of AFQT score is small: a one standard deviation increase in AFQT score increases the probability of being in the most risk accepting category by just 1.4 percentage point. Nevertheless, it is much larger than the statistically insignificant 0.4 percentage point increase in probability of being in the same category from an additional year of schooling.

The implied existence of an unlearned or nascent entrepreneurial skill separate from learned skills is similar to the λ in Lazear's (2005) 'jack-of-all-trades' model of entrepreneurship. Along with the experimental evidence of a positive correlation between measured risk acceptance and cognitive ability suggest that measures of risk attitudes are in fact measures of entrepreneurial ability or the ability to manage risk. The more confidence agents have in their own ability, the greater confidence they will have in their decisions under uncertainty and so greater willingness to take risks.

6. Conclusion

This paper presents a standard theoretical model of occupational choice under uncertainty in order to explain more risk averse agent requires higher expected return at the time of entry into entrepreneurship. Because the expected return is the value adjusted by risk aversion, higher expected return implies a higher survival probability. From that proposition, we hypothesize that more risk averse entrepreneurs have a higher probability of survival than their less risk averse counterparts. This paper empirically tests the hypothesis applying a frailty hazard model to successive entry cohorts of young entrepreneurs in the NLSY79. Success is judged as surviving at least 6 years which puts the venture in the upper third of the tenure of start-ups.

Surprisingly, the empirical tests soundly refute the hypothesis. We find less risk averse entrepreneurs are less likely to fail than are their more risk averse counterparts. This finding also holds true when controlling for individual human capital and demographic variables. Furthermore, the unexpected result is not sensitive to different time windows over which to judge a venture’s success. When incorporating risk preference dummies in our regression, we still observe a monotonically negative relationship between risk acceptance and firm failure, which is inconsistent with the psychological theory that the most successful entrepreneurs are intermediate risk-takers. Consequently, our conclusion that the most successful entrepreneurs are the least risk averse holds up well.

This surprising finding casts doubt on the use of measured risk aversion as a measure of taste for risk. Instead, measured willingness to accept risks behaves more like an index of entrepreneurial skill. The least risk averse appear able to make better decisions in the uncertain economic environment of the business owner. Our interpretation is supported by recent experimental studies (Frederick, 2005; Benjamin et al., 2006; Burks et al., 2009; Dohmen et al., 2010) that find the least risk averse individuals exhibit higher cognitive ability.

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Table 1 Definitions and descriptive statistics of variables

	Definition	Mean (Std.)	Min	Max
Risk acceptance index (1-4)	Willingness to take risk: the risk index 1 indicates the most risk averse and 4 means the least risk averse	2.35 (1.26)	1	4
Education	Years of schooling completed	12.82 (2.40)	1	20
Work experience	Years of previous labor market employment experience before self-employment	13.59 (5.33)	0.35	24.58
Age	Age in years	35.90 (3.75)	27	45
Married, spouse present	=1 if married and spouse present	0.57 (0.49)	0	1
Number of kids	Number of bio/step/adopted children in household	1.34 (1.31)	0	6
Male	=1 if male	0.51 (0.50)	0	1
White	=1 if white	0.72 (0.45)	0	1
F-proprietor/manager	=1 if father was/is a proprietor or manager	0.10 (0.30)	0	1
M-proprietor/manager	=1 if mother was/is a proprietor or manager	0.02 (0.15)	0	1
Urban	=1 if reside in urban area	0.73 (0.44)	0	1
Northeast	=1 if reside in northeast	0.14 (0.35)	0	1
North central	=1 if reside in north central	0.23 (0.42)	0	1
South	=1 if reside in south	0.41 (0.49)	0	1
West	=1 if reside in west	0.22 (0.41)	0	1
Indus1	=1 if Agriculture, Forestry and Fisheries	0.063 (0.24)	0	1
Indus2	=1 if Construction	0.14 (0.34)	0	1
Indus3	=1 if Manufacturing	0.03 (0.16)	0	1
Indus4	=1 if Wholesale trade, Retail trade	0.16 (0.37)	0	1
Indus5	=1 if Transportation, Communication, Public Utilities	0.05 (0.21)	0	1
Indus6	=1 if Finance, Insurance, and Real Estate	0.03 (0.17)	0	1
Indus7	=1 if Business and Repair Services	0.16 (0.37)	0	1
Indus8	=1 if Personal Services	0.23 (0.42)	0	1
Indus9	=1 if Entertainment and Recreation Services	0.03 (0.17)	0	1
Indus10	=1 if Professional and related services	0.10 (0.30)	0	1
Indus11	=1 if Public administration	0.003 (0.06)	0	1

Table 2 Six year survival and exit rates by entry cohort (NLSY79)

	1992 Age 27-35	1994 Age 29-37	1996 Age 31-39	1998 Age 33-41	2000 Age 35-43	2002 Age 37-45	Total
Survived	16 (29%)	31 (31%)	63 (43%)	44 (42%)	34 (51%)	56 (47%)	243 (41%)
Died	39 (71%)	69 (69%)	84 (57%)	60 (58%)	33 (49%)	63 (53%)	345 (59%)
Total	55 (100%)	100 (100%)	147 (100%)	104 (100%)	67 (100%)	119 (100%)	588 (100%)

Note: Number of observations is reported with percentage in parenthesis. Survival is measured based on 6 year longevity in business.

Table 3 Distribution of risk aversion by entry cohort (%) NLSY79

Risk acceptance index	1992	1994	1996	1998	2000	2002	overall
1: Most risk averse	43 %	52 %	35 %	34 %	39 %	43 %	40 %
2	17 %	9 %	12 %	14 %	7 %	11 %	11 %
3	7 %	13 %	24 %	22 %	24 %	25 %	21 %
4: Least risk averse	33 %	26 %	29 %	30 %	30 %	21 %	28 %
Total Obs.	54	99	147	103	67	118	588

Table 4 Regressions explaining probability of failure from frailty hazard and Cox proportional model

	(1) Frailty Hazard	(2) Frailty Hazard	(3) Cox proportional	(4) Frailty Hazard
Panel A				
Risk acceptance index(1-4)	0.851 (-2.35)[b]	0.863 (-2.08)[b]	0.929 (-1.66)[c]	0.875 (-1.88)[c]
Previous Labor market experience (in years)		0.919(-3.99)[a]	0.958 (-3.33)[a]	0.921 (-3.84)[a]
Education		1.178 (0.75)	1.112 (0.72)	1.161 (0.68)
Education squared		0.996 (-0.53)	0.997 (-0.58)	0.996 (-0.53)
Male		0.730 (-1.53)	0.824 (-1.51)	0.902 (-0.43)
Married, spouse present		1.067 (0.31)	1.032 (0.24)	1.010 (0.05)
Number of Kids		0.930 (-0.94)	0.959 (-0.86)	0.929 (-0.94)
White		1.234 (0.97)	1.092 (0.66)	1.213 (0.89)
Age		0.380 (-2.31)[b]	0.629 (-1.81)[c]	0.381 (-2.31)[b]
Age squared		1.013 (2.26)[b]	1.0066 (1.76)[c]	1.013 (2.25)[b]
Urban		1.267 (1.11)	1.121 (0.86)	1.234 (0.98)
Father-proprietor		0.806 (-0.70)	0.915 (-0.46)	0.815 (-0.66)
Mother-proprietor		0.546 (-0.96)	0.700 (-0.85)	0.548 (-0.95)
Entry cohort dummies	Yes	Yes	Yes	Yes
4 region dummies		Yes	Yes	Yes
Industry dummies				Yes
θ (frailty variance)	5.221 [1.936][a]	5.578[2.344][b]		5.468 [2.300][a]
p (ancillary parameter)	1.818 [0.134][a]	1.878 [0.147][a]		1.881 [0.147][a]
Log likelihood	-723.2	-704.98	-2099.47	-702.04
N	588	588	588	588
Likelihood Ratio (LR) test	$\chi^2(6)$=31.55[a]	$\chi2$ (22)=72.49[a]	$\chi^2(22)$=48.93[a]	$\chi^2(33)$=78.64[a]
LR test for $\theta = 0$	$\overline{\chi^2}(1)$=45.1[a]	$\overline{\chi^2}(1)$=38.6[a]		$\overline{\chi^2}(1)$=38.55[a]
Panel B				
Willingness to take medium risk	0.71 (-1.48)	0.75 (-1.23)	0.86 (-1.03)	0.79 (-1.00)
Willingness to take high risk	0.62 (-2.30)[b]	0.65 (-2.01)[b]	0.81 (-1.57)	0.67 (-1.89)[c]

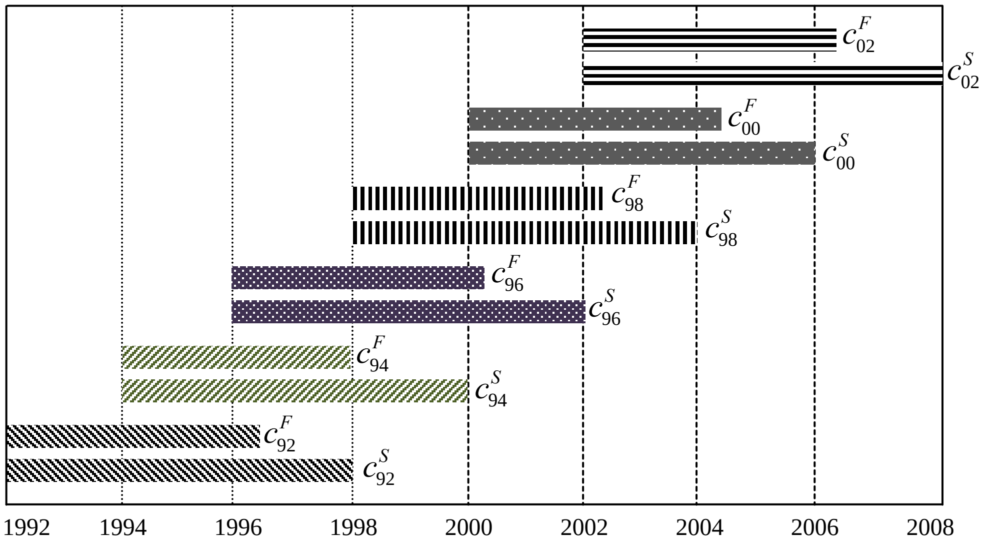
Note: Hazard ratios are exponentiated coefficients. t-statistics are reported in parentheses. Standard errors are in brackets. Risk preference index 1 indicates the most risk averse. [a/b/c] significance level at 1%/5%/10%. The null distribution of the LR test statistic is a 50:50 mixture of a χ^2 with zero degree of freedom and a χ^2 with one degree of freedom, denoted as $\overline{\chi}^2(1)$. Controls used in Panel B regressions are the same as in Panel A.

Table 5 Sensitivity of risk attitudes: Negative relationship between risk attitudes and hazard

Risk acceptance index	(1) Frailty hazard	(2) Frailty hazard	(3) Cox proportional	(4) Frailty hazard	Sample size
Panel A					
Main estimation: 6 year period	0.851 (-2.35)[b]	0.863 (-2.08)[b]	0.929 (-1.66)[c]	0.875 (-1.88)[c]	588
4 year period	0.919 (-1.20)	0.924 (-1.09)	0.965 (-0.82)	0.930 (-1.01)	679
8 year period	0.849 (-2.33)[b]	0.859 (-2.09)[b]	0.926 (-1.66)[c]	0.864 (-1.97)[b]	470
Panel B					
2002 risk preference	0.988 (-0.17)	0.954 (-0.64)	0.977 (-0.52)	0.963 (-0.51)	568
2004 risk preference	0.990 (-0.14)	0.995 (-0.06)	0.100 (-0.01)	0.987 (-0.17)	551
2006 risk preference	1.006 (0.09)	0.970 (-0.41)	0.982 (-0.38)	0.975 (-0.34)	574
Panel C					
Omitting 1992 cohort with 1993 risk preference	0.825 (-2.53)[b]	0.812 (-2.61)[a]	0.901 (-2.18)[b]	0.825 (-2.40)[b]	534
Panel D					
Self-employed in 2002 With 1993 risk preference	1.000 (0.01)	1.011 (0.15)	1.011 (0.24)	1.007 (0.10)	639

Note: Top number is the estimated hazard ratio for the risk attitude index where firm success is measured under alternative time windows. The Risk index varies from 1: most risk averse to 4: least risk averse. Columns correspond to the specifications used in the corresponding columns in Table 4.
t- statistics reported in parenthesis.
[a/b/c] significance level at 1%/5%/10%.

Figure 1 Successive entry cohorts overlapped based on windows of 6 years



Note: Superscript indicates status of survival or failure. Subscript denotes entry cohorts.

Appendix 1

An agent is indifferent between the risky job and the safe job when $EU_e = EU_w$,

or

$$u(\mu_e) + \frac{1}{2}u''(\mu_e)\sigma_e^2 + \alpha_e = u(y_w) + \alpha_w \quad (1)$$

Multiplying both sides of (1) by $-\frac{\mu_e}{u'(\mu_e)}$ and rearranging (1) yields

$$\frac{1}{2}\gamma\sigma_e^2 = \frac{\mu_e\{u(\mu_e) - u(y_w) + \alpha_e - \alpha_w\}}{u'(\mu_e)} \equiv \frac{F(\mu_e)}{u'(\mu_e)} \quad (2)$$

where $\gamma = -\mu_e \frac{u''(\mu_e)}{u'(\mu_e)}$ is the Arrow-Pratt coefficient of relative risk aversion.

Taking partial derivative of μ_e with respect to γ in (2) yields

$$\frac{\partial \mu_e}{\partial \gamma} = \frac{\frac{1}{2}\sigma_e^2[u'(\mu_e)]^2}{F'(\mu_e)u'(\mu_e) - u''(\mu_e)F(\mu_e)} > 0 \quad (3)$$

where $F'(\mu_e) = u(\mu_e) - u(y_e) + \alpha_e - \alpha_w + \mu_e u'(\mu_e)$.

The equation (3) is positive because $F' > 0$, $F > 0$, $u' > 0$, and $u'' < 0$.

Appendix 2

In 1993 NLSY79, respondents were asked the following questions:

(Q1) Suppose that you are the only income earner in the family, and you have a good job guaranteed to give you your current (family) income every year for life. You are given the opportunity to take a new and equally good job, with a 50-50 chance that it will double your (family) income and a 50-50 chance that it will cut your (family) income by a third. Would you take the new job?

The individuals who answered 'yes' to this question were then asked: (Q2) suppose the chances were 50-50 that it would double your (family) income and 50-50 that it would cut it in half. Would you still take the new job? Those who answered 'no' to the first question (Q1) then asked: (Q3) suppose the changes were 50-50 that it would double your (family) income and 50-50 that it would cut it by 20 percent. Would you take the new job?

Appendix 3 Different classifications of risk preference dummy variables

	(1) Frailty Hazard	(2) Frailty Hazard	(3) Cox proportional	(4) Frailty Hazard
Panel A				
Risk2	0.96 (-0.14)	0.98 (-0.08)	0.98 (-0.13)	1.02 (0.08)
Risk3	0.71 (-1.47)	0.75 (-1.21)	0.85 (-1.03)	0.79 (-0.95)
Risk4	0.62 (-2.25)[b]	0.65 (-1.95)[c]	0.81 (-1.54)	0.67 (-1.79)[c]
Panel B				
Willingness to take medium risk (risk2)	0.96 (-0.14)	0.98 (-0.08)	0.98 (-0.13)	1.03 (0.08)
Willingness to take high risk (risk3+risk4)	0.65 (-2.31)[b]	0.69 (-1.97)[b]	0.83 (-1.61)	0.72 (-1.72)[c]
Panel C				
Willingness to take medium risk (risk2+risk3)	0.79 (-1.15)	0.82 (-0.93)	0.90 (-0.82)	0.87 (-0.65)
Willingness to take high risk (risk4)	0.62 (-2.25)[b]	0.65 (-1.95)[c]	0.81 (-1.54)	0.67 (-1.80)[c]
Panel D				
Willingness to take medium risk (risk3)	0.71 (-1.48)	0.75 (-1.23)	0.86 (-1.03)	0.79 (-1.00)
Willingness to take high risk (risk4)	0.62 (-2.30)[b]	0.65 (-2.01)[b]	0.81 (-1.57)	0.67 (-1.89)[c]

Note: In Panel A, the categorical variable of 4-point risk preferences is converted to four risk dummies. Risk1 indicates the most risk aversion and Risk4 the least risk aversion. Willingness to take low risk (Risk 1) is used as base in Panel B and C. The consolidated category of Risk1 and Risk2 is used as base in Panel D. t- statistics reported in parenthesis. [a/b/c] significance level at 1%/5%/10%.

Appendix 4 Effect of AFQT score on risk attitudes

Risk acceptance index	(1) OLS	(2) Ordered Probit	(3) Ordered Probit Marginal effect
AFQT	0.002*	0.002**	0.009
	(1.87)	(2.24)	
Education	0.006	0.005	0.002
	(0.70)	(0.67)	
Male	0.206***	0.184***	0.036
	(6.40)	(6.25)	
Age	-0.222	-0.205	0.091
	(1.10)	(1.12)	
Age squared	0.003	0.003	0.088
	(1.06)	(1.08)	
White	0.015	0.010	0.002
	(0.40)	(0.28)	
log(family income)	-0.051**	-0.047**	0.009
	(2.34)	(2.31)	
Number of kids	-0.023*	-0.022*	0.005
	(1.64)	(1.68)	
Married	-0.194***	-0.169***	0.033
	(5.04)	(4.80)	
Previous labor market work experience	-0.014***	-0.0124***	0.010
	(2.88)	(2.85)	
Constant	6.208*		
	(1.95)		
/cut1		-3.782	
		[2.910]	
/cut2		-3.474	
		[2.910]	
/cut3		-2.983	
		[2.910]	

Note: t-statistics are reported in parenthesis. Standard errors are in bracket. 4 regions are controlled.

Appendix 5 Marginal and discrete changes in predicted probabilities for each outcome of risk attitudes

	Average Change	Risk acceptance index=1	Risk acceptance index=2	Risk acceptance index=3	Risk acceptance index=4
AFQT	0.009	-0.018	0.000	0.004	0.014
Education	0.002	-0.005	0.000	0.001	0.004
Male	0.036	-0.073	0.001	0.014	0.058
Age	0.091	0.182	-0.003	-0.035	-0.144
Age squared	0.088	-0.175	0.003	0.034	0.139
white	0.002	-0.004	0.000	0.001	0.003
Log(family income)	0.009	0.017	-0.000	-0.003	-0.014
Number of Kids	0.005	0.011	-0.000	-0.002	-0.009
Married	0.033	0.067	-0.001	-0.013	-0.053
Previous labor market work experience	0.010	0.020	-0.000	-0.004	-0.016