



Risk preference and entrepreneurial investment at the top of the wealth distribution

Frank M. Fossen^{1,2} · Johannes König³ · Carsten Schröder^{3,4}

Received: 8 December 2022 / Accepted: 16 July 2023 / Published online: 1 August 2023
© The Author(s) 2023

Abstract

We present evidence on how individual risk preferences are related to entrepreneurial investment among the wealthy. To do so, we use novel survey data from the top of the wealth distribution, which have been fully integrated into the 2019 German Socio-economic Panel Study. The data include private wealth balance sheets, in particular the value of own private business assets, and a standard measure of risk tolerance. We find that wealthy individuals are more likely to be entrepreneurs and invest a larger share of their wealth in their own businesses when they are more willing to take risks. A comparison with less wealthy individuals reveals that these associations are stronger among the wealthy. Since the wealthy dominate aggregate risky investment, their extraordinarily high preference for risk and its link to entrepreneurial activity should be taken into account in theory development, empirical analysis, and the design of public policies influencing the riskiness of income and wealth such as progressive taxation.

Keywords Risk · Wealth · Entrepreneurship · Portfolio choice

JEL Classification J22 · J23 · L26 · D14

1 Introduction

According to economic theory, an individual's risk preference should relate positively to the choice to become an entrepreneur due to the riskiness of entrepreneurial income

✉ Frank M. Fossen
ffossen@unr.edu

¹ University of Nevada-Reno, Reno, USA

² IZA, Bonn, Germany

³ DIW Berlin, Berlin, Germany

⁴ Freie Universität Berlin, Berlin, Germany

relative to wage and salary income (Knight 1921; Kihlstrom and Laffont 1979). The positive association has been empirically confirmed for the general population in the thick middle of the wealth distribution (e.g., Cramer et al. 2002; Caliendo et al. 2009, 2010; Ahn 2010; Skriabikova et al. 2014). Further, risk tolerance influences the intensity of entrepreneurial activity, measured by the share of an individual's wealth invested in his or her own business. Moskowitz and Vissing-Jørgensen (2002) document the riskiness of undiversified investment in one's own business, as is typical for entrepreneurs, in comparison with investment in a market portfolio. Consistent with this, Fossen (2011) shows for the middle of the wealth distribution that—conditional on being an entrepreneur—those individuals who are more risk tolerant invest a larger share of their wealth portfolio in their own business. Due to credit constraints, primarily caused by asymmetric information, especially in the case of innovative start-ups, businesses started by entrepreneurs may often only be able to grow if the owners are willing to put up their own wealth and expose themselves to risk (Evans and Jovanovic 1989; Blanchflower and Oswald 1998; Johansson 2000; Nykvist 2008; Takalo and Toivanen 2012). Therefore, entrepreneurship can be seen as the link between risk preferences and economic growth, which makes understanding the relationship between individual risk preferences and entrepreneurship very important.

Yet, the existing empirical studies on this relationship miss an important group: entrepreneurs from the top tail of the wealth distribution. Studying the risk preferences and risk taking behavior of the wealthy is important as their risk taking and investment choices dominate the aggregate amount of risky investment in the economy (Grüner 2003). Atkeson and Irie (2022) show in a random growth model that the decision of a few families to bear a large amount of idiosyncratic risk by concentrating their wealth in a single business explains the prevalence of new fortunes and the dynamics of top wealth inequality. Entrepreneurs dominate rich lists in many countries¹ and occupy key positions in the economy. Wealthy entrepreneurs often run large businesses with large numbers of employees, so their risk taking and investment behavior has large impacts on the workforce as well as on public finances because governments participate in upside risks through tax revenues and in downside risks through the safety net provided for the employees.²

An important reason for the lack of meaningful empirical analyses of wealthy entrepreneurs is that they are represented in existing surveys only in very small numbers. For instance, the US Survey of Income and Program Participation used by Hamilton (2000) to analyze entrepreneurial earnings oversamples low-income households, but not high-wealth households. Quadrini (1999) uses the 1984 and 1989 waves of the US Panel Study of Income Dynamics (PSID) to analyze entrepreneurial wealth, which do not oversample wealthy households either. Pfeffer et al. (2016) show that estimates of average net worth, especially of business assets, are significantly underestimated in the PSID, primarily in the top 2% of the wealth distribution.

¹ For example, the top 10 in the Forbes list for 2022 (Forbes 2022) is dominated by entrepreneurs such as Elon Musk and Jeff Bezos from the USA, while the ten richest Germans and their families all made their fortunes by founding firms and entrepreneurship (Welt 2020).

² Starting from the observation that business owners are disproportionately represented among the wealthy and are exposed to substantial idiosyncratic risk, Phelan (2021) derives implications for optimal taxation.

To close this research gap, the fundamental research questions regarding risk preferences and entrepreneurship need to be answered for the wealthy: Does risk tolerance affect entrepreneurial choice, i.e., the choice to be an entrepreneur? Further, among wealthy entrepreneurs, does risk tolerance affect the portfolio share that they invest in their own business the same way it does among less wealthy entrepreneurs? These are empirical questions because theory is ambiguous. On the one hand, risk tolerance could play a smaller role for wealthy individuals because they can afford to lose some of their wealth. On the other hand, risk tolerance could play a larger role for the wealthy because in relative terms the wealthy are less secured by the social insurance system. An individual starting a business with little own wealth will quickly be eligible for means-tested welfare benefits in case of failure, and in case of bankruptcy, the individual may receive a discharge from debt after some time (Fossen 2014). This limits the downside risk in comparison with wealthy entrepreneurs, who put their wealth at risk. Liquidity constraints may also play a role. While the non-wealthy may be restricted in their ability to obtain the capital necessary to start and grow their own businesses, the wealthy may be able to choose their desired level of entrepreneurial activity more freely following their risk preferences, since they already possess the capital to invest.

The German Socio-Economic Panel (SOEP) opens up new possibilities to answer these research questions. Since 2019, the SOEP has included a novel sub-sample, SOEP-P, which heavily oversamples from the segment of wealthy shareholders in Germany. SOEP-P comprises 1956 adult anchorpersons plus 484 adult household members (mainly spouses). 45% of the anchorpersons hold an individual net worth of at least one million euro. Individual net worth is the share of a household's net worth (total assets minus liabilities) that can be attributed to the individual.

We first document that the wealthy, i.e., persons with an individual net worth above the 90th percentile of the population's wealth distribution, have a significantly higher preference for risk than the non-wealthy. Harrison et al. (2007), who elicit risk aversion using a lottery experiment in Denmark, present the effects of high and low *income* (flow) on the risk aversion estimates. They do not find significant effects of the income categories. In contrast, we document that risk tolerance differs along the *wealth* (stock) dimension, which is correlated with but different from income: the Pearson coefficient of correlation between net worth and gross labor income in our sample is 0.25.³

The difference in risk tolerance we find along the wealth gradient is reflected in more risky entrepreneurial behavior among the wealthy. Wealthy entrepreneurs invest 42% of their personal wealth in their own businesses, as opposed to only 24% among non-wealthy entrepreneurs.

Our econometric analysis reveals several novel empirical relationships. First, we document that a higher willingness to take risk is related to a higher probability of

³ Andersen et al. (2018) directly integrate an individual's wealth position when they elicit risk attitudes and find that individuals take their wealth into account only to a limited extent when they consider risky choices among lotteries. They focus on financial risk tolerance, whereas we focus on general risk tolerance. Further, Andersen et al. (2018) do not take into account business assets, which are a major component of the portfolio of the wealthy, as we document below. Our finding of higher risk tolerance of the wealthy is consistent with Brenner (2015), who reports that senior managers are more risk tolerant than less senior managers, given that senior managers are more wealthy on average.

being an entrepreneur among the wealthy.⁴ Second, conditional on being a wealthy entrepreneur, a higher willingness to take risk is associated with a larger portfolio share invested in one's business, controlling other relevant factors. Third, risky entrepreneurial investment at the top of the wealth distribution is even more strongly related to individual risk preferences than what results from the general population would have suggested. These relationships are robust to specification choices, including instrumental variables estimations accounting for potential endogeneity of risk tolerance and selection models.

Our results inform central debates on redistributive public policies affecting the riskiness of income and wealth, such as progressive taxation, loss offset provisions and bankruptcy law. As the riskiness of after-tax income influences how much wealthy entrepreneurs invest in their business, these policies will affect aggregate entrepreneurial risk-taking, which is crucial for innovation and economic growth (Van Stel et al. 2005; Acs and Armington 2006; Carree and Thurik 2010). Our results suggest that policies affecting the riskiness of income and wealth influence risky investment decisions at the top of the wealth distribution in ways strongly varying with individual risk preferences. Thus, the higher risk tolerance of the wealthy and the heterogeneity among them should be taken into account for theory development, future empirical analyses and the design of public policies.

2 Top wealth data

2.1 Data requirements and data overview

Studying wealthy entrepreneurs is difficult for a number of reasons. First, they constitute only a very small fraction of the overall population. As a result, their numbers in standard household surveys, which traditionally build on random draws from the base population, are small. Second, the data must provide information on entrepreneurial activity, asset portfolio composition, and a reliable measure of risk tolerance. The inclusion of all this information in a dataset at the same time is rare.

With its new high-wealth subsample, SOEP-P, first collected in 2019 (see Schröder et al. 2020c), the German Socio-Economic Panel (SOEP) is unique in fulfilling the aforementioned data requirements. SOEP is a representative survey of German households (Goebel et al. 2019; Schröder et al. 2020a) and has frequently been used in studies of self-employment and entrepreneurship (e.g., Nikolova 2019). The new SOEP-P subsample builds on a novel sampling strategy to oversample from the top tail of the wealth distribution. Since there is no direct register information on wealth in Germany (or other countries without a wealth tax such as the USA), the sampling strategy rests on an empirical pattern found in many countries: the vast majority of high-net-worth individuals allocate at least part of their portfolio in the form of corporate holdings. The global company database ORBIS provided by Bureau van Dijk, which draws from administrative company registers, provides comprehensive worldwide company

⁴ For the purpose of this paper, we define entrepreneurs as owners of one or multiple private businesses. In a robustness check, we use self-employment in the main job as an alternative definition.

information with ownership data. From the population of individuals with shares in companies worldwide, SOEP-P randomly draws from the 600,000 German residents with the largest company shares (in monetary units).⁵ Schröder et al. (2020c) show that this strategy was highly effective in targeting the wealthy. First, all rich individuals on the German rich list provided by the Manager Magazin are represented in ORBIS and also hold high company shares. Second, self-reported wealth in SOEP-P positively and highly correlates with values of company shares from ORBIS.⁶

In the current dataset, SOEP-P is fully integrated with the SOEP (Siegers et al. 2021). The same interviewing method (computer-assisted personal interviews) and the same questionnaire were used for SOEP-P and SOEP. Thus, variables are fully harmonized between the two datasets, which makes them ideal for comparisons of wealthy and non-wealthy populations. The fully integrated dataset for 2019 comprises 2189 entrepreneurs with strictly positive private business holdings, of which 817 hold an individual net worth of at least one million euro.

As regards wealth, the SOEP questionnaire contains a module about respondents' asset portfolios. Surveyed assets include: owner-occupied housing, rental property, financial assets, building-loan contracts, life and private pension insurance, tangible assets, vehicles, and, most importantly for this analysis, own private businesses (market value). In case an asset like a home or a business is owned by multiple individuals such as spouses or business partners, the respondent is asked about his or her individual share. The survey also collects the individual's liabilities: the mortgage on owner-occupied housing, mortgage on rental property, consumer debt, and education debt.

Figure 1 shows kernel density estimates for net worth calculated for the original SOEP without sample P and for sample P alone. The figure shows that the original SOEP had very few observations in the right tail of the net worth distribution above one million euro, while sample P is populating the right tail of the wealth distribution to a much larger extent. Importantly, sample P shows distributional mass even in the area of tens and hundreds of millions of euro, thus providing insight into the top of the wealth distribution.

2.2 Focal variables

The main outcome of interest is entrepreneurial activity, which we define based on own business assets. An individual is classified as an entrepreneur if the value of own private businesses is strictly positive. In a robustness check, we alternatively define entrepreneurs as those who indicate that their primary occupation is self-employment.⁷ The intensity of entrepreneurial activity is captured by the share of own business assets in an individual's assets portfolio (like in Fossen 2011). We calculate the portfolio share of business assets as the value of own business assets divided by total gross wealth. An

⁵ 600,000 individuals amount to roughly 1% of the German adult population.

⁶ Note that the sampling strategy does not imply that the wealthy individuals in the survey are entrepreneurs by construction because virtually all wealthy non-entrepreneurs own significant shares in companies as an investment (including asset and real estate management) and are therefore included in the sampling.

⁷ The self-employed may or may not employ others in their business and may or may not have other self-employed partners.

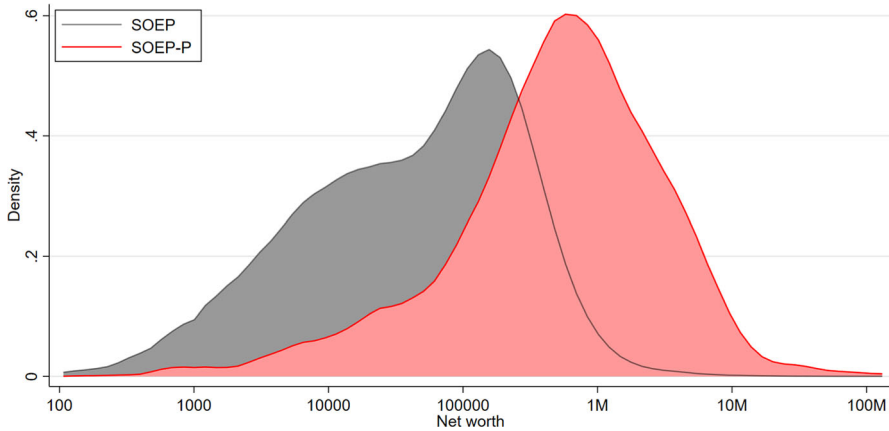


Fig. 1 Kernel density for SOEP and SOEP-P. *Notes:* We show kernel densities on a logarithmic net worth scale (in euro) for the SOEP without sample P (SOEP) and sample P (SOEP-P). Only observations with more than 100 euro net worth used for calculations. Results are unweighted. Source: Own calculations based on the SOEP

individual's total gross wealth is the sum of all assets, and net worth is gross wealth minus the sum of all liabilities. Thus, the portfolio share of own business assets in total gross wealth ranges between zero and one. The portfolio share of own business assets provides much richer information on the intensity of entrepreneurial activity compared to a binary indicator of entrepreneurship used in almost all prior studies of the relationship between individual risk preferences and entrepreneurship.⁸

The main independent variable is risk tolerance. In the SOEP questionnaire, respondents rate how much risk they are willing to take in general on a scale from 0 to 10, where 0 means “completely unwilling” and 10 means “fully willing.” Dohmen et al. (2011) compare this self-rated risk measure with risk preferences in an incentivized lottery experiment in the field, which is an established method of eliciting risk preferences (Andersen et al. 2008; Harrison et al. 2007), and find that the self-rating predicts actual risk-taking behavior very well. In some of our specifications, we use dummy variables for ranges of risk tolerance, defining a range of 0–3 as low, 4–7 as medium, and 8–10 as high risk tolerance.

We include a rich set of control variables that have been shown to be relevant for an individual's entrepreneurial choice (e.g., Parker 2018): educational degrees, age and its square, gender, the number of children, marital status, migration background, disability, region (in particular, residence in former East Germany), and the personal income tax rate.⁹

A potentially important determinant of entrepreneurship, which is related to risk preferences, is personality. The SOEP covers the Big Five personality traits openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism (Zhao et al. 2010). These traits are related to entrepreneurial decisions (e.g., Caliendo et al.

⁸ The paper by Fossen (2011) is the only exception, but it does not report any results for the wealthy because the data used in Fossen (2011) do not include a sufficient number of wealthy entrepreneurs.

⁹ The individual average effective tax rate is calculated as $1 - \frac{\text{net-of-tax income}}{\text{gross income}}$.

2014), which makes them potentially important control variables to isolate the effect of risk tolerance. The short inventory elicits the traits by asking respondents how much they agree with 15 statements about themselves on a 7-point Likert scale (see Caliendo et al. 2014). We standardize the variables of risk tolerance and the Big 5 traits to facilitate interpretation of the marginal effects.

We also control for possibly nonlinear wealth and income effects. This is important in our setting because risk tolerance may change with the wealth level, and wealth may affect entrepreneurial choice for reasons other than risk tolerance, for example, due to credit constraints (e.g., Hurst and Lusardi 2004). In a robustness check, we exclude the wealth, income and tax variables to address potential endogeneity concerns.

2.3 Population and estimation sample

We use the full SOEP including SOEP-P, but we exclude all SOEP respondents younger than 19 and older than 65 to focus on the population at working age. The working sample contains 1989 entrepreneurs and 18,679 non-entrepreneurs.

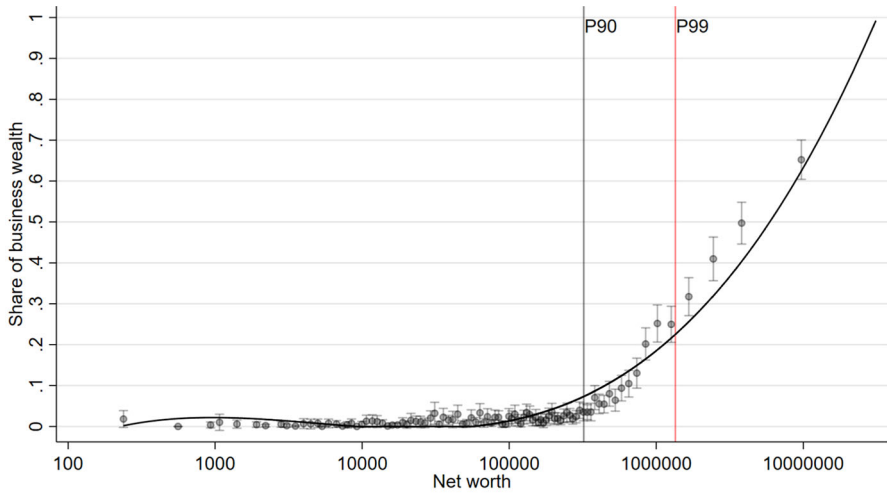
We define respondents with *individual* net worth greater than or equal the 90th percentile of the distribution of net worth (using population weights), which corresponds to 321,000 euro, as “wealthy,” and those with lower net worth as “non-wealthy.” This threshold clearly corresponds to a breakpoint in the relationship between net worth and the share of business assets, as will be shown in Sect. 3. Using this definition, 2839 respondents in our sample are wealthy, 45% of whom are entrepreneurs. 17,829 respondents are non-wealthy, 4% of whom are entrepreneurs.¹⁰ Thus, the sample provides sufficient statistical power to analyze wealthy entrepreneurs.

3 Motivating facts and descriptive statistics

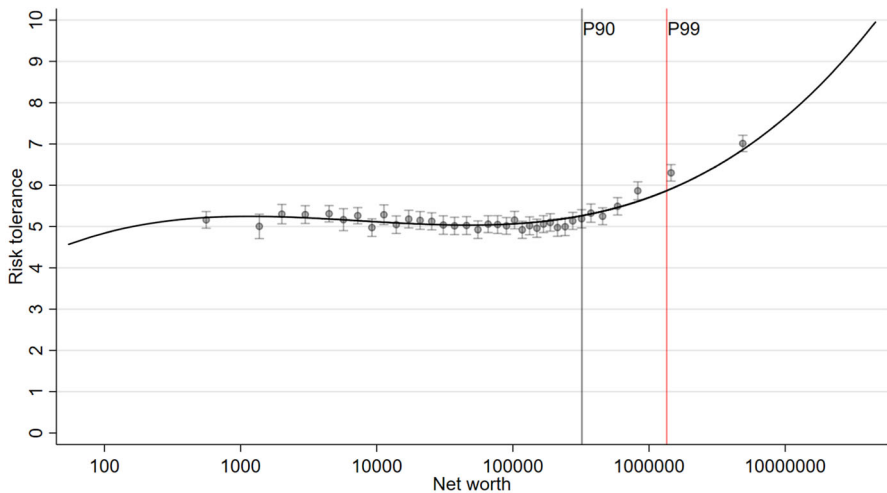
This section illustrates bivariate relationships between our three main variables of interest: wealth, risk tolerance, and the portfolio share of own business assets, i.e., entrepreneurial investment. Panel (a) of Fig. 2 shows that for most of the wealth distribution the portfolio share of business assets is very close to zero until roughly the 90th percentile. Past the 90th percentile, the share of business assets rises strongly with net worth. Similarly, Panel (b) shows that for most of the range of the wealth distribution, there is no relationship between net worth and risk tolerance. However, again, past the 90th percentile risk tolerance increases with wealth. These patterns have motivated our assignment rule to the wealthy and non-wealthy group. We use a higher cutoff in an alternative estimation.

Figure 2 suggests that the relationship between risk tolerance and the share of business assets might differ between the wealthy and the non-wealthy. To examine this in more detail, Fig. 3 presents local cubic polynomial fits of the relationships of three variables with risk tolerance for the non-wealthy and the wealthy groups: (1) the rate of entrepreneurship (i.e., the fraction of individuals who own private business assets),

¹⁰ Because of partial unit non-response, numbers of observations for analyses with more covariates can be smaller.



(a) Portfolio Share of Business Assets



(b) Risk Tolerance

Fig. 2 Net worth, risk tolerance, and entrepreneurial investment. *Notes:* We show binscatters and cubic fits of the binscatters (Cattaneo et al. 2021). Net worth (in euro) is shown on a logarithmic scale. Values for the 90th and 99th percentiles (P90 and P99) are calculated based on the population-weighted wealth distribution. Source: Own calculations based on the SOEP

(2) the unconditional portfolio share of business assets, and (3) the portfolio share of business assets conditional on being an entrepreneur. Panel (a) displays the relationships among the non-wealthy and Panel (b) among the wealthy. Entrepreneurial activity is much larger among the wealthy than among the non-wealthy across all risk preferences. For example, for the risk tolerance level of 5, the probability of being an entrepreneur is about 40% for the wealthy and only about 4% for the non-wealthy, and

the conditional portfolio share of own business assets is about 40% for the wealthy and 25% for the non-wealthy. For both the wealthy and the non-wealthy, the figure shows that there are positive relationships between the willingness to take risk and the portfolio share of own business assets, at both the extensive margin (probability of being an entrepreneur) and the intensive margin (conditional portfolio share), although the association at the intensive margin is not as strong. The positive relationships are plausible because investment in undiversified small business equity is very risky (Moskowitz and Vissing-Jørgensen 2002).

Table 1 provides descriptive sample statistics. The observation numbers show that 45% of the wealthy individuals in the sample are entrepreneurs in the sense of being private business owners. The average monthly labor income of wealthy non-entrepreneurs is 4309 euro and of wealthy entrepreneurs 7376 euro, as compared to 2048 euro and 4095 euro, respectively, among the non-wealthy. The wealthy are also older on average and have higher educational attainment than the non-wealthy (see also Schröder et al. 2020b).¹¹ The wealthy are male dominated, particularly in the group of entrepreneurs.

The wealthy express a higher risk tolerance than the non-wealthy: Among wealthy entrepreneurs, general willingness to take risk is about 6.6 on average on the scale from 0 to 10 and higher than that of wealthy non-entrepreneurs, which is only about 5.2. For the non-wealthy, the respective numbers are smaller, i.e., 6.1 and 5.1. In both the wealthy and non-wealthy group, entrepreneurs have a significantly higher willingness to take risk than non-entrepreneurs, as indicated by *p*-values below 0.01. The difference between entrepreneurs and non-entrepreneurs is consistent with what prior research shows for the general population (Caliendo et al. 2009, 2014).

Nicholson et al. (2005) report that the willingness to take risk is correlated with personality traits as described by the Big Five factors, combining high openness to experience and extraversion with low neuroticism, agreeableness, and conscientiousness. Consistent with this, entrepreneurs score significantly higher than non-entrepreneurs in the traits openness to experience and extraversion and lower in neuroticism (independent of wealth). However, entrepreneurs score higher in conscientiousness, and agreeableness is not significantly different across entrepreneurs and non-entrepreneurs.

Entrepreneurs hold their private wealth in remarkably undiversified portfolios.¹² Table 2 shows portfolio composition of the wealthy and compares them to the non-wealthy, separately for non-entrepreneurs and entrepreneurs. The table provides the new insight that wealthy entrepreneurs diversify their investments even less than non-wealthy entrepreneurs: wealthy entrepreneurs invest 42% of their wealth in their own business, whereas this share is only 24% among non-wealthy entrepreneurs.¹³

To explore the heterogeneity in the data further, we distinguish between the factors that contributed to an individual's wealth accumulation. In the SOEP, respondents

¹¹ The educational degrees are not mutually exclusive because they can be accumulated.

¹² In samples without the top tail of the wealth distribution, this result was reported for Germany based on the SOEP without SOEP-P (Fossen 2012; Fossen et al. 2020) and for the USA based on the Survey of Consumer Finances (Gentry and Hubbard 2004).

¹³ These are the shares of the aggregate asset values in aggregate gross wealth within the groups. When alternatively calculating the averages of the individual portfolio shares as done in Table 1, the shares are 42% among the wealthy and 29% among the non-wealthy.

Table 1 Descriptive statistics

Variable	Wealthy			Non-wealthy			p-value
	All	Non-Entrp	Entrp	All	Non-Entrp	Entrp	
Wealth share of own business	0.19	0.00	0.42	0.01	0.00	0.29	0.00
Self-employment	0.41	0.15	0.73	0.06	0.03	0.66	0.00
Risk tolerance	5.83	5.18	6.62	5.16	5.12	6.13	0.00
Low risk tolerance	0.20	0.29	0.10	0.27	0.28	0.16	0.00
Medium risk tolerance	0.53	0.54	0.50	0.55	0.55	0.53	0.22
High risk tolerance	0.27	0.17	0.40	0.18	0.17	0.31	0.00
Openness	4.76	4.61	4.93	4.59	4.57	4.99	0.00
Conscientiousness	5.92	5.88	5.96	5.77	5.76	5.93	0.00
Extraversion	5.04	4.95	5.15	4.94	4.93	5.13	0.00
Agreeableness	5.37	5.38	5.36	5.40	5.40	5.35	0.25
Neuroticism	3.19	3.32	3.03	3.65	3.67	3.33	0.00
Highschool	0.57	0.56	0.57	0.32	0.32	0.45	0.00
Apprenticeship	0.32	0.34	0.31	0.37	0.37	0.37	0.80
Technical College	0.25	0.24	0.26	0.21	0.20	0.27	0.00
University	0.46	0.48	0.44	0.22	0.21	0.33	0.00

Table 1 continued

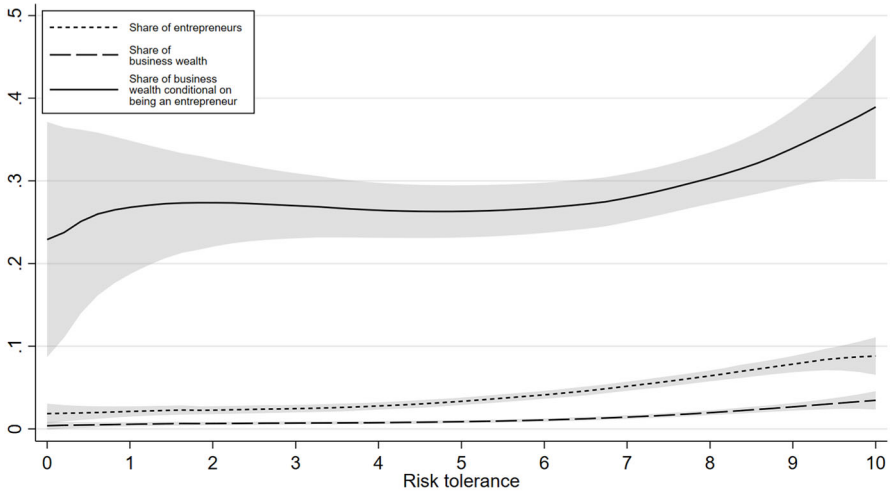
Variable	Wealthy			Non-wealthy			p-value
	All	Non-Entrp	Entrp	All	Non-Entrp	Entrp	
Age	52	52	52	42	42	48	0.00
Female	0.37	0.48	0.24	0.55	0.56	0.39	0.00
Married	0.77	0.78	0.75	0.55	0.54	0.71	0.00
Number of children in HH	0.77	0.79	0.74	0.77	0.77	0.79	0.57
Migration background	0.13	0.12	0.13	0.27	0.27	0.17	0.00
Disability degree	0.05	0.07	0.03	0.09	0.09	0.04	0.00
Father self-employed	0.22	0.17	0.30	0.09	0.08	0.19	0.00
Mother self-employed	0.09	0.08	0.10	0.04	0.04	0.08	0.00
East	0.13	0.09	0.18	0.20	0.20	0.26	0.00
South	0.38	0.44	0.31	0.24	0.25	0.21	0.05
North	0.10	0.10	0.10	0.14	0.14	0.10	0.00
Monthly gross income (euro)	5696	4309	7376	2129	2048	4095	0.00
Average tax rate	0.31	0.29	0.35	0.22	0.22	0.32	0.00
Observations	2839	1555	1284	17,829	17,124	705	

Notes: The *p*-values refer to tests of equal means between non-entrepreneurs and entrepreneurs within the samples of the wealthy and non-wealthy. The Big Five personality scores are non-standardized in this table. Results are unweighted. Source: Own calculations based on the SOEP

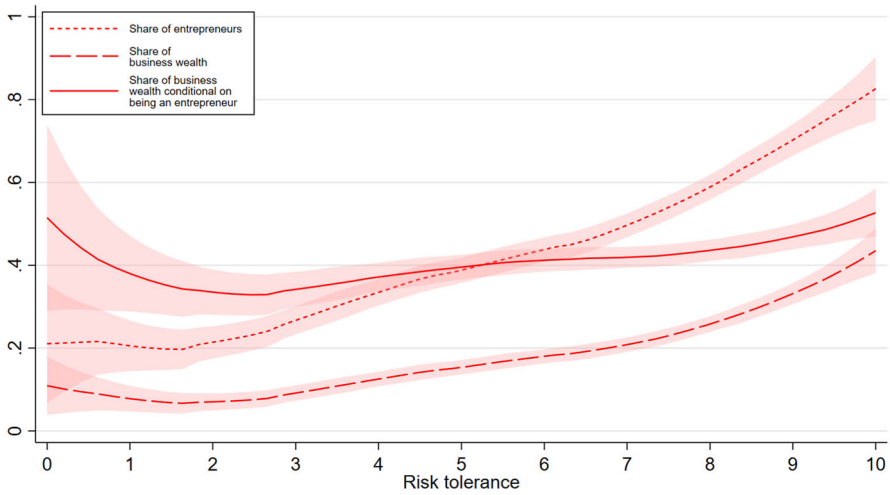
Table 2 Portfolio composition

	All		Non-entrepreneurs		Entrepreneurs	
	Mean	Share	Mean	Share	Mean	Share
	Wealthy					
Owner-occupied housing	340, 509	0.40	347, 627	0.54	331, 888	0.23
Rental property	400, 506	0.21	231, 441	0.22	605, 252	0.19
Financial assets	143, 268	0.09	108, 421	0.11	185, 471	0.06
Building loan contracts	9690	0.01	9695	0.02	9683	0.01
Private life & pension insur	112, 429	0.07	112, 410	0.07	112, 453	0.06
Own business assets	838, 824	0.19	0	0.00	1, 854, 690	0.42
Vehicles	37, 074	0.02	42, 108	0.03	38, 591	0.02
Tangible assets	10, 303	0.01	7017	0.01	14, 283	0.00
Gross wealth	1, 892, 603	1.00	858, 720	1.00	3, 144, 696	1.00
Owner-occ. housing debt	41, 412	0.04	37, 783	0.05	45, 808	0.03
Rental property debt	101, 969	0.04	43, 355	0.03	172, 953	0.04
Consumer debt	19, 314	0.01	3397	0.00	38, 591	0.02
Education debt	116	0.00	209	0.00	2	0.00
Total debt	162, 810	0.09	84, 744	0.09	257, 354	0.09
Net worth	1, 729, 792	0.91	773, 976	0.91	2, 887, 342	0.91
Observations	2839		1555		1284	
	Non-wealthy					
Owner-occupied housing	45, 613	0.60	44, 360	0.62	76, 022	0.40
Rental property	7231	0.09	6414	0.09	27, 064	0.14
Financial assets	6582	0.09	6408	0.09	10, 791	0.06
Building loan contracts	2703	0.04	2663	0.04	3675	0.02
Private life & pension insur	6731	0.09	6346	0.09	16, 063	0.08
Own business assets	1844	0.02	0	0.00	46, 586	0.24
Vehicles	5372	0.07	5199	0.07	9564	0.05
Tangible assets	379	0.00	344	0.00	1240	0.01
Gross wealth	76, 455	1.00	71, 735	1.00	191, 004	1.00
Owner-occ. housing debt	14, 444	0.19	13, 967	0.19	26, 030	0.14
Rental property debt	2746	0.04	2269	0.03	14, 324	0.07
Consumer debt	5534	0.07	3561	0.05	53, 407	0.28
Education debt	278	0.00	282	0.00	186	0.00
Total debt	23, 013	0.30	20, 089	0.28	93, 947	0.49
Net worth	53, 452	0.70	51, 655	0.72	97, 057	0.51
[0.5em] Observations	17,829		17,124		705	

Notes: Assets are in euro. Share is the mean asset or debt amount divided by mean gross wealth. Results are unweighted. *Source:* Own calculations based on the SOEP



(a) Non-wealthy



(b) Wealthy

Fig. 3 Entrepreneurship and risk tolerance. *Notes:* We show local quadratic polynomial smooths of the data. Results are unweighted. Source: Own calculations based on the SOEP

are asked to rate factors that contributed to or detracted from their wealth accumulation on a Likert scale from -5 to $+5$, where larger numbers mean a larger positive contribution. Following König et al. (2022), we distinguish between three groups: Self-made individuals (versus inheritors) rate the importance of entrepreneurship and self-employment in contributing to their wealth higher than 3 (3 or lower) and the importance of gifts, inheritances or marriage 3 or lower (higher than 3). All other individuals belong to the mixed group. Table C1 in Online Appendix C shows that

among the wealthy and the non-wealthy, self-made individuals are more risk tolerant, are more likely to be entrepreneurs, and hold more of their wealth in their own business in comparison with both the inheritors and the mixed group. Among the wealthy, risk tolerance, the rate of entrepreneurship and the share of business assets are generally larger than among the non-wealthy, and the gap in these variables between the wealthy and the non-wealthy is largest among the self-made individuals.

In sum, the descriptive evidence suggests that both risk tolerance and the share of own business assets behave differently when we split the sample by wealth. It also suggests that risk tolerance and entrepreneurship may be related. In the following econometric analysis, we estimate the relationships between risk tolerance and entrepreneurship in the different wealth groups controlling for other individual characteristics.

4 Empirical strategy

Our primary goal is to estimate the association of entrepreneurial activity with risk tolerance. We evaluate the relationship at the intensive margin (portfolio share invested in one's own business), conditional on being an entrepreneur, and at the extensive margin (being an entrepreneur, as measured by a strictly positive portfolio share, or not). We estimate the relationship separately for the wealthy and the non-wealthy, which allows all coefficients to differ by group.¹⁴

Because the portfolio share of own business assets is bounded between zero and one and most individuals have zero business assets (non-entrepreneurs), we estimate a Tobit model with these lower and upper bounds. The latent index model is,

$$\text{share_business}_i^* = \alpha + \beta \times \text{risk_tolerance}_i + X_i\gamma + \epsilon_i. \quad (1)$$

The explanatory variable of main interest, *risk_tolerance*, is treated as a continuous variable in the main model. We relax the linearity assumption in the latent index model in an additional specification where *risk_tolerance* is coded into a vector of three dummy variables (see “focal variables” above). Based on the estimated Tobit model, we will provide average marginal effects both on the extensive and intensive margins.¹⁵ The vector X_i includes the control variables described in Sect. 2.2. Finally, ϵ_i is the error term.

The Tobit model is restrictive in the sense that it implies that the effect of risk tolerance at the extensive margin (probability of being an entrepreneur) has the same sign as the effect at the intensive margin (portfolio share of own business assets conditional on being an entrepreneur). Therefore, we also estimate the relationship at the extensive margin separately by means of the Probit model,

¹⁴ An alternative approach, which could be pursued in future research, would be the estimation of joint models for both wealth categories. The models could be fully interacted or restrict some coefficients to be the same across groups.

¹⁵ As mentioned above, we use the portfolio share of own business assets to measure both the extensive margin of entrepreneurial activity (zero versus strictly positive share) and the intensive margin (share conditional on being strictly positive).

$$P(\text{entrepreneur}_i = 1 | \text{risk_tolerance}_i, X_i) = \Phi \left(\tilde{\alpha} + \tilde{\beta} \times \text{risk_tolerance}_i + X_i \tilde{\gamma} \right), \quad (2)$$

with the dependent variable being a dummy variable equal to one if an individual is an entrepreneur (with positive private business assets) and zero otherwise. Φ is the cumulative normal distribution. The independent variables are the same as in the Tobit model.

5 Results

5.1 Risk tolerance, entrepreneurship, and entrepreneurial investment

This section presents the results from the Tobit and Probit estimations of the share of own private business assets in an individual's wealth portfolio and the probability of being an entrepreneur. We show average marginal effects corresponding to the Tobit and Probit models for risk tolerance and the Big Five personality traits in Table 3 and provide the full set of coefficients in Table C2 in Online Appendix C.¹⁶ The marginal effects of risk tolerance are positive and significant at the 1% level for both the non-wealthy and the wealthy at both the intensive and extensive margins of entrepreneurial activity, and irrespective of the use of the Tobit or the Probit model. This indicates that more risk-tolerant individuals are more likely to be entrepreneurs and invest a larger share of their wealth in their own business.

The estimated effect sizes are larger for the wealthy than the non-wealthy. Starting with the intensive margin using the Tobit estimates (conditional expectation), an increase in risk tolerance by one standard deviation is associated with a 1.2 percentage points (pp) larger share of own wealth invested in one's own business for the non-wealthy and with a 2.7 pp larger share for the wealthy entrepreneurs. Thus, the effect size for the wealthy is more than twice as large as that for the non-wealthy. At the extensive margin this pattern reinforces: In the Tobit specification, an increase in risk tolerance by one standard deviation is associated with a 1.3 pp higher probability of being an entrepreneur for the non-wealthy and a 6.5 pp higher probability for the wealthy. The marginal effects at the extensive margin are similar in the Probit specification, indicating robustness of the results with respect to the Tobit model assumptions. Overall, the estimated marginal effects show that the association between entrepreneurship and risk tolerance is stronger for the wealthy than for the non-wealthy, at both the intensive and extensive margins.

Concerning the Big 5 traits, openness to experience has a strong positive association with entrepreneurship at both the intensive and extensive margins. At the intensive margin, an increase in openness by one standard deviation is associated with a 1.1 pp higher share invested in one's own business for the non-wealthy and a 0.6 pp higher

¹⁶ Table C2 also reports the p -value of a coefficient equivalence test, testing all coefficients, between the wealthy and non-wealthy groups. The test results indicate rejection of the null hypothesis of equal coefficients at the 1%-level, supporting our choice of running separate regressions for the wealthy and the non-wealthy.

share for the wealthy. At the extensive margin, a one point increase in openness is associated with a 1.1–1.2 pp higher probability of being an entrepreneur among the non-wealthy and with a 1.4–2.0 pp higher probability among the wealthy, depending on the whether the Tobit or Probit model is used. The results for the extensive margin for the non-wealthy concur with the findings of Caliendo et al. (2014) while the results for the wealthy are new in the literature. Further, for the non-wealthy the marginal effect of openness is similar to the marginal effect of risk tolerance at both the intensive and extensive margins. However, for the wealthy risk tolerance has a much larger marginal effect at both margins.

5.2 Results for the very wealthy

To further analyze the very wealthy, we repeat our main analysis but with a different sample split. We categorize individuals as *very wealthy* when their net worth is equal to or exceeds one million euro, which cuts down the group size to about a third of the original wealthy group. This threshold is close to the 99th percentile of the wealth distribution in the overall German population. SOEP-P is unique in providing a sufficient sample size for analyzing this top percentile of the wealth distribution. Note that the group of the not very wealthy now contains many individuals that we categorized as wealthy in the main specification.

Table 4 reports the average marginal effects for risk tolerance and the Big 5. The patterns of results obtained from the alternative sample split are similar to those from the previous one. The marginal effects for the non-wealthy group do not change much, as one would expect. For the very wealthy results at the intensive margin are also very similar to the estimates in Table 3: the marginal effect of a one-standard-deviation increase in risk tolerance on the portfolio share of own business assets is 2.5 pp. At the extensive margin, the marginal effect for the very wealthy becomes smaller: increasing risk tolerance by one standard deviation increases the probability of being an entrepreneur by 2.3 pp for the very wealthy instead of 6.5 pp for the wider wealthy group in the Tobit specification. Note that the group of the very wealthy has an even larger baseline probability of being an entrepreneur of 78%.

A further difference in comparison with the results in Table 3 is that the marginal effect of openness is statistically insignificant for the very wealthy at both the extensive and intensive margins. This is in contrast to the results for risk tolerance, which remain statistically significant.

5.3 Robustness checks

5.3.1 Potentially nonlinear effects of risk tolerance

To capture potential nonlinearities in the relationship between risk tolerance and entrepreneurial activity, an alternative specification includes dummy variables for medium and high risk tolerance instead of the continuous variable, with cutoffs as defined in Sect. 2.2; low risk tolerance is the omitted base category. Table 5 provides the estimated Tobit and Probit average marginal effects. Apart from the risk tolerance

Table 3 Average marginal effects for entrepreneurial investment and entrepreneurship

	Tobit—Condit. Expectation		Tobit—Probability		Probit	
	Non-wealthy	Wealthy	Non-wealthy	Wealthy	Non-wealthy	Wealthy
Risk tolerance	0.012*** (0.002)	0.027*** (0.003)	0.013*** (0.002)	0.065*** (0.008)	0.014*** (0.002)	0.076*** (0.010)
Openness	0.011*** (0.002)	0.006** (0.003)	0.012*** (0.002)	0.014** (0.007)	0.011*** (0.002)	0.020** (0.009)
Conscientiousness	-0.001 (0.001)	0.002 (0.003)	-0.001 (0.002)	0.006 (0.007)	-0.001 (0.002)	0.009 (0.010)
Extraversion	-0.000 (0.001)	0.003 (0.003)	-0.000 (0.002)	0.006 (0.007)	0.000 (0.002)	0.003 (0.010)
Agreeableness	-0.000 (0.001)	0.005* (0.003)	-0.000 (0.001)	0.012* (0.007)	-0.000 (0.002)	0.009 (0.009)
Neuroticism	0.001 (0.001)	0.001 (0.003)	0.001 (0.002)	0.002 (0.007)	0.001 (0.002)	0.009 (0.009)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Income & wealth controls	Yes	Yes	Yes	Yes	Yes	Yes
N	16,973	2796	16,973	2796	16,973	2796

Notes: The dependent variable in the Tobit model is the portfolio share of own business assets and in the Probit model a dummy variable indicating business ownership. *N* gives the number of observations. Results are unweighted. Robust standard errors in parentheses. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source:* Own calculations based on the SOEP

Table 4 Average marginal effects for entrepreneurial investment and entrepreneurship—very wealthy

	Tobit—Condit. Expectation		Tobit—Probability		Probit	
	Not V. Wealthy	V. Wealthy	Not V. Wealthy	V. Wealthy	Not V. Wealthy	V. Wealthy
Risk tolerance	0.013*** (0.001)	0.025*** (0.007)	0.018*** (0.002)	0.023*** (0.007)	0.020*** (0.002)	0.040*** (0.015)
Openness	0.009*** (0.001)	-0.001 (0.006)	0.013*** (0.002)	-0.001 (0.006)	0.012*** (0.002)	0.012 (0.014)
Conscientiousness	-0.001 (0.001)	0.004 (0.006)	-0.001 (0.002)	0.004 (0.006)	-0.000 (0.002)	0.014 (0.015)
Extraversion	-0.001 (0.001)	0.008 (0.006)	-0.001 (0.002)	0.008 (0.006)	-0.000 (0.002)	0.021 (0.014)
Agreeableness	0.001 (0.001)	0.005 (0.006)	0.002 (0.002)	0.005 (0.005)	0.002 (0.002)	-0.016 (0.013)
Neuroticism	0.002 (0.001)	0.002 (0.006)	0.002 (0.002)	0.002 (0.006)	0.003 (0.002)	-0.008 (0.014)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Inc & wealth controls	Yes	Yes	Yes	Yes	Yes	Yes
<i>N</i>	18,868	901	18,868	901	18,868	901

Notes: The very wealthy are defined as those with an individual net worth of 1 million euro or more. The dependent variable in the Tobit model is the portfolio share of own business assets and in the Probit model a dummy variable indicating business ownership. *N* gives the number of observations. Results are unweighted. Robust standard errors in parentheses. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source:* Own calculations based on the SOEP

variables, the specifications are analogous to those in Table 3, and we return to the original threshold to distinguish between the wealthy and the non-wealthy.

At both the intensive and extensive margins, using Tobit or Probit, the estimated marginal effects of medium and high risk tolerance (in comparison with low risk tolerance) on entrepreneurial activity are positive and significant at the 1%-level for both the wealthy and the non-wealthy. Further, the marginal effects for high risk tolerance are always larger than those for medium risk tolerance, showing that risk tolerance has a monotonously increasing effect on entrepreneurial activity.

The estimated marginal effects of having medium and high risk tolerance are larger for the wealthy than for the non-wealthy, in line with the results from our main estimations. For example, non-wealthy individuals with high risk tolerance hold a 3 pp larger share of own business assets in their wealth portfolio than the non-wealthy with low risk tolerance, while the difference among the wealthy is 7.2 pp, so the effect size of high risk tolerance is 2.4 times larger for the wealthy than for the non-wealthy.

To compare the estimations based on the model with a linear term for risk tolerance or the dummy set, we show predicted values from the Tobit model for the wealthy and the non-wealthy in Fig. 4. For both the non-wealthy and the wealthy, the predictions from the linear and the dummy specifications for the rate of entrepreneurs and the conditional portfolio share of own business assets line up closely. This confirms that the main model using the linear term of risk tolerance approximates the relationships well.

5.3.2 Self-employment

Next, we estimate the probability of being self-employed instead of the probability of being a business owner. Table 1 shows that 66% of the non-wealthy private business owners also report self-employment as their primary occupation and even 73% among the wealthy business owners. A possible explanation for the different shares is that among the non-wealthy, more business owners have sideline businesses, but are employees in different companies as their main jobs because their own businesses do not generate sufficient income. Table 6 shows the average marginal effects obtained by estimating the Probit model for the probability of self-employment. The estimated marginal effects of risk tolerance are similar to those we obtained when estimating the probability of being a business owner (last two columns of Table 3), indicating robustness of the results.

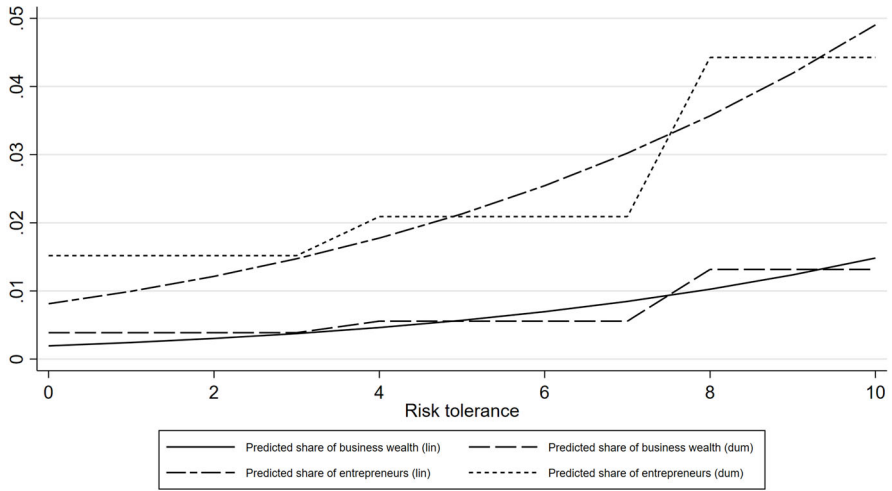
5.3.3 Restricted controls

A potential concern could be that wealth, income, and the tax rate in our main model might be endogenous because these variables might be partially a result of entrepreneurial activity. Hence, we reestimate the main Tobit and Probit specifications without including these control variables and show the resulting average marginal effects in Table 7. The estimated marginal effects of risk tolerance on entrepreneurial activity remain significant and are similar or somewhat larger than those in Table 3, confirming that the results are robust with or without the inclusion of the income and wealth controls.

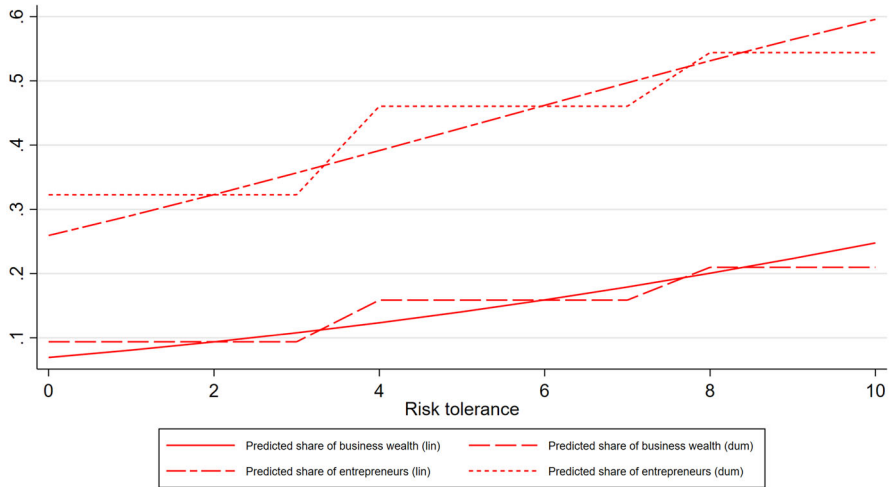
Table 5 Average marginal effects for entrepreneurial investment and entrepreneurship—dummy variables model

	Tobit—Condit. expectation		Tobit—Probability		Probit	
	Non-wealthy	Wealthy	Non-wealthy	Wealthy	Non-wealthy	Wealthy
RT: Medium	0.009*** (0.003)	0.044*** (0.008)	0.009*** (0.004)	0.108*** (0.019)	0.010*** (0.004)	0.106*** (0.022)
RT: High	0.030*** (0.004)	0.072*** (0.009)	0.033*** (0.004)	0.173*** (0.022)	0.036*** (0.005)	0.205*** (0.027)
Openness	0.011*** (0.001)	0.007** (0.003)	0.012*** (0.002)	0.017** (0.007)	0.012*** (0.002)	0.022** (0.009)
Conscientiousness	-0.001 (0.001)	0.002 (0.003)	-0.001 (0.002)	0.005 (0.007)	-0.001 (0.002)	0.008 (0.010)
Extraversion	-0.000 (0.001)	0.003 (0.003)	-0.000 (0.002)	0.007 (0.007)	0.001 (0.002)	0.003 (0.010)
Agreeableness	-0.000 (0.001)	0.004 (0.003)	-0.000 (0.001)	0.010 (0.007)	-0.000 (0.002)	0.007 (0.009)
Neuroticism	0.001 (0.001)	-0.000 (0.003)	0.001 (0.002)	-0.000 (0.007)	0.000 (0.002)	0.006 (0.009)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Income & wealth controls	Yes	Yes	Yes	Yes	Yes	Yes
N	16,973	2796	16,973	2796	16,973	2796

Notes: The dependent variable in the Tobit model is the portfolio share of own business assets and in the Probit model a dummy variable indicating business ownership. RT is risk tolerance. N gives the number of observations. Results are unweighted. Robust standard errors in parentheses. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Source: Own calculations based on the SOEP



(a) Non-wealthy



(b) Wealthy

Fig. 4 Predicted entrepreneurial investment and entrepreneurship. *Notes:* The figure shows the predicted ownership probability and conditional portfolio share of private business assets as a function of risk tolerance at average values of the control variables in the estimation samples. The predictions are based on the estimated Tobit models in Tables 3 and 5. The models including risk tolerance as a linear variable are denoted lin and the models including risk tolerance as dummy variables are denoted dum. Results are unweighted. Source: Own calculations based on the SOEP

Table 6 Average marginal effects for self-employment

	Probit	
	Non-wealthy	Wealthy
Risk tolerance	0.016*** (0.002)	0.073*** (0.009)
Openness	0.024*** (0.002)	0.040*** (0.009)
Conscientiousness	-0.004* (0.002)	0.008 (0.010)
Extraversion	0.001 (0.002)	0.016* (0.009)
Agreeableness	0.002 (0.002)	0.016* (0.009)
Neuroticism	-0.001 (0.002)	0.003 (0.009)
Control variables	Yes	Yes
Income and wealth controls	Yes	Yes
<i>N</i>	16,973	2796

Notes: The dependent variable is a dummy variable indicating self-employment as the respondent's primary occupation. *N* gives the number of observations. Results are unweighted. Robust standard errors in parentheses. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source:* Own calculations based on the SOEP

5.3.4 Potential endogeneity and selection

Risk tolerance might be endogenous due to reverse causality if past or present experiences of entrepreneurship influence the risk tolerance of an individual. To address this potential issue, we also estimate our Tobit and Probit models with instrumental variables. We use two instruments: a dummy variable indicating that a respondent practiced sports during childhood and a dummy indicating frequent fights with one's parents during childhood. Both variables cannot be influenced by past or present experiences of entrepreneurship as they are determined before an individual enters the labor market, so the IV method rules out potential bias from reverse causality. Online Appendix A discusses the instruments further and provides the results, which generally confirm the baseline results.

We also estimate an IV-Heckit model to address selection into entrepreneurship (see Online Appendix B). The results are consistent with the main results, but imprecisely estimated.

5.4 Results summary

From the analysis, we derive four main results. First, there are significant and positive associations of risk tolerance with both the extensive and intensive margins of entrepreneurial activity. Second, these associations are stronger for the wealthy than for

Table 7 Average marginal effects for entrepreneurial investment and entrepreneurship—restricted controls

	Tobit—Condit. Expectation		Tobit—Probability		Probit	
	Non-wealthy	Wealthy	Non-wealthy	Wealthy	Non-wealthy	Wealthy
Risk tolerance	0.012*** (0.001)	0.035*** (0.003)	0.013*** (0.002)	0.086*** (0.008)	0.014*** (0.002)	0.109*** (0.010)
Openness	0.010*** (0.001)	0.008*** (0.003)	0.011*** (0.002)	0.021*** (0.007)	0.011*** (0.002)	0.027*** (0.010)
Conscientiousness	0.001 (0.001)	0.004 (0.003)	0.001 (0.002)	0.009 (0.007)	0.002 (0.002)	0.015 (0.010)
Extraversion	0.000 (0.001)	0.004 (0.003)	0.000 (0.002)	0.011 (0.007)	0.001 (0.002)	0.012 (0.010)
Agreeableness	-0.001 (0.001)	0.002 (0.003)	-0.001 (0.001)	0.005 (0.007)	-0.002 (0.002)	0.003 (0.009)
Neuroticism	-0.001 (0.001)	-0.003 (0.003)	-0.001 (0.002)	-0.007 (0.007)	-0.001 (0.002)	-0.005 (0.010)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Income & wealth controls	No	No	No	No	No	No
N	16,973	2796	16,973	2796	16,973	2796

Notes: The dependent variable in the Tobit model is the portfolio share of own business assets and in the Probit model a dummy variable indicating business ownership. *N* gives the number of observations. Results are unweighted. Robust standard errors in parentheses. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source:* Own calculations based on the SOEP

the non-wealthy. Third, risk tolerance is prime among the personality variables determining entrepreneurial activity. Especially for the wealthy, a one-standard-deviation increase in risk tolerance has larger positive marginal effects on the extensive and intensive margins of entrepreneurial activity than a one-standard-deviation increase in openness to experience, the factor among the Big Five personality traits that has the strongest association with entrepreneurial activity. Fourth, the estimated associations of risk tolerance with entrepreneurial activity for both the wealthy and the non-wealthy are robust. The pattern of results holds when we alter the wealth threshold, the functional form or the set of control variables, and when we address potential endogeneity and selection issues.

6 Discussion and conclusion

We provide first evidence that the economic theory predicting a positive relationship between risk preference and entrepreneurship (Knight 1921; Kihlstrom and Laffont 1979) holds for the wealthy. Individuals at the top of the wealth distribution are more likely to be entrepreneurs and invest a larger share of their wealth in their own businesses when they are more willing to take risk. These associations are even stronger among the wealthy than among less wealthy individuals. Existing empirical studies had been based on the thick middle of the wealth distribution and did not allow conclusions for the wealthy (Cramer et al. 2002; Caliendo et al. 2009, 2010; Ahn 2010; Fossen 2011; Skriabikova et al. 2014). In addition, we show that the wealthy are on average more risk tolerant than the non-wealthy. Thus, risk preferences play an even more important role for portfolio investment decisions of wealthy potential entrepreneurs than for the general population that prior empirical research was based on.

The evidence is consistent with several theoretical explanations. Risk preferences may play a stronger role for entrepreneurial decisions of the wealthy because the social insurance system is less relevant for them. Alternatively, liquidity constraints among the non-wealthy may explain the results. When one moves up in the wealth distribution these constraints become less binding, so the wealthy may be able to align their entrepreneurial decisions better to their risk preferences. In an expected utility framework, it is unclear whether the utility functions of wealthy individuals differ from those of the non-wealthy, with a different curvature at all levels of wealth, or whether they have the same utility function (in the other polar case), but with the curvature varying by wealth level. Our portfolio choice results are consistent with decreasing relative risk aversion; other literature provides mixed results on the shape of utility functions (Dynan 1993; Lugilde et al. 2019; Christelis et al. 2020). Importantly, we find that even among the wealthy, where liquidity constraints are unlikely, there is considerable variation in risk tolerance. These heterogeneous risk preferences determine individual risk-taking decisions, controlling for income and wealth. With our data, we cannot distinguish between the theories, and we suggest this as an avenue for future research.

The results have important implications for debates on policies affecting the income distribution and income risk because they shed light on how such policies influence entrepreneurial risk-taking of the wealthy. Progressive taxation and loss offset provisions, implemented for distributional purposes, also affect the riskiness of after-tax

income, and this insurance effect has been shown to affect entrepreneurship in the thick middle of the wealth distribution (Cullen and Gordon 2007; Fossen 2009; Wen and Gordon 2014; Arulampalam and Papini 2023). This paper shows that wealthy entrepreneurs are not only more risk tolerant on average than less wealthy entrepreneurs, but their risky investment in their own businesses is also more strongly shaped by their individual level of risk tolerance. Thus, taking into account heterogeneity in risk preferences when evaluating the effects of policies influencing risk is even more important when considering the wealthy: Economic theory should not assume homogeneous risk preferences among the wealthy and across the wealth distribution. These insights should be taken into account for any prediction of the influence of policies affecting risk on aggregate entrepreneurial investment: The reactions of the wealthy to such policies shape the overall effects on aggregate private investment because of their dominating influence. Understanding these relationships is crucial due to the importance of entrepreneurial risk-taking for innovation and economic growth. Future research should investigate the effects of specific policies influencing risk, such as tax policy and bankruptcy law, on entrepreneurial choices of the wealthy, taking into account the pronounced heterogeneity in risk preferences.

Our analysis is not without limitations. First, the novel high-wealth data are cross-sectional, so a panel data analysis is infeasible. When further waves of the high-wealth data become available, future research should investigate the dynamics of risk preferences, entrepreneurial investment and wealth. Second, incentivized lottery experiments in the field could be used to elicit risk preferences of the wealthy in addition to the self-rated willingness to take risk (Andersen et al. 2008; Harrison et al. 2007), although Dohmen et al. (2011) show that the self-rating predicts actual risk-taking behavior well. A complication will be that incentives might have to be large to be meaningful for the wealthy. Third, a challenge for future research is to exploit quasi-experimental variation in risk preferences to establish the causality of the relationships between risk preferences and entrepreneurial investment documented in this paper; our instrumental variables estimation provides a first step in this direction.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s00181-023-02475-x>.

Acknowledgements We thank participants at the 2021 Babson College Entrepreneurship Research Conference and the 2021 Annual Meetings of the Southern Economic Association for valuable comments. We also thank the German Federal Ministry of Education and Research and the German Federal Ministry of Labour and Social Affairs for financial support of our field work to collect the new subsample, P, of the Socio-Economic Panel. Johannes König and Carsten Schröder acknowledge financial support by Deutsche Forschungsgemeinschaft (project “Wealthholders at the Top” (WATT), project number: 430972113). Frank Fossen thanks HEC Paris, where he conducted part of this project as a visiting researcher, and the University of Nevada, Reno, for research sabbatical assistance.

Data availability statement The data used in this study are available from the Research Data Center SOEP at https://www.diw.de/en/diw_01.c.678568.en/research_data_center_soep.html, and the program codes that generate the results reported in this paper are available at the Open Science Framework (<https://osf.io/yzwhj/>).

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence,

and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

References

- Acs ZJ, Armington C (2006) *Entrepreneurship, geography, and American economic growth*. Cambridge University Press, Cambridge
- Ahn T (2010) Attitudes toward risk and self-employment of young workers. *Labour Econ* 17(2):434–442
- Andersen S, Harrison GW, Lau MI, Rutström EE (2008) Eliciting risk and time preferences. *Econometrica* 76(3):583–618
- Andersen S, Cox JC, Harrison GW, Lau MI, Rutström EE, Sadiraj V (2018) Asset integration and attitudes toward risk: theory and evidence. *Rev Econ Stat* 100(5):816–830
- Arulampalam W, Papini A (2023) Tax progressivity and self-employment dynamics. *Rev Econ Stat* 105(2):376–391
- Atkeson AG, Irie M (2022) Rapid dynamics of top wealth shares and self-made fortunes: What is the role of family firms? *Am Econ Rev Insights* 4(4):409–424
- Blanchflower DG, Oswald AJ (1998) What makes an entrepreneur? *J Law Econ* 16(1):26–60
- Brenner S (2015) The risk preferences of U.S. executives. *Manag Sci* 61(6):1344–1361
- Caliendo M, Fossen FM, Kritikos AS (2009) Risk attitudes of nascent entrepreneurs—new evidence from an experimentally validated survey. *Small Bus Econ* 32(2):153–167
- Caliendo M, Fossen FM, Kritikos AS (2010) The impact of risk attitudes on entrepreneurial survival. *J Econ Behav Organ* 76(1):45–63
- Caliendo M, Fossen FM, Kritikos AS (2014) Personality characteristics and the decisions to become and stay self-employed. *Small Bus Econ* 42(4):787–814
- Carree MA, Roy Thurik A (2010) The impact of entrepreneurship on economic growth. In: Acs ZJ, Audretsch DB (eds) *Handbook of entrepreneurship research*. Springer, New York, 557–594
- Cattaneo MD, Crump RK, Farrell MH, Feng Y, Feng MY (2021) Package binsreg. <https://cran.microsoft.com/web/packages/binsreg/binsreg.pdf>
- Christelis D, Georgarakos D, Jappelli T, van Rooij M (2020) Consumption uncertainty and precautionary saving. *Rev Econ Stat* 102(1):148–161
- Cramer JS, Hartog J, Jonker N, Van Praag CM (2002) Low risk aversion encourages the choice for entrepreneurship: an empirical test of a truism. *J Econ Behav Organ* 48(1):29–36
- Cullen JB, Gordon RH (2007) Taxes and entrepreneurial risk-taking: theory and evidence for the US. *J Public Econ* 91(7–8):1479–1505
- Dohmen T, Falk A, Huffman D, Sunde U, Schupp J, Wagner Gert G (2011) Individual risk attitudes: measurement, determinants, and behavioral consequences. *J Eur Econ Assoc* 9(3):522–550
- Dynan KE (1993) How prudent are consumers? *J Polit Econ* 101(6):1104–1113
- Evans DS, Jovanovic B (1989) An estimated model of entrepreneurial choice under liquidity constraints. *J Polit Econ* 97(4):808–827
- Forbes (2022) *World's Billionaires List—The Richest in 2022*. <https://www.forbes.com/billionaires/>
- Fossen FM (2009) Would a flat-rate tax stimulate entrepreneurship in Germany? A behavioural microsimulation analysis allowing for risk. *Fisc Stud* 30(2):179–218
- Fossen FM (2011) The private equity premium puzzle revisited—New evidence on the role of heterogeneous risk attitudes. *Economica* 78(312):656–675
- Fossen FM (2012) Risk attitudes and private business equity. In: Cumming D (ed) *The Oxford handbook of entrepreneurial finance*. Oxford University Press, Oxford, 109–132
- Fossen FM (2014) Personal bankruptcy law, wealth, and entrepreneurship—Evidence from the introduction of a “fresh start” policy. *Am Law Econ Rev* 16(1):269–312
- Fossen FM, Rees R, Rostam-Afschar D, Steiner V (2020) The effects of income taxation on entrepreneurial investment: a puzzle? *Int Tax Public Financ* 27:1321–1363
- Gentry WM, Glenn HR (2004) Entrepreneurship and household saving. *BE J Econ Anal Policy* 4(1):1–57

- Goebel J, Grabka MM, Liebig S, Kroh M, Richter D, Schröder C, Schupp J (2019) The German socio-economic panel (SOEP). *Jahrbücher für Nationalökonomie und Statistik* 239(2):345–360
- Grüner HP (2003) Redistribution as a selection device. *J Econ Theory* 108(2):194–216
- Hamilton BH (2000) Does entrepreneurship pay? An empirical analysis of the returns to self-employment. *J Polit Econ* 108(3):604–631
- Harrison GW, Lau MI, Rutström EE (2007) Estimating risk attitudes in Denmark: a field experiment. *Scand J Econ* 109(2):341–368
- Hurst E, Lusardi A (2004) Liquidity constraints, household wealth, and entrepreneurship. *J Polit Econ* 112(2):319–347
- Johansson E (2000) Self-employment and liquidity constraints: evidence from Finland. *Scand J Econ* 102(1):123–134
- Kihlstrom RE, Laffont J-J (1979) A general equilibrium entrepreneurial theory of firm formation based on risk aversion. *J Polit Econ* 87(4):719–748
- Knight FH (1921) *Risk, uncertainty and profit*, vol 31. Houghton Mifflin, Boston
- König J, Leckelt M, Richter D, Back MD, Schröder C (2022) The personality traits of self-made and inherited millionaires. *Humanit Soc Sci Commun* 9(1):1–12
- Lugilde A, Bande R, Riveiro D (2019) Precautionary saving: a review of the empirical literature. *J Econ Surv* 33(2):481–515
- Moskowitz TJ, Vissing-Jørgensen A (2002) The returns to entrepreneurial investment: a private equity premium puzzle? *Am Econ Rev* 92(4):745–778
- Nicholson N, Soane E, Fenton-O’Creevy M, Willman P (2005) Personality and domain-specific risk taking. *J Risk Res* 8(2):157–176
- Nikolova M (2019) Switching to self-employment can be good for your health. *J Bus Ventur* 34(4):664–691
- Nykvist J (2008) Entrepreneurship and liquidity constraints: evidence from Sweden. *Scand J Econ* 110(1):23–43
- Parker SC (2018) *The economics of entrepreneurship*, 2nd edn. Cambridge University Press, Cambridge
- Pfeffer FT, Schoeni RF, Kennickell A, Andreski P (2016) Measuring wealth and wealth inequality: comparing two US surveys. *J Econ Soc Meas* 41(2):103–120
- Phelan T (2021) *The optimal taxation of business owners*. Federal Reserve Bank of Cleveland Working Paper No. 19-26R
- Quadrini V (1999) The importance of entrepreneurship for wealth concentration and mobility. *Rev Income Wealth* 45(1):1–19
- Schröder C, König J, Fedorets A, Goebel J, Grabka MM, Lüthen Holger, Metzging Maria, Schikora Felicitas, Liebig Stefan (2020) The economic research potentials of the German Socio-Economic Panel study. *German Econ Rev* 21(3):335–371
- Schröder C, Bartels C, Göbler K, Grabka MM, König J (2020) Millionaires under the microscope: Data gap on top wealth holders closed. *DIW Weekly Report* 10(30/31):313–322
- Schröder C, Bartels C, Grabka MM, König J, Kroh M, Siegers Rainer (2020) A novel sampling strategy for surveying high net-worth individuals—a pretest application using the Socio-Economic Panel. *Rev Income Wealth* 66:825–849
- Siegers R, Steinhauer HW, König J (2021) SOEP-Core-2019: sampling, nonresponse, and weighting in Sample P. *SOEP Survey Papers* 1080
- Skriabikova OJ, Dohmen T, Kriechel B (2014) New evidence on the relationship between risk attitudes and self-employment. *Labour Econ* 30:176–184
- Takalo T, Toivanen O (2012) Entrepreneurship, financiership, and selection. *Scand J Econ* 114(2):601–628
- Van Stel A, Carree M, Thurik R (2005) The effect of entrepreneurial activity on national economic growth. *Small Bus Econ* 24(3):311–321
- Welt (2020) Die zehn reichsten Deutschen. <https://www.welt.de/wirtschaft/gallery131923894/Die-zehn-reichsten-Deutschen.html>. Retrieved on 9/21/2020
- Wen J-F, Gordon DV (2014) An empirical model of tax convexity and self-employment. *Rev Econ Stat* 96(3):471–482
- Zhao H, Seibert SE, Lumpkin GT (2010) The relationship of personality to entrepreneurial intentions and performance: a meta-analytic review. *J Manag* 36(2):381–404