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ORIGINAL ARTICLE

Mental health changes and the willingness to take risks

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Abstract
Utilizing the longitudinal SOEP data representative of the German population, we find that mental health shocks significantly decrease the willingness to take risks. We also find that mental health improvements increase the willingness to take risks significantly. Our findings are relevant for better understanding the economic decision making of the large number of individuals with mental health issues.

Keywords Willingness to take risks · Health shock · Health improvement · Mental health · SF-12

JEL classification I12 · D12 · D18 · D81

1 Motivation

The impact of mental health on economic preferences has not received much focus in the economics literature. This is surprising as mental health problems have high prevalence, high relevance to individual well-being and constitute a growing societal

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burden. Bloom et al. (2012) estimate the global burden of mental health problems alone to equal nearly $2.5 T in 2010 while the total health care costs in 2009 were around $5.1 T.[1] The continuously increasing number of deaths and disability cases caused by mental health problems in recent years (Statista 2017) calls for a clearer understanding of the economic situation of this part of the population. For this purpose, a crucial question to ask is how people's economic preferences (and ultimately their economic decisions) are affected by mental health changes.

In our paper, we specifically focus on risk preferences as the majority of economically relevant decisions during the lifetime of an individual are made under risk and uncertainty. Important examples include the decision to pursue an education,[2]whether to take up a specific job, and how much to save and invest. In these and other prevalent decisions, the risk attitude of an individual can be expected to play a major role.[3] Prior literature suggests that individuals' risk taking preferences are not constant, but can be influenced by various exogenous factors (Hao and Cowan 2019; Browne et al. 2019, 2021; Guiso and Paiella 2008; Menkhoff et al. 2006). We add to this literature by expanding this list of factors that change risk preferences by mental health changes.

Our paper therefore contributes to the growing literature on health and economic decision-making. Sickness and injuries are known as important contributors to individuals' quality of life[4,5] and have been shown by previous research to impact people's economic decisions. We distinguish ourselves from this literature in two main aspects. First, the majority of existing research associates health directly with observed behavior. For instance, Rosen and Wu (2004) show the impact of health state on asset holdings. Dahal and Fertig (2013) look at the effect of mental illness on household spending. Bogan and Fertig (2013) and Lindeboom and Melnychuk (2015) find that mental health issues are correlated with lower investments in risky assets. Others aim at detecting a correlation between health risk type and insurance purchases (see, e.g. Cutler and Reber 1998). Such direct observation of economic behavior can resemble a black box experiment as health changes can affect financial positions both by changing one's income perspective through medical costs and by changing one's economic preferences. Since both of these channels affect the ultimate choices made by individuals, we shed light into this black box by isolating the impact of health changes on economic preferences. Second, existing studies predominantly focus on physical health and not on mental health changes. For

[1] This demonstrates a nearly even division of health care costs between physical and mental health conditions, even when the prevalence of mental health conditions is often underestimated due to high stigma (Bharadwaj et al. 2017).

[2] See, e.g. Davies et al. (2002).

[3] Recently, there has been more research published on factors that change risk attitudes of individuals such as macro-economic conditions and major life events, see e.g. Hoffmann et al. (2013) and Browne et al. (2019).

[4] This is underlined by the fact that much research in health economics focusses on measuring the quality of life after certain health changes or treatments.

[5] In our analysis, we utilize the SF-12 mental component summary score as a quality of life measure dependent on one's mental health state, see more details in Sect. 3.

instance, Viscusi and Evans (1990) and Finkelstein et al. (2013) find that impaired physical health is associated with lower marginal utility of consumption. Evans and Viscusi (1991), however, do not confirm this association. The impact of physical health on risk preferences has been addressed in a few recent studies. Decker and Schmitz (2016) find that a physical health shock (measured by a loss of grip strength) decreases one's willingness to take risks (WTR). Schurer (2015) finds a positive association between self-rated health and the WTR, which was confirmed more recently by Courbage et al. (2017).

To the best of our knowledge, there are only two studies addressing the relationship between risk preferences and mental health issues: Halek and Eisenhauer (2001) investigate whether depression is associated with risk aversion (measured by life insurance demand). They find no statistically significant result and consider this surprising. Instead of relying on self-reported depression, we utilize a metric for mental health, i.e. the SF-12 mental component summary score that has been validated in numerous studies globally. In addition, we utilize a direct measure for risk aversion rather than the elicitation of risk aversion from life insurance demand. The latter may be susceptible to potentially impaired social functioning, which, together with high health costs, may reduce individuals' ability to get or keep insurance coverage. Furthermore, the longitudinal nature of our dataset tracks risk preferences before and after the health changes, which allows a more in-depth investigation of the causal impact. This also allows us to focus on risk preferences rather than risk taking behavior, which is particularly relevant when preference changes are not (instantaneously) aligned with behavioral change. More recently, Cobb-Clark et al. (2021) find that depression is associated with less self-reported risk taking in general and also less risk taking in several other specific domains such as driving, finances, and sports/leisure. They do not, however, find that depression impacts choices in an incentivized lottery. At the same time, the authors find more risk taking in the health domain. We add to these two papers by specifically investigating current shocks to mental health rather than the state of being depressed. This sheds further light on whether a low willingness to take risks just happens to be correlated with the propensity of mental health issues or whether the acute onset of a mental health deterioration is associated with a decrease in the WTR. In addition, we consider mental health as a general construct rather than focusing on the mental health diagnosis of depression.

In economics, risk preferences are considered a neutral individual trait of a decision maker. Yet, the eventual outcome resulting from a decision, which heavily depends on one's risk preference, can be positive or negative. For instance, investment in risky securities will lead to high expected returns but also to fluctuating outcomes. Entrepreneurship, which is shown to be chosen more likely by people with low risk-aversion (Cramer et al. 2002), may potentially lead to desirable career achievement but is also associated with highly volatile income. We therefore investigate whether sudden changes in mental health affect risk preferences without assigning risk preferences a positive or negative connotation. In the psychology literature, the relationship between sensation seeking/excessive risk taking and mental health has been analyzed for certain types of personality disorders. While sensation seeking/excessive risk taking are part of the risk taking domain, they have a negative

connotation and are considered detrimental to a person's well-being as the following examples illustrate. For personality disorders, Campbell et al. (2004) show that narcissistic individuals lose more money on bets and generally bet higher amounts due to greater overconfidence. Ellis et al. (1995) find higher levels of sexual risk taking in men with anti-social personality disorders. Reddy et al. (2014) find less risk taking in individuals with schizophrenia. However, mood disorders, including but not restricted to depression, anxiety and adjustment disorders, have received less attention even though they are more prevalent than personality disorders (World Health Organization, 2017). We add to findings from the psychology literature both by viewing risk preferences as an individual characteristic independent from any specific domain and by relaxing the sole focus on sensation seeking/excessive risk taking. In addition, we extend the notion of mental health to beyond certain types of diseases. Specifically, we employ a holistic approach and look at all mental health aspects affecting one's quality of life by utilizing the SF-12 mental component summary score.

We find that negative mental health shocks lead to a lower WTR. While prior literature has placed more focus on the consequences of health shocks, we also study the impacts of health improvements, such as the recovery from a major disease or an improvement in lifestyle. We find that mental health improvements increase the WTR.

In addition, we separately evaluate mental health improvements that are recoveries from earlier mental health shocks. Our data shows that a recovery increases the WTR to a comparable degree as the previous mental health shock decreases the WTR. On the other hand, an idiosyncratic mental health improvement not following an earlier health shock has a much weaker effect on WTR.

In addition to looking into recoveries, we also conduct a complementary analysis on the persistence of the impacts. We show that, conditional on no reoccurrence and no recovery, the impact of health changes in the current period extends to 2 years, but not 4 years after the health change. Furthermore, the persistence effect is asymmetric: health improvements cause more sustainable impacts than health shocks, which suggests that downward changes on the WTR wash out more easily in time, whereas upward changes tend to last longer.

Our findings indicate that mental health issues, apart from inducing direct costs such as medical treatment and loss of productivity, may have even deeper implications for individuals' future wellbeing through changing their economic preferences. A lower willingness to take risks may affect one's life choices across many domains. Considering the financial domain, for instance, in the context of multivariate risk preferences, our findings shed light on the third cross derivative of state-dependent utility functions. In particular, they empirically support the notion of cross-DARA, which means higher risk aversion in the consumption domain caused by a worse health status (Malevergne and Rey 2009).[6]

[6] In addition, cross-DARA implies cross-prudence in health, a concept discussed in Eeckhoudt et al. (2007).

The rest of the paper is organized as follows: after reviewing relevant existing research in Sect. 2, we introduce our empirical strategy and data in Sects. 3 and 4, respectively. Results of the analyses and robustness checks are shown in Sects. 5 and 6, respectively. Section 7 concludes and suggests future research.

2 Mental health changes and the willingness to take risk

The theory of decision making under risk assumes that being in a risky position is costly to a risk averse individual. We suggest that being in a risky position becomes more costly in terms of individual welfare, if mental health resources become scarce and argue as follows: Kahnemann (2011) discuss two systems of thinking, which they coin as thinking fast, and thinking slow. Fast thinking is intuitive and efficient and therefore relies on simple heuristics. Kahenmann coins this as using System 1. System 2 or slow thinking is (more) rational but also effortful. Under System 2, we carefully evaluate risky endeavors in order to trade off cost and benefits while a fast and intuitive System 1 response to risk can be to shy away from risky endeavor. We use stock investments as an example: an individual may invest into a specific stock if the expected return is sufficiently large to compensate her for the riskiness of the stock when evaluated under System 2. When evaluated under System 1, she may completely shy away from purchasing any stocks as they are risky and she does not like any kind of losses.

The assumption is that using System 2 is effortful and requires mental resources to override System 1. If being mentally unwell consumes additional mental resources, we would expect more System 1 thinking in mentally unwell individuals. In this spirit, we would expect that higher mental well-being equip individuals better to tolerate risky positions. Accordingly, a mental health shock should reduce the WTR, while a mental health improvement increases it.

Research has shown that specific mental health conditions have been linked to changes in risk taking behavior, as briefly discussed in the introduction. Overall, personality disorders such as schizophrenia constitute only one part of the bigger picture of mental disorders. Mood disorders such as depression, anxiety and adjustment disorders have higher prevalence in our society.[7] Halek and Eisenhauer (2001) do not find a significant impact of depression on risk attitude, while Cobb-Clarke et al. (2021) find that depression is associated with a lower self-reported WTR. More generally, depression has been shown to affect people's probability assessment and cognitive ability under risk and uncertainty, suggesting the potential existence of an influence on risk attitude as well. For instance, depression has been shown to be associated with reduced optimism bias, i.e. while general population tends to overestimate the likelihood of positive events, depressive individuals do so less frequently (see e.g. Sharot et al. 2007 and Weinstein 1989). In addition, Smoski et al.

[7] The World Health Organization (WHO) ranks depression as the 1st most common contributor to disability worldwide. Anxiety ranks 6th according to WHO (2017).

(2008) find that depressive adults are able to better identify low-risk, high-return random outcomes through learning.

Generally, more research has aimed at investigating how health affects individuals' economic preferences in terms of marginal utility of consumption as well as risk attitude. Decker and Schmitz (2016) find that physical health shocks measured by significant grip strength loss decrease individuals' WTR. Schurer (2015) and Courbage et al. (2017) find a positive association between self-rated health and the WTR. When it comes to the impact of health on risk-taking behavior instead of risk preferences, existing evidence is more mixed. Sundmacher (2012) finds that health shocks have a positive impact on smoking cessation, but not on weight loss. Rosen and Wu (2004) find that individuals with poor health have a lower demand for investment in risky assets. However, Love and Smith (2010) do not confirm this finding. As both physical and mental health are components of an individual's health and wellbeing, we aim to find out whether mental health shocks also decrease the willingness to take risks as documented for physical health shocks.

Cobb-Clark et al. (2021) discuss several theoretical reasons how depression may affect risk taking across different domains. We rely on their work to discuss channels that may drive or mediate why mental health changes affect risk taking. The authors mention three general channels: budget constraints and discounting, time-inconsistent preferences, and emotions and expectations. For budget constraints and discounting, the argument is that lower mental health is associated with less wealth, which would imply less financial risk taking for individuals who exhibit DARA preferences. In addition, lower patience in depressed individuals may lead to more discounting which is relevant for risk taking in domains with different points in time between the initial risk taking decision and the realization of the risk as e.g. in investments or insurance. Cobb-Clark et al. (2021) discuss that depressed individuals may be more likely to have time inconsistent preferences like lower self-control, less locus of control, higher impulsivity, lower conscientiousness and cognitive limitations. They argue that in terms of financial risk taking, individuals with depression may invest less in risky assets as the process of investment is a complicated task. In terms of emotions and expectations, lower optimism in depressed individuals may lead to fewer risky investments but potentially more insurance demand.

We specifically investigate how changes in mental health are associated with the WTR. In addition, we are interested in a broader notion of mental health changes. Health changes do not have to be negative. Health can also drastically improve as individuals recover from certain conditions they had before, or their health can improve through life style or environmental changes. As the SF-12 mental component summary score measures mental-health-related quality of life, we also investigate how the improvement of the score affects the WTR. In particular, we aim to find out whether mental health improvements have the opposite impact of mental health shocks. In addition, we decompose mental health improvements into two categories: those that are recovered from mental health shocks in the previous period, and those that experienced no health shocks in the previous period. This subgroup analysis aims at identifying a residual impact on the WTR of a mental health shock after the original health status is restored.

Finally, we are interested in the mid to long-term impact of health changes. If the effect on the WTR caused by health changes in one period does not carry over to the next, we have reasons to believe such impacts are only temporary and will soon depreciate in time. To see whether this is the case, we also analyze the persistence of the effects on the WTR caused by each type of mental health change by examining WTRs in periods after the health change.

3 Empirical strategy

To estimate the effect of mental health changes on individuals' WTR, we apply a regression-adjusted matching technique. In this section, we discuss the implementation of this approach. We also run several alternative models to double-check the robustness of our findings, the detailed results of which are reported in Sect. 6.

Matching is a commonly adopted technique in the treatment effects literature. It is used to estimate the causal impact of some treatment variable (the health shocks/improvements in our case) on an outcome variable (the WTR in our case) when the treatment is not randomly assigned but also depends on some pre-treatment confounding conditions. Since individuals in the treatment group, i.e. those having experienced a health change between the current and the previous periods, may differ from those in the control group in aspects beyond the treatment, we need to account for potential confounding covariates—factors that influence both the outcome variable and the propensity to land in the treatment group. In our context, age, for instance, affects the probability of having a sudden health change, which is why we include age (among others) as a confounding covariate. Matching accounts for such covariates by selecting the most "comparable" controlled observations for the treated observations based on the values of the covariates, whereas regression does this by incorporating the covariates into a model where their impact on the outcome variable is parameterized. A regression-adjusted matching is a combination of both approaches, which benefits from the double robustness property, that is, a consistent estimation can be obtained as long as one of the two models is correctly specified (Rubin 1979; Bang and Robins 2005; Kreif et al. 2013).

At the same time, matching can only correct bias between treated and untreated individuals based on the observable variables included. Despite the wide range of potential confounding factors included in our analysis, we acknowledge that there may be additional factors that potentially impact the probability of mental health shocks which we cannot control for. To be on the side of caution, we speak of associations rather than of causal effects whilst still aiming to correct the treatment bias to the best of our abilities. In the following, $\mathrm{WTR}_{i,t}$ denotes our outcome variable—individual i's willingness to take risks in year t. Further, since our health variables are available every second year, we let $S_{i,p,q,t}$ be the (dummy) treatment variable that equals one if individual i undergoes a health change between year $t-2$ and year t, where the type of the health change is described by p and $q \in \{\text{shock, improvement}\}$. In addition, $X_{i,t}$ represents the collection of all covariates for individual i in year t.

In the first step, we conduct a propensity score matching using $\mathrm{WTR}_{i,t}$ as the outcome variable, $S_{i,p,q,t}$ as the treatment variable together with all confounding

covariates in the previous period $X_{i,t-2}$, whose components we explain below. Similar to Decker and Schmitz (2016), we use a Probit model to estimate the propensity scores and apply an Epanechnikov kernel matching, where weights are assigned to the untreated observations according to the closeness of their propensity scores to those of the treated group. In the second step, we apply the kernel weights obtained from the matching in an OLS regression of $\text{WTR}_{i,t}$ on $S_{i,p,q,t}$ and $X_{i,t-2}$. As mentioned before, this approach strengthens our result by allowing it to benefit from the double robustness property.

A crucial condition for the matching estimates to be consistent is the unconfoundedness assumption (see Rubin 1990), under which the potential outcome and the treatment are independent conditional on the pre-treatment covariates. In other words, by accounting for covariates affecting both the outcome and the treatment, bias can be removed from the comparison between treated and untreated units, making a causal interpretation possible. The richness of our dataset allows us to control for a variety of potential confounders. We use a collection of covariates $X_{i,t-2}$ from the previous period when analyzing the impact of a health shock taking place between $t-2$ and t on the outcome of the current period $\text{WTR}_{i,t}$. Following Decker and Schmitz (2016), we take the covariates from the previous period in order to avoid overadjustment bias (see Schisterman et al. 2009).[8] The complete set of covariates and the summary statistics can be found in Table 2. In the following paragraph, we discuss all potential confounders included in our analysis as well as the reasons to include them.

We include $\text{WTR}_{i,t-2}$, which we refer to as the baseline WTR, into the set of pre-treatment covariates. An individual with higher baseline WTR could, for instance, be more likely to experience a health shock because of her higher inclination to engage in risky activities such as extreme sports and careless driving, thus exposing herself to higher health risks. The baseline WTR may also correlate with the outcome variable, for instance, due to unobservable individual characteristics such as genetic factors.

We also include stressful life events as confounding covariates for our analyses of mental health. It has been shown that mental health problems, such as depression, can be caused by both genetic vulnerability and stressful life events, as argued by the World Health Organization (2012), Kendler et al. (2010) and MacFadyen et al. (1996). In both cases, we do not rule out the possibility that causes of mental health problems also have direct impacts on the WTR. Indeed, as shown by Browne et al. (2021), starting to provide care for a family member and being separated from one's partner increase one's WTR, while getting married is associated with a decrease in WTR. We identify stressful life events according to the Social Readjustment Rating Scale (SRRS)—a widely used measurement instrument in the stress literature with a list of stressful life events that can contribute to illness, where events are rated according to the degree of readjustment needed (see Holmes and Rahe 1967; Scolley et al. 2000).

[8] We also run a separate robustness check with covariates of the current period and obtain very similar findings. These results are available upon request.

As shown by Table 1, our analysis includes 9 out of 10 top events according to Scolley et al. (2000). Out of these 10 events, only jail terms are not available in our dataset. Jail terms are, however, very rare events in Germany where only 0.078% of the population is incarcerated. Accordingly, leaving incarceration out of the analysis seems unlikely to affect the validity of our results. In addition, we control for age as a u-shaped relationship between age and stress has been documented by e.g. Graham and Pozuelo (2017).

We do not have an explicit control for sex difficulties, but sex difficulties are classified as impairment to health and should therefore be accounted for by our baseline health variables. As SF-12 and SF-36 scores are routinely used to measure quality of life for individuals with sexual difficulties (see e.g. Litwin et al. 1998 and Nortwedt et al. 2001). In addition, we also include the events of losing one's job[9] and giving birth to the first child, since they are shown by Browne et al. (2021) to affect WTR.

We also control for individuals' baseline mental and physical health measured by their SF-12 MCS and PCS scores in the previous period. We explain the calculation of these scores in the next section. Furthermore, we also include a set of social-demographic factors in the previous period including gender, age, income, occupation, education, marital status, immigration background and family structure. Geographical region and calendar year are also included in the set of covariates.

In order to examine the impact of a recovery from a previous health shock, we extend our analysis on health improvements by isolating those health improvements that are recoveries from previous health shocks. That is, for the treatment variable $S_{i,p,q_1,t}$, $q_1 =$ improvement, we additionally conduct a subgroup analysis by splitting our sample based on $S_{i,p,q_2,t-2}$, $q_2 =$ shock, $S_{i,p,q_2,t-2} = 1$ indicating the health shock taking place between $t-4$ in $t-2$ recovers between in $t-2$ and t.

For the persistence effect, we extend our focus on $\text{WTR}_{i,t}$ to $\text{WTR}_{i,t+2}$ and $\text{WTR}_{i,t+4}$ for all types of health changes. While doing this, we explicitly exclude future health changes so that any persistence effect being detected can only be attributed to health changes in the current period.

Finally, in addition to our baseline approach, we also apply a panel data model to account for unobserved individual fixed effects. The detailed description and the results of the robustness check are reported in Sect. 6.

4 Data

To conduct our analysis, we use the German Socio-economic Panel (SOEP)—a representative panel dataset of adult population living in Germany (see Wagner et al. 2007). Since 1984, the SOEP annually asks approximately 30,000 individuals from around 11,000 households a wide range of questions. These include, in addition to various social-demographic indicators, health- and lifestyle-related information, financial situation such as income, investment decisions and insurance purchase, as

[9] Regarding job loss, we exclude those individuals who quit their jobs on their own initiative.

Table 1 The inclusion of stressful life events. 9 out of the top 10 life events in Scolley et al. (2000) are accounted for in our analysis

Rank	Life event	Weights as in Scolley et al. (2000)	Included?
1	Death of a spouse	100	Yes
2	Divorce	58	Yes
3	Personal injury or illness	57	Yes (SF-12 variables)
4	Marital separation	51	Yes
5	Jail term	50	No
6	Marriage	50	Yes
7	Change in health of family member	46	Yes
8	Death of a close family member	45	Yes
9	Change in financial state	43	Yes (wealth indicators)
10	Sex difficulties	36	Yes (SF-12 variables)

well as the respondents' opinions towards various topics such as politics and media, etc.

For our analyses, we use the 2004, 2006, 2008, 2010, 2012, 2014, 2016 and 2018 waves of the SOEP, where both the self-reported WTR and the SF-12 questionnaire were surveyed.[10] Our balanced dataset consists of 4191 individuals (33,528 observations) in total. We balance our sample as we also investigate long-term consequences of mental health changes.

4.1 Willingness to take risks (WTR)

Starting in 2004, the SOEP asks its respondents to self-assess their willingness to take risks on a scale from 0 to 10, with 0 indicating zero risk tolerance and 10 being fully ready to take risks. The self-rated willingness to take risks (WTR) was surveyed in 2004, 2006, and every year from 2008 to 2014. The self-reported WTR has been proven to be a valid measure to assess risk preferences in large, longitudinal surveys despite that paid lottery choices have been considered the standard to elicit risk attitudes in lab experiments. Mata et al. (2018) conduct a meta study comparing self-reported risk preferences and show that they outperform incentivized, lab elicited preferences in terms of time stability, convergent and predictive validity. Andersson et al. (2016) find that risk attitude elicited with multiple price list methods are subject to considerable noise, especially for individuals with low cognitive ability. Dohmen et al. (2011) and Vieider et al. (2015) show that the self-reported WTR significantly positively correlates with preferences elicited through paid lottery choices in 30 countries. As shown by Loennqvist et al. (2015), the self-reported WTR has high explanatory power for decisions made in a trust game. The

[10] The detailed questions of the SF12 component scores are described in Appendix.

same study also shows superior retest-stability of the self-reported WTR compared to risk preferences elicited from lottery experiments. As we investigate how risk attitudes change with health and control for individual-specific characteristics that do not change over time, we have only few reservations regarding potential hypothetical bias, i.e. that individuals may systematically over- or underreport their WTR.[11]

Figure 1 shows the distributions of both absolute levels of WTR and year-to-year WTR changes.

4.2 The SF-12 MCS score, mental health shocks and mental health improvements

Starting from 2002, the 12-item short-form health survey (SF-12) has been included biennially in the SOEP. In our analysis, we use the mental component summary (MCS) score extracted from the SF-12 questionnaire to measure individuals' mental health conditions.

The SF-12 questionnaire was originally developed by the RAND Corporation for the Medical Outcomes Study (see Stewart and Ware 1992). It has been validated for a variety of mental and physical illness through populations across the globe (see e.g. Gandek et al. 1998 and Sanderson and Andrews 2002). The SF-12 questionnaire contains twelve questions[12] considering the respondents' health-related quality of life. Upon each survey, respondents are asked to answer these twelve questions on a five-point or three-point scale based on their health status in the previous 4 weeks. Subsequently, the twelve items are aggregated into eight subscales, namely *vitality (VT)*, *physical functioning (PF)*, *bodily pain (BP)*, *general health perceptions (GH)*, *physical role functioning (RP)*, *emotional role functioning (RE)*, *social role functioning (SF)*, and *mental health (MH).* We describe the twelve questions and how they are associated with the eight subscales in Appendix. The MCS score is computed from the eight subscales based on standardized scoring rules.[13] The distribution of the SF-12 MCS score according to age groups is shown in Fig. 2. Figure 3 shows the distribution of year-to-year changes of the SF-12 MCS score. As shown by the figures, the yearly MCS changes in our dataset are uni-modal.

We then generate indicators for mental health shocks/improvements based on the SF-12 MCS score. Health shocks have been defined in different ways in existing empirical literature. The advantages of using the SF-12 scores are that they have been validated in a large number of studies for different conditions measuring health related quality of life. At the same time, some authors rely on changes in categorical self-assessed health, see Lange et al. (2017) and Sundmacher (2012), while others utilize newly diagnosed diseases, see Sahm (2012). More recently, Decker and Schmitz (2016) use grip strength as an indicator for (physical) health status and define a shock as a 25% or higher decrease of grip strength from the previous period.

[11] For a more detailed analysis of different ways to elicit risk attitudes, we refer to Browne et al. (2017).

[12] The SF-12 is a shorter version of the SF-36, which contains thirty-six questions in total. It has been shown that if physical and mental component scales are of interest, SF-12 may replace SF-36 while significantly reducing the burden of the respondents. See Jenkinson et al. (1996).

[13] Scoring rules are adopted from http://gim.med.ucla.edu/FacultyPages/Hays/utils/

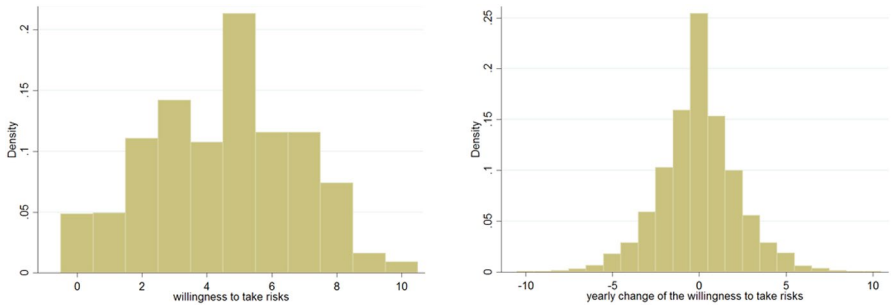

Fig. 1 Left: the distribution of willingness to take risks. "0" indicates no risk tolerance, "10" indicates fully ready to take risks. Right: the distribution of yearly changes in willingness to take risks. *Source*: SOEP, v31, 2004–2018

Similarly, we use the 25%-mark as an indicator for a shock and define a mental health shock as a decrease of the SF-12 MCS score by at least 25%. In a symmetric manner, mental health improvements are defined as an increase of the SF-12 MCS score by at least 25%. To avoid the baseline effect, we use the midpoint formula when computing the year-to-year changes of the SF-12 MCS score, that is, we use the average of previous-period and current period SF-12 MCS scores as the base for computing the 25% change. In order to account for any potential spillover between mental and physical health shocks, we exclude all individuals from our analysis who undergo a physical health and mental health shock simultaneously. Therefore, the variable mental health shock equals one only when an individual experiences a mental health shock and not a physical health shock at the same time.

One potential disadvantage of this definition of shocks is that with a lower baseline score, a smaller absolute change in health will be considered a shock. Another potential concern with this measure comes from the fact that the SF-12 scores are based on the subjective responses. We address these concerns in the robustness check, which we report in Sect. 6. In one robustness check, we adopt an alternative definition of mental health shocks by looking at individuals whose SF-12 MCS score falls below a constant threshold. In an additional robustness check, we use (self-reported) diagnosed depression rather than changes in the SF-12 MCS score as the indicator for mental health shocks in order to alleviate concerns about bias because of self-reported variables. Yet, we rely on the SF-12 score for the main part of the analysis as depression itself is often underdiagnosed specifically in some groups. Besides, in Germany, there is usually a long waiting time for individuals seeking medical treatment, which may create a delay between the onset of a depressive episode and the reporting in our data.[14]

We also compute the SF-12 PCS score from the SF-12 questionnaire, which is an indicator for individuals' physical health condition. Using a similar approach as

[14] See Sheehan (2004) for a general discussion. Among others, Allan et al. 2014 discuss underdiagnosed depression for elderly, while Kilmartin (2005) discusses gender bias.

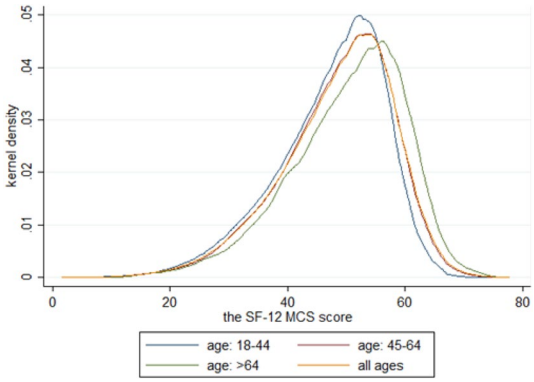

Fig. 2 The distribution of the SF-12 MCS score. *Source*: SOEP, v31, 2004–2018

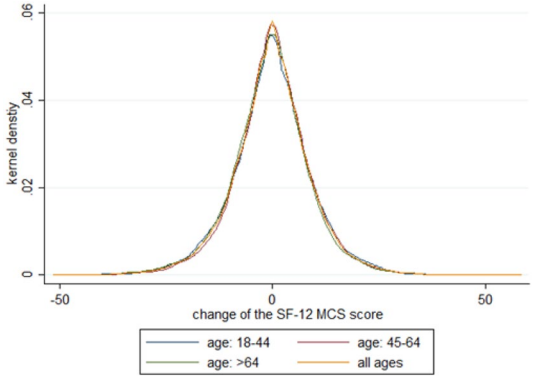

Fig. 3 The distribution of yearly changes of the SF-12 MCS score. *Source*: SOEP, v31, 2004–2018

before, we define physical health shocks/improvements based on the SF-12 PCS score. Although physical health is not the main focus of our paper, we compute the SF-12 PCS score because we use it to control for individuals' baseline physical health, as explained in the previous section. In addition, we also exclude those cases where both a mental health change and a physical health change take place during the same period. This is to disentangle potential interactions between mental and physical health changes.

Figure 4 shows the distributions of the WTR in each treatment group and the control group. Both graphs indicate a negative (positive) association between mental health shocks (improvements) and the WTR. In our analysis, we investigate these in more depth by accounting for potential covariates.

Table 2 shows the descriptive statistics for all variables used in our analysis. Our dataset allows us to control for a wide range of control variables, which may also impact health.

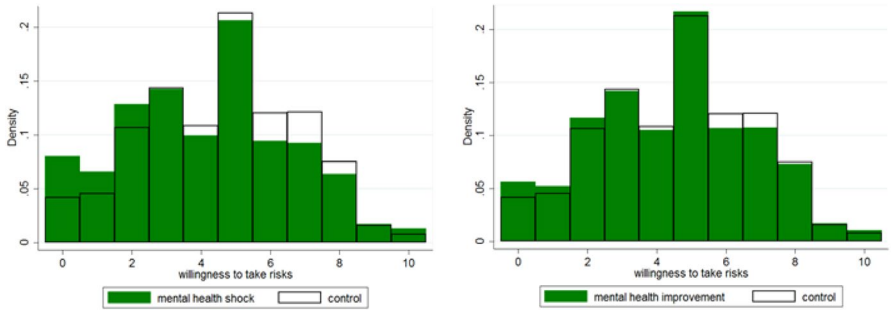

Fig. 4 The distribution of the willingness to take risks in treatment and control groups. Left: treatment: mental health shock. Right: mental health improvement. *Source*: SOEP, v31, 2004–2018. Shocks/improvements defined as an increase/decrease of the SF-12 MCS score by at least 25%

5 Results

5.1 Health changes and the willingness to take risks

Table 3 shows the main results of the regression-adjusted matching analysis. The estimated coefficients for the covariates are reported in Appendix. Overall, the matching performs well with standardized biases below the recommended guidelines in the literature, see e.g. by Ho et al. (2017).[15]

Table 3 shows a reduction of the WTR by 0.275 points caused by a mental health shock, which is significant at the 1% level. Considering a period-to-period change of WTR of − 0.174 points on average, this result shows that a reduced quality of life by deteriorating mental health substantially raises people's risk aversion.

As mentioned before, health improvements have not been the focus of prior literature. Column 2 of Table 3 shows that a mental health improvement increases the WTR by 0.3 points at the 1% level, suggesting a higher readiness to take risks induced by an improvement of mental health.[16]

In terms of assessing whether the observed coefficient estimates matter in terms of risk taking, we can offer only guidance by comparing them to size of other variables, where evidence established that these factors influence risk taking. A 0.275 reduction in the WTR equals approximately 60% of the difference in the WTR between males and females (0.437). Van Rooij et al. (2011) show that men are almost twice as likely invested into the stock market than women in a representative

[15] We omit the detailed list of standardized bias which is available upon request. Average standardized bias ranges between − 0.03% and 0.98% for all four estimation models. All biases are below the 15% threshold which is well below the rule of thumb that standardized bias should not exceed 0.25.

[16] By examining the impact of physical health shocks/improvements (defined as 25% decrease/increase of the SF-12 PCS score) on the WTR in a separate analysis, we find that mental health changes have a much stronger impact on the WTR than physical health changes. In particular, a mental health shock decreases the WTR by almost 3 times as much as a physical health shock does. These results are available upon request.

Table 2 summary statistics of the outcome variable, treatment variable and covariates. *Source*: SOEP, v31, 2004–2018. *Indicator variable. female, otherMaritalStatus, Bluecollar, eastGermnay and year2018 are used as omitted categories

Variables	Definition	Mean	sd	Min	Max
WTR	Individual's willingness to take risks	4.508	2.228	0	10
MentalShock*	Individual had a mental health shock	0.0805	0.272	0	1
MentalImprovement*	Individual had a mental health improvement	0.0833	0.276	0	1
PhysicalShock*	Individual had a physical health shock	0.0736	0.261	0	1
PhysicalImprovement*	Individual had a physical health improvement	0.0549	0.228	0	1
MCS	SF-12 MCS score	49.42	9.077	1.593	77.37
PCS	SF-12 PCS score	46.05	8.714	10.79	71.19
Male*	(1) Male	0.480	0.500	0	1
Age	Age	53.91	14.74	17	100
Age^2	Age squared	3,124	1,601	289	10,000
Married*	(1) Married	0.691	0.462	0	1
Single*	(1) Single	0.157	0.364	0	1
First_child*	(1) Individual had her/his first child	0.00701	0.0834	0	1
ln(income)	The natural logarithm of individual's household income per capita	7.530	0.824	4.448	13.79
Nojob*	(1) Individual has no job	0.0546	0.227	0	1
Trainee*	(1) Trainee	0.0171	0.130	0	1
Unemployed*	(1) Unemployed	0.0372	0.189	0	1
Retired*	(1) Retired	0.289	0.453	0	1
Selfemployed*	(1) Self-employed	0.0624	0.242	0	1
Whitecollar*	(1) White collar	0.350	0.477	0	1
Civilservant*	(1) Civil servant	0.0563	0.230	0	1
Jobloss*	(1) Individual lost her/his job	0.294	0.455	0	1
West Germany*	(1) Individual lives in west Germany	0.744	0.437	0	1
HighLevelSchool*	(1) Individual has high-level school leaving certificate	0.322	0.467	0	1
Immigrant*	(1) Immigrant	0.966	0.181	0	1

Table 2 (continued)

Variables	Definition	Mean	sd	Min	Max
GotMarried*	(1) Individual got married	0.0113	0.106	0	1
SeparatedPartner*	(1) Individual separated from her/his partner	0.0131	0.114	0	1
GotDivorced*	(1) Individual got divorced	0.00471	0.0685	0	1
DeathPartner*	(1) Individual's partner died	0.00537	0.0731	0	1
DeathFather*	(1) Individual's father died	0.0120	0.109	0	1
DeathMother*	(1) Individual's mother died	0.0133	0.114	0	1
Number_children	number of children	0.586	0.933	0	12
StartCare*	(1) Individual started to take care of a family member	0.0203	0.141	0	1
Observations	33,528				

*Indicates a dummy variable

Table 3 the effect of health changes on the willingness to take risks. *Source*: SOEP, v31, 2004–2018. Propensity score matching with regression adjustment (Epanechnikov kernel, bandwidth k = 0.02). Columns refer to health shocks/improvements (increase/decrease of the SF-12 MCS score by at least 25%). ◆Weighted number of observations

Health shock (≥ 25% change of the SF-12 scores)	(1) Mental health shock	(2) Mental health improvement
Effect on WTR	− 0.275***	0.300***
Standard error	(0.046)	(0.056)
Number of observations◆	25,445	25,441
Adjusted R-squared	0.334	0.367

sample of the Dutch population. This indicates that the estimated coefficient of 0.437 units in GRQ corresponds to substantial differences in financial risk taking. At the same time, caution is required to extrapolate differences in financial risk taking between genders on mental health shocks. Several factors may moderate differences and the SOEP is representative for the German population. The purpose of the exercise is to show that differences in GRQ for several factors have been shown to matter substantially in some risk taking domains.

5.2 Recoveries and persistence

In this section, we posit the question of whether changes in the WTR induced by mental health changes are memoryless or are of path-dependent/persistent nature. Given that health shocks and health improvements have opposite effects on the WTR, one might naturally ask whether an individual will restore her original WTR after experiencing a health shock and a subsequent health improvement.

To answer this question, we extend our main analysis by distinguishing recoveries from idiosyncratic health improvements. When an individual experiences a mental health shock in one period and a mental health improvement in the next period, we classify the health improvement as a recovery.[17] If a health improvement incurs without a previous shock, we classify it as an idiosyncratic health improvement. In our dataset, 40.1% of mental health improvements are identified as recoveries. We examine whether health recoveries have the same impact as idiosyncratic health improvements by repeating our previous analysis in the corresponding subsamples.

Comparing Tables 3 and 4, we see that mental health recoveries raise the WTR to a comparable extent as mental health shocks decrease the WTR, suggesting that once an individual's WTR is reduced by a mental health shock, the WTR will likely bounce back to the original level after she recovers from the shock. At the same time, mental health improvements not following a previous mental health shock raises the WTR by 0.154 points at the 5% significance level, suggesting that the

[17] Even though we may not necessarily capture recoveries from the same disease that caused the shock.

effect of an idiosyncratic mental health improvement is much weaker compared to a recovery. Note that we lose one year of observation in this analysis since we do not have information on health shocks occurring before year 2004.

We now look into the after-effect of mental health changes and ask whether there are long-lasting effects of mental health changes that extend into future periods. In particular, we select individuals who undergo a mental health change in the current period, but no further health changes in future periods, and examine the impact of the current-period mental health change on future WTRs. If our results in the previous section do not carry over to the future, we could claim that the impact of mental health changes on the WTR are only present in the short-term horizon (less than 2 years). Table 5 shows the results of this analysis.

Two insights can be drawn from Table 5. First, the impact is barely significant 4 years after the mental health change. Such a finding indicates that the consequence caused by mental health changes on the WTR will likely extend to the short-term future (2 years after the current period), but begin to fade away in the mid-term horizon (4 years and more). Second, the persistence effect is highly asymmetric. We observe a stronger and more significant persistence of mental health improvements than mental health shocks, indicating that while upward changes of WTR are more likely to sustain, downward changes wash out in time more easily.

Taken together, our findings suggest that the WTR exhibits moderate resilience to mental health shocks. First, the after-effect of mental health shocks does not extend beyond the short-term future. Second, recoveries from recent health shocks will likely restore the WTR to the original level before the shocks. At the same time, mental health improvements seem to cause a more persistent effect on the WTR, although the immediate impact of idiosyncratic mental health improvements appears weaker than mental health recoveries.

6 Robustness checks

In addition to our baseline approach, we conduct alternative analyses in this section to check the robustness of our results.

6.1 Mental health shocks based on an absolute SF-12 MCS score

The first robustness check uses a different definition of mental health changes. While our baseline definition focuses on relative score changes universally applied to all score levels, we realize that the same percentile change of scores may actually represent different magnitudes of health change depending on the absolute level of the baseline score. For instance, a change from perfectly healthy to fairly healthy may be different from a change from barely healthy to having a severe disease. In addition, starting with a lower baseline score means a small change of the absolute score will be considered a shock. For these reasons, even though relative score changes are most frequently used on the SF-12 MCS score, we run a robustness check where health shocks are based on absolute score levels. We define mental health shocks

Table 4 The effect of health recoveries and idiosyncratic health improvements on the willingness to take risks. *Source*: SOEP, v31, 2004–2018. Propensity score matching with regression adjustment (Epanechnikov kernel, bandwidth $k = 0.02$). Columns refer to different types of health improvements (recoveries from previous health shocks and absolute health improvements). ◆Weighted number of observations

Type of health improvement	(1) Recovery	(2) Idiosyncratic improvement
Effect on WTR	0.283***	0.154**
Standard error	(0.086)	(0.068)
Number of observations◆	21,731	21,741
Adjusted R-squared	0.375	0.367

Table 5 The effect of health changes on the willingness to take risks in future periods. *Source*: SOEP, v31, 2004–2018. Propensity score matching with regression adjustment (Epanechnikov kernel, bandwidth k = 0.02). Columns refer to mental health shocks/improvements (increase/decrease of the SF-12 MCS score by at least 25%). *Weighted number of observations

Health shock (≥ 25% change of the SF-12 scores)	(1) Mental health shock	(2) Mental health improvement
Effect on WTR in 2 years	− 0.225***	0.346***
Standard error	(0.076)	(0.077)
Number of observations*	17,044	17,049
Adjusted R-squared	0.296	0.332
Effect on WTR in 4 years	− 0.189*	0.210**
Standard error	(0.097)	(0.100)
Number of observations*	11,427	11,738
Adjusted R-squared	0.315	0.313

as a decrease of the SF-12 MCS score from above to below 45.6 points, as this is shown by Vilagut et al. (2013) to successfully indicate 30-day depressive disorders. On the other hand, we define mental health improvements as an increase of the SF-12 MCS score from below to above 45.6 points.

Table 6 shows the summary statistics of the alternative shock variables. We report the results of the regression-adjusted matching analysis using the alternative shock variables in Table 7.

As shown by Table 7, these results are consistent with those from the baseline model: a significant (at the 1% level) reduction (increase) of the WTR by 0.136 (0.166) points is shown to be induced by a mental health shock (improvement). Hence, conclusions from our baseline analysis remain robust after adopting the alternative health shock definitions.

6.2 Diagnosis of depression as alternative measure of a mental health shocks

SF-12 scores are based on individuals' subjective responses and may be influenced by different kinds of bias. Economists have voiced concerns about spurious correlations when self-reported measures are present on both sides of the estimation

Table 6 Summary statistics of the alternative treatment variables. *Source*: SOEP, v31, 2004–2018. Mental health shocks/improvements defined as increases/decreases of the SF-12 MCS score from below/to above 45.6 points

Health shock variables	Mean	sd	Min	Max
MentalShock_lowScore	0.1238	0.3294	0	1
MentalImprovement_lowScore	0.1278	0.3338	0	1

Table 7 The effect of health changes on the willingness to take risks. *Source*: SOEP, v31, 2004–2018. Propensity score matching with regression adjustment (Epanechnikov kernel, bandwith k = 0.02). Columns refer to mental health shocks/improvements (increase/decrease of the SF-12 MCS score from below/to above 45.6 points). *Weighted number of observations

Health shock (increase/decrease of the SF-12 scores from below/to above thresholds)	(1) Mental health shock	(2) Mental health improvement
Effect on WTR	− 0.136***	0.166***
Standard error	(0.036)	(0.039)
Number of observations*	25,558	16,302
Adjusted R-squared	0.328	0.355

Table 8 The effect of mental health shocks on the willingness to take risks. *Source*: SOEP, v31, 2009–2017. Propensity score matching with regression adjustment (Epanechnikov kernel, bandwith k = 0.02). Newly diagnosed depression as mental health shocks. *Weighted number of observations

	Mental health shock (newly diagnosed depression)
Effect on WTR	− 0.229***
Standard error	(0.066)
Number of observations*	38,268
Adjusted R-squared	0.311

procedure because of reporting bias.[18] To see whether our results change substantially when utilizing a potentially less biased health shock indicator, we conduct a second robustness check and use newly diagnosed depression as a measure for a mental health shock.[19] Our dataset contains information on whether the respondents have been diagnosed with depression in 2009, 2011, 2013, 2015 and 2017. We identify those individuals who answered yes to this question in year t, but not in years before t as those who experienced a mental health shock between $t-2$ and

[18] Even though the SF-12 scores have been optimized with a complex computing routine and have been validated in hundreds of studies for different diseases.

[19] Depression is the only reported mental health condition in our dataset.

t. Table 8 shows the results of the regression-adjusted matching analysis using this definition for mental health shocks: the onset of a depression decreases individuals' WTR by 0.229 points.

Table 9 Theeffect of health changes on the willingness to take risks. *Source*: SOEP, v31, 2004–2018. OLS with individual and year fixed effects, unbalanced panel. Columns refer to mental health shocks/improvements (increase/decrease of the SF-12 MCS score by at least 25%)

Health shock (≥ 25% change of the SF-12 scores)	(1) Mental health shock	(2) Mental health improvement
Effect on WTR	− 0.1916***	0.0823***
Standard error	(0.026)	(0.029)
Number of observations	95,067	95,067
Adjusted R-squared	0.032	0.031

6.3 Panel estimation

Our final robustness check takes further advantage of the panel structure of our dataset to address potential individual-specific time-invariant unobserved variables. Regression adjusted matching utilized in the paper allows us to balance the sample on time varying observables in our samples. In order to capture potential impact of prior traumatic events on mental health in general as well as risk preferences specifically, we include baseline mental health as well as past WTR as variables we base our matching on. This allows us to capture genetic factors as well as events prior to the observation period potentially that may differ between the "treated and untreated". At the same time, we acknowledge that we may not be able to fully capture the individual's inherent mental health exposure and WTR. The fixed effects panel estimation solves this issue but is not able to address the potentially confounding effect of time varying factors. Results from both approaches are consistent though in terms of significance and sign which let us conclude that there is a stable association between a mental health shock and the WTR.

Utilizing a panel comes, however, at the cost of potentially accepting an endogeneity problem implying potentially biased estimators as we do not rebalance the panel according to potentially time varying factors that impact the likelihood of a mental health shock.[20] Note that the lagged dependent variable is excluded from the set of covariates, since it would otherwise result in inconsistent estimation.[21]

[20] To address the concern that the self-reported WTR measure has an ordinal nature, we alternatively apply ordered probit/logit models, which yield similar results.

[21] In another robustness check, we implemented an Arellano-Bond estimator to see if the WTR follows an autoregressive pattern when individual fixed effects are included. We do not find evidence that the lagged WTR has a significant impact on the current period's WTR. Accordingly, we omit the results here but they are available upon request.

Instead, we assume in this model that the lagged WTR is associated with the health shocks and the WTR of the current period only through the unobserved individual fixed effects. Results of the second robustness check are reported in Table 9.

In Table 9, we observe consistent evidence for the mental health treatments as in the baseline approach. We observe a reduction of WTR by 0.192 points at the 1% level as a result of a mental health shock. Similarly, a mental health improvement increases the WTR by 0.082 points at the 1% level. Note that we utilize the whole sample in this analysis as we do not check for persistence. Accordingly, we have a higher number of observations in the unbalanced sample (95,067) than in the balanced sample (25,565, viz Table 10).[22]

Table 10 The effect of health changes on the willingness to take risks. *Source*: SOEP, v31, 2004–2018. OLS with individual and year fixed effects, balanced panel. Columns refer to mental health shocks/improvements (increase/decrease of the SF-12 MCS score by at least 25%)

Health shock (≥ 25% change of the SF-12 scores)	(1) Mental health shock	(2) Mental health improvement
Effect on WTR	− 0.145***	0.096**
Standard error	(0.045)	(0.048)
Number of observations	25,565	25,565
Adjusted R-squared	0.028	0.027

7 Conclusion and Future Research

Our paper contributes to the understanding of how health changes affect risk attitudes by investigating the impact of mental health changes on individuals' WTR. Mental health has received little attention in the economic literature so far despite its high prevalence, high social cost and potentially strong impact on (economic)

[22] As a robustness check, we also ran the panel estimation on the balanced sample and find consistent estimates in terms of significance levels and relatively robust size of coefficient estimates. Results are available in Table 10 Appendix.

decision-making. We also include mental health improvements in addition to mental health shocks in our analysis, which adds a new perspective to the analysis of health changes and risk preferences.

We use the nationally representative SOEP-dataset on the German population to assess the relationship between mental health changes and the WTR. We use drastic decreases/increases in the SF-12 MCS score to define mental health shocks/improvements. These scores measure health related well-being and have been validated in numerous previous studies. Mental health shocks are shown to significantly decrease the WTR. We also find that mental health improvements have opposite effects on the WTR than mental health shocks. These findings are robust to alternative definitions of health shocks and alternative estimation methods.

We also find evidence that the impact of mental health changes persists in the short run, but not in the long run. In the short run, mental health shocks cause reductions in the WTR that may be recovered by subsequent recoveries, suggesting a moderate resilience of economic preferences against drastic deteriorations of mental health. On the other hand, conditional on no reoccurrence nor recoveries, impacts on the WTR caused by mental health changes depreciate over time and hardly sustain beyond a 4-year horizon. Interestingly, we also observe a more sustainable impact caused by mental health improvements than by mental health shocks, suggesting that upward changes on the WTR tend to last longer.

To sum up, we find that mental health changes have a strong impact on risk preferences. This suggests a significant role mental health plays in economic decision-making under risk and uncertainty. One may speculate at this point whether and how other economic preferences, such as marginal utility and time preferences, depend on mental health as they have been found to depend on physical health (see e.g. Finkelstein et al. 2013) before. Given the high prevalence of mental health issues in the population, an interesting avenue for future research would be to investigate the impact of mental health on these preferences aiming to understand economic decision making of individuals with mental health issues more holistically.

Appendix

See Tables 11 and 12.

Table 11 The SF-12 subscales

Items[a]	Scales
When you have to climb several flights of stairs on foot, does your health limit you greatly, somewhat, or not at all?	Physical Functioning (PF)
And what about other demanding everyday activities, such as when you have to lift something heavy or do something requiring physical mobility: Does your health limit you greatly, somewhat, or not at all?	
During the last 4 weeks, how often did you feel that you achieved less than you wanted to at work or in everyday activities due to physical health problems?	Role-Physical (RP)
During the last 4 weeks, how often did you feel that you were limited in some way at work or in everyday activities due to physical health problems?	
During the past 4 weeks, how often did you have severe physical pain?	Bodily Pain (BP)
How would you describe your current health?	General Health (GH)
During the past 4 weeks, how often did you feel energetic?	Vitality (VT)
During the last 4 weeks, how often did you feel that you were limited socially, that is, in contact with friends, acquaintances, or relatives, due to physical or mental health problems?	Social Functioning (SF)
During the last 4 weeks, how often did you feel that you achieved less than you wanted to at work or in everyday activities due to mental health or emotional problems?	Role-Emotional (RE)
During the last 4 weeks, how often did you feel that you carried out your work or everyday tasks less thoroughly than usual due to mental health or emotional problems?	
During the past 4 weeks, how often did you feel calm and relaxed?	Mental Health (MH)
During the past 4 weeks, how often did you feel down and gloomy?	

As in the English Version of the SOEP survey, see TNS Infratest Sozialforschung (2014)

Table 12 Results for covariates *Source*: SOEP, v31, 2004–2018. Propensity score matching with regression adjustment (Epanechnikov kernel, bandwith k = 0.02). Dependent variable: WTR in the current period. Covariates are taken from the previous period. Columns refer to different types of mental health shocks (increase/decrease of the SF-12 MCS score by at least 25%). *Weighted number of observations

Variables	Treatment: mental health shock Dependent Variable: WTR (current period)	Treatment: mental health improvement Dependent variable: WTR (current period)
WTR	0.5088***	0.5457***
	[0.0128]	[0.0158]
MCS	0.0134***	0.0195***
	[0.0029]	[0.0043]
PCS	0.0102***	0.0042
	[0.0033]	[0.0038]
Age	0.0094	0.0087
	[0.0130]	[0.0157]
Age^2	− 0.0002	− 0.0001
	[0.0001]	[0.0002]
Male	0.4423***	0.3282***
	[0.0517]	[0.0637]
HighLevelSchool	0.0112	0.0138
	[0.0546]	[0.0680]
Married	− 0.1384*	0.0550
	[0.0786]	[0.0944]
Single	− 0.1887*	0.0345
	[0.1008]	[0.1188]
NumberChildren	0.0698**	0.0511
	[0.0292]	[0.0373]
Immigrant	0.1087	0.3285*

Table 12 (continued)

Variables	Treatment: mental health shock Dependent Variable: WTR (current period)	Treatment: mental health improvement Dependent variable: WTR (current period)
	[0.1547]	[0.1990]
ln(income)	0.0379	0.0653
	[0.0342]	[0.0408]
NoJob	− 0.0859	− 0.1675
	[0.1299]	[0.1436]
Trainee	0.2320	− 0.1009
	[0.1702]	[0.1844]
Umemployed	− 0.0933	− 0.1247
	[0.1377]	[0.1491]
Retired	0.1549	− 0.1390
	[0.1115]	[0.1319]
Whitecollar	0.0048	− 0.1972**
	[0.0756]	[0.0903]
Selfemployed	0.3688***	0.2724*
	[0.1117]	[0.1447]
Civilservant	− 0.1479	− 0.1325
	[0.1144]	[0.1371]
Year2006	0.7014***	0.7090***
	[0.1427]	[0.1645]
Year2008	0.4017***	0.3961**
	[0.1418]	[0.1665]

Table 12 (continued)

Variables	Treatment: mental health shock Dependent Variable: WTR (current period)	Treatment: mental health improvement Dependent variable: WTR (current period)
Year2010	0.4438***	0.3292**
	[0.1408]	[0.1603]
Year2012	0.8583***	0.8367***
	[0.1374]	[0.1582]
Year2014	0.5104***	0.5311***
	[0.1400]	[0.1653]
Year2016	0.5541***	0.6959***
	[0.1438]	[0.1614]
WestGermany	− 0.0011	− 0.0749
	[0.0564]	[0.0686]
StartCare	− 0.1237	− 0.0355
	[0.2221]	[0.1813]
SepPartner	− 0.0328	0.1564
	[0.1508]	[0.1578]
Jobloss	0.1138	0.1072
	[0.1176]	[0.1197]
GotMarried	− 0.0006	0.1654
	[0.1902]	[0.1922]
FirstChild	0.1402	− 0.1763
	[0.2225]	[0.3501]
DeathPartner	0.7561***	0.1044

Table 12 (continued)

Variables	Treatment: mental health shock Dependent Variable: WTR (current period)	Treatment: mental health improvement Dependent variable: WTR (current period)
	[0.2658]	[0.2172]
DeathFather	0.6768***	0.3248
	[0.2258]	[0.1992]
DeathMother	− 0.2926	0.0436
	[0.3410]	[0.1895]
GotDivorced	0.3353	0.4906
	[0.2643]	[0.3007]
Constant	− 0.0251	− 0.5722
	[0.4886]	[0.5919]
Observations*	25,445	25,441
Adjusted R-squared	0.334	0.367

Robust standard errors in brackets

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

Declarations

Conflict of interest The authors declare that there are no conflicts of interest.

References

Allan, C.E., V. Valkanova, and K.P. Ebmeier. 2014. Depression in Older People is Underdiagnosed. *The Practitioner* 258 (1771): 19–22.

Andersson O., H.J. Holm, J.-R. Tyran and E. Wengström, 2016. Risk aversion relates to cognitive ability: Preferences or noise? *Journal of the European Economic Association* 14 (5): 1129–1154. https://doi.org/10.1111/jeea.12179

Angst, J. 1995. The Epidemiology of Depressive Disorders. *European Neuropsychopharmacology* 5: 95–98. https://doi.org/10.1016/0924-977X(95)00025-K.

Bang, H., and J.M. Robins. 2005. Doubly Robust Estimation in Missing Data and Causal Inference Models. *Biometrics* 61: 962–973.

Bharadwaj, P., M.M. Pai, and A. Suziedelyte. 2017. Mental Health Stigma. *Economic Letters* 159: 57–60. https://doi.org/10.1016/j.econlet.2017.06.028.

Bloom, D.E., E. Cafiero, E. Jané-Llopis, S. Abrahams-Gessel, L.R. Bloom, S. Fathima, A.B. Feigl, T. Gaziano, A. Hamandi, M. Mowafi, and D. O'Farrell. 2012. *The global economic burden of noncommunicable diseases*. PGDA Working Papers 8172, Program on the Global Demography of Aging.

Bogan, V.L., and A.R. Fertig. 2013. Portfolio choice and mental health. *Review of Finance* 17 (3): 955–992.

Browne, M., V. Jaeger, and P. Steinorth. 2019. The impact of economic conditions on individual and managerial risk taking. *The Geneva Risk and Insurance Review* 44 (1): 27–53.

Browne, M. J., V. Jäger, A. Richter, and P. Steinorth. 2021. Family changes and the willingness to take risks. *Journal of Risk and Insurance*.

Bucciol, A., and L. Zarri. 2015. The Shadow of the Past: Financial Risk Taking and Negative Life Events. *Journal of Economic Psychology* 48: 1–16. https://doi.org/10.1016/j.joep.2015.02.006.

Campbell, W.K., A.S. Goodie, and J.D. Foster. 2004. Narcissism, Confidence, and Risk Attitude. *Journal of Behavioral Decision Making* 17: 297–311. https://doi.org/10.1002/bdm.475.

Cobb-Clark, D.A., S.C. Dahmann, and N. Kettlewell. 2021. Depression, Risk Preferences and Risk-Taking Behavior. *Journal of Human Resources*, 0419–10183R1.

Courbage, C., G. Montoliu-Montes, and B. Rey 2017. How Vulnerable is Risk Aversion to Wealth, Health and Other Risks? An Empirical Analysis for Europe. *Preceedings of the 44th Seminar of the European Group of Risk and Insurnace Economists*, London.

Cramer J.S., J. Hartog, N. Jonker, and C.M. Van Praag. 2002. Low risk aversion encourages the choice for entrepreneurship: an empirical test of a truism. *Journal of Economic Behavior & Organization* 48 (1): 29–36. https://doi.org/10.1016/S0167-2681(01)00222-0.

Cutler, D.M., and S.J. Reber. 1998. Paying for Health Insurance: The Trade-Off Between Competition and Adverse Selection. *The Quarterly Journal of Economics* 113 (2): 433–466.

Dahal, A., and A. Fertig. 2013. An Economic Assessment of the Effect of Mental Illness on Household Spending Behavior. *Journal of Economic Psychology* 37: 18–33. https://doi.org/10.1016/j.joep.2013.05.004.

Davies, R., E. Heinesen, and A. Holm. 2002. The Relative Risk Aversion Hypothesis of Educational Choice. *Journal of Population Economics* 15 (4): 683–713.

Decker, S., and H. Schmitz. 2016. Health Shocks and Risk Aversion. *Journal of Health Economics* 50: 156–170. https://doi.org/10.1016/j.jhealeco.2016.09.006.

Dohmen, T., A. Falk, D. Huffman, U. Sunde, J. Schupp, and G.G. Wagner. 2011. Individual Risk Attitudes: Measurement, Determinants, and Behavioral Consequences. *Journal of the European Economic Association* 9: 522–550. https://doi.org/10.1111/j.1542-4774.2011.01015.x.

Eeckhoudt, L., B. Rey, and H. Schlesinger. 2007. A Good Sign for Multivariate Risk Taking. *Management Science* 53 (1): 117–124. https://doi.org/10.1287/mnsc.1060.0606.

Ellis, D., I. Collis, and M. King. 1995. Personality Disorder and Sexual Risk Taking among Homosexually Active and Heterosexually Active Men Attending a Genitourinary Medicine Clinic. *Journal of Psychosomatic Research* 39: 901–910. https://doi.org/10.1016/0022-3999(95)00042-0.

Evans, W.N., and W.K. Viscusi. 1991. Estimation of State-Dependent Utility Functions Using Survey Data. *The Review of Economics and Statistics* 73: 94–104. https://doi.org/10.2307/2109691.

Finkelstein, A., E.F. Luttmer, and M.J. Notowidigdo. 2013. What Good is Wealth without Health? The Effect of Health on the Marginal Utility of Consumption. *Journal of the European Economic Association* 11: 221–258. https://doi.org/10.1111/j.1542-4774.2012.01101.x.

Gandek, B., J.E. Ware, N.K. Aaronson, G. Apolone, J.B. Bjorner, J.E. Brazier, M. Bullinger, S. Kaasa, A. Leplege, L. Prieto, and M. Sullivan. 1998. Cross-Validation of Item Selection and Scoring for the SF-12 Health Survey in Nine Countries: Results from the IQOLA Project. *Journal of Clinical Epidemiology* 51: 1171–1178. https://doi.org/10.1016/S0895-4356(98)00109-7.

Graham, C., and J.R. Pozuelo. 2017. Happiness, Stress, and Age: How the U Curve Varies Across People and Places. *Journal of Population Economics* 30 (1): 225–264.

Guiso, L. and M. Paiella. 2008. Risk Aversion Wealth and Background Risk. *Journal of the European Economic Association* 6 (6): 1109–1150. https://doi.org/10.1162/JEEA.2008.6.6.1109

Halek, M., and J.G. Eisenhauer. 2001. Demography of Risk Aversion. *The Journal of Risk and Insurance* 68: 1–24. https://doi.org/10.2307/2678130.

Hao, Z., and B.W. Cowan. 2019. The Effects of Graduation Requirements on Risky Health Behaviors of High School Students. *American Journal of Health Economics* 5 (1): 97–125.

Ho, D., K. Imai, G. King, and E.A. Stuart. 2017. Matching as Nonparametric Preprocessing for Reducing Model Dependence in Parametric Causal Inference. *Political Analysis* 15: 199–236. https://doi.org/10.1093/pan/mpl013.

Hoffmann, A.O., T. Post, and J.M. Pennings. 2013. Individual Investor Perceptions and Behavior During the Financial Crisis. *Journal of Banking & Finance* 37: 60–74. https://doi.org/10.1016/j.jbankfin.2012.08.007.

Holmes, T.H., and R.H. Rahe. 1967. The social readjustment rating scale. *Journal of Psychosomatic Research* 11 (2): 213–218. https://doi.org/10.1016/0022-3999(67)90010-4.

Jenkinson, C., R. Layte, D. Jenkinson, and J.R. Stradling. 1996. A Shorter Form Health Survey: Can the SF-12 Replicate Results from the SF-36 in Longitudinal Studies? *Journal of Public Health Medicine* 19: 179–186.

Judd, L.L., M.P. Paulus, K.B. Wells, and M.H. Rapaport. 1996. Socioeconomic Burden of Subsyndromal Depressive Symptoms and Major Depression in a Sample of the General Population. *American Journal of Psychiatry* 153: 1411–1417. https://doi.org/10.1176/ajp.153.11.1411.

Kahneman, D. 2011. Thinking, Fast and Slow. Farrar, Straus and Giroux.

Kendler, K.S., R.C. Kessler, E.E. Walters, C. Maclean, M.C. Neale, A.C. Heath, and L.J. Eaves. 2010. Stressful Life Events, Genetic Liability, and Onset of an Episode of Major Depression in Women. *Genetics and Genomics* 8: 459–470. https://doi.org/10.1176/foc.8.3.foc459.

Kilmartin, C. 2005. Depression in Men: Communication, Diagnosis and Therapy. *Journal of Men's Health and Gender* 2 (1): 95–99.

Kreif, N., R. Grieve, R. Radice, and J.S. Sekhon. 2013. Regression-Adjusted Matching and Double-Robust Methods for Estimating Average Treatment Effects in Health Economic Evaluation. *Health Services and Outcomes Research Methodology* 13: 174–202. https://doi.org/10.1007/s10742-013-0109-2.

Lange, R., J. Schiller, and P. Steinorth. 2017. Demand and Selection Effects in Supplemental Health Insurance in Germany. *The Geneva Papers on Risk and Insurance - Issues and Practice* 42: 5–30. https://doi.org/10.1057/s41288-016-0023-2.

Le, H.T., and H.T. Nguyen. 2018. The Impact of Maternal Mental Health Shocks on Child Health: Estimates from Fixed-Effects Instrumental Variables Models for Two Cohorts of Australian Children. *American Journal of Health Economics* 4 (2): 185–225.

Lindeboom, M., and M. Melnychuk. 2015. Mental Health and Asset Choices. *Annals of Economics and Statistics/Annales d'Économie et de Statistique*, (119/120), 65–94.

Litwin, M.S., R.J. Nied, and N. Dhanani. 1998. Health-Related Quality of Life in Men with Erectile Dysfunction. *Journal of General Internal Medicine* 13: 159–166. https://doi.org/10.1046/j.1525-1497.1998.00050.x.

Lönnqvist, J., M. Verkasalo, G. Walkowitz, and P.C. Wichardt. 2015. Measuring Individual Risk Attitudes in the Lab: Task or Ask? An Empirical Comparison. *Journal of Economic Behavior & Organization* 119: 254–266. https://doi.org/10.1016/j.jebo.2015.08.003.

Love, D.A., and P.A. Smith. 2010. Does Health Affect Portfolio Choices? *Health Economics* 19: 1141–1460. https://doi.org/10.1002/hec.1562.

MacFadyen, A.J., H.W. MacFadyen, and N.J. Prince. 1996. Economic Stress and Psychological Well-Being: An Economic Psychology Framework. *Journal of Economic Psychology* 17: 291–311. https://doi.org/10.1016/j.joep.2013.05.004.

Malevergne, Y., and B. Rey. 2009. On cross-risk vulnerability. *Insurance: Mathematics and Economics* 45 (2): 244–229. https://doi.org/10.1016/j.insmatheco.2009.06.002.

Mata, R., R. Frey, D. Richter, J. Schupp, and R. Hertwig. 2018. Risk Preference: A View from psychology. *Journal of Economic Perspectives* 32 (2): 155–172.

Menkhoff, L., U. Schmidt, and T. Brozynski. 2006. The Impact of Experience on Risk Taking, Overconfidence, and Herding of Fund Managers: Complementary Survey Evidence. *European Economic Review* 50: 1753–1766. https://doi.org/10.1016/j.euroecorev.2005.08.001.

Nortvedt, M.W., T. Riise, K.M. Myhr, A.M. Landtblom, A. Bakke, and H.I. Nyland. 2001. Reduced Quality of Life Among Multiple Sclerosis Patients with Sexual Disturbance and Bladder Dysfunction. *Multiple Sclerosis Journal* 7: 231–235. https://doi.org/10.1177/135245850100700404.

Rahe, R.H., and R.J. Arthur. 1978. Life Change and Illness Studies: Past History and Future DIRECTIONS. *Journal of Human Stress* 4: 3–15. https://doi.org/10.1080/0097840X.1978.9934972.

Reddy, L.F., J. Lee, M.C. Davis, L. Altshuler, D.C. Glahn, D.J. Miklowitz, and M.F. Green. 2014. Impulsivity and Risk Taking in Bipolar Disorder and Schizophrnia. *Neuropsychopharmacology* 39: 456–463. https://doi.org/10.1038/npp.2013.218.

Rosen, H.S., and S. Wu. 2004. Portfolio Choice and Health Status. *Journal of Financial Economics* 72: 457–484. https://doi.org/10.1016/S0304-405X(03)00178-8.

Rubin, D.B. 1979. Using Multivariate Matched Sampling and Regression Adjustment to Control Bias in Observational Studies. *Journal of the American Statistical Association* 74: 318–328. https://doi.org/10.1002/j.2333-8504.1978.tb01163.x.

Rubin, D.B. 1990. Formal Modes of Statistical Inference for Causal Effects. *Journal of Statistical Planning and Inference* 25: 279–292. https://doi.org/10.1016/0378-3758(90)90077-8.

Sahm, C.R. 2012. How Much Does Risk Tolerance Change? *Quarterly Journal of Finance* 2: 1250020. https://doi.org/10.1142/S2010139212500206.

Sanderson, K., and G. Andrews. 2002. The SF-12 in the Australian Population: Cross-Validation of Item Selection. *Australian and New Zealand Journal of Public Health* 26: 343–345. https://doi.org/10.1111/j.1467-842X.2002.tb00182.x.

Schisterman, E.F., S.R. Cole, and R.W. Platt. 2009. Overadjustment Bias and Unnecessary Adjustment in Epidemiologic Studies. *Epidemiology* 20: 488–495. https://doi.org/10.1097/2FEDE.0b013e3181a819a1.

Schurer, S. 2015. Lifecycle Patterns in the Socioeconomic Gradient of Risk Preferences. *Journal of Economic Behavior & Organization* 119: 482–495. https://doi.org/10.1016/j.jebo.2015.09.024.

Scolly, J.A., H. Tosi, and K. Banning. 2000. Life Event Checklists: Revisiting the Social Readjustment Rating Scale after 30 Years. *Educational and Psychological Measurement* 60: 864–876. https://doi.org/10.1177/00131640021970952.

Sharot, T., A.M. Riccardi, C.M. Raio, and E.A. Phelps. 2007. Neural Mechanisms Mediating Optimism Bias. *Nature* 450: 102–105. https://doi.org/10.1038/nature06280.

Sheehan, D.V. 2004. Depression: Underdiagnosed, Undertreated, Underappreciated.

Smoski, M.J., T.R. Lynch, M.Z. Rosenthal, J.S. Cheavens, A.L. Chapman, and R.R. Krishnan. 2008. Decision-Making and Risk Aversion Among Depressive Adults. *Journal of Behavior Therapy and Experimental Psychiatry* 39: 567–576. https://doi.org/10.1016/j.jbtep.2008.01.004.

Socio-economic Panel (SOEP), Data for Years 1984–2019, Version 36, SOEP, 2020. https://doi.org/10.5684/soep.v36.

Statista, 2017. Psychische Erkrankungen. https://de.statista.com/statistik/studie/id/6522/dokument/psychische-erkrankungen--statista-dossier-2012/

Stewart, A., and J.E. Ware. 1992. *Measuring Function and Well-Being: The Medical Outcomes Study Approach*. Durham: Duke University Press. https://doi.org/10.7249/CB361.

Sundmacher, L. 2012. The Effect of Health Shocks on Smoking and Obesity. *The European Journal of Health Economics* 13: 451–460. https://doi.org/10.1007/s10198-011-0316-0.

TNS Infratest Sozialforschung, 2014. SOEP 2014 - Erhebungsintrumente 2014 (Welle 31) des Sozio-oekonomischen Panels: Personenfragebogen, Altstichproben. SOEP Survey Papers 235: Series A. Berlin: DIW/SOEP.

Vieider, F.M., M. Lefebvre, R. Bouchouicha, T. Chmura, R. Hakimov, M. Krawczyk, and P. Martinsson. 2015. Common Components of Risk and Uncertainty Attitudes across Contexts and Domains: Evidence from 30 Countries. *Journal of the European Economic Association* 13: 421–452. https://doi.org/10.1111/jeea.12102.

Vilagut, G., C.G. Forero, A. Pinto-Meza, J.M. Haro, R. De Graaf, R. Bruffaerts, V. Kovess, G. De Girolamo, H. Matschinger, M. Ferrer, and J. Alonso. 2013. The Mental Component of the Short-Form 12 Health Survey (SF-12) as a Measure of Depressive Disorders in the General Population: Results with Three Alternative Scoring Methods. *Value in Health* 16 (4): 564–573. https://doi.org/10.1016/j.jval.2013.01.006.

Viscusi, W.K., and W.N. Evans. 1990. Utility Functions that Depend on Health Status: Estimates and Economic Implications. *The American Economic Review* 80: 353–374.

Wagner, G.G., J.R. Frick, and J. Schupp. 2007. The German Socio-economic Panel Study (SOEP) - Scope, Evolution and Enhancements. *Schmollers Jahrbuch* 127: 139–169.

Weinstein, N.D. 1989. Optimistic Biases about Personal Risks. *Science* 246: 1232–1234. https://doi.org/10.1126/science.2686031.

World Health Organization, 2012. Risks to Mental Health: an Overview of Vulnerabilities and Risk Factors. Background Paper.

World Health Organization, 2017. Depression and other common mental disorders: global health estimates.

van Rooij, M., A. Lusardi and R. Alessie. 2011. Financial literacy and retirement planning in the Netherlands. *Journal of Economic Psychology* 32 (4): 593–608. https://doi.org/10.1016/j.joep.2011.02.004.