Risk attitudes across the life course

THE
ECONOMIC
JOURNAL

The Economic Journal, **127** (*October*), F95–F116. Doi: 10.1111/ecoj.12322 © 2017 Royal Economic Society. Published by John Wiley & Sons, 9600 Garsington Road, Oxford OX4 2DQ, UK and 350 Main Street, Malden, MA 02148, USA.

RISK ATTITUDES ACROSS THE LIFE COURSE*

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This article investigates how risk attitudes change over the life course. We study the age trajectory of risk attitudes all the way from early adulthood until old age, in large representative panel data sets from the Netherlands and Germany. Age patterns are generally difficult to identify separately from cohort or calendar period effects. We achieve identification by replacing calendar period indicators with controls for the specific underlying factors that may change risk attitudes across periods. The main result is that willingness to take risks decreases over the life course, linearly until approximately age 65 after which the slope becomes flatter.

How do risk attitudes vary over the life course? Are risk attitudes stable or do they change with age? Do cohorts differ regarding their risk attitudes? Do risk attitudes change across time periods? Addressing these questions is of great importance, particularly in an ageing society. Several studies have documented that fundamental economic attitudes affect individual decision making in a myriad of contexts. Risk attitudes have a key impact on economic decisions (e.g. savings and investment decisions, labour market outcomes), demographic outcomes (e.g. fertility decisions) and socio-political behaviour (e.g. voting). Systematic changes in aggregate risk attitudes in an ageing society would have far-reaching consequences for economic, political and social outcomes.

This article studies the age profile of risk attitudes. For the analysis, we use data from two different sources: the Dutch DNB Household Survey – a panel data set that contains questions about risk attitudes every year since 1993 – and six waves of the German Socio-Economic Panel Study (SOEP), which contain information about risk attitudes and span eight years.[1]

Even with panel data that span several years, age profiles are typically difficult to identify because they may also reveal changes across cohorts or periods of observation. It is not possible to control for age, birth year and period of observation at the same time because age is a perfect linear combination of birth year and survey period, *a priori*; there is reason to believe that age, cohort and survey period may all be related to stated risk attitudes to some extent, however, so none of these variables can be

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We received valuable comments from the editor Frederic Vermeulen, two anonymous referees, Lex Borghans, Michela Coppola, Ryanne van Dalen, Hauke Heekeren, Olivier Marie, Peter Mohr, Irene Nagel, Nicolás Salamanca, Anders Stenberg, Bas ter Weel, Christoph Wunder and participants of the ESRC Workshop on Preferences and Personality in Stirling (Scotland) and the DUHR seminar at Maastricht University. This research was supported by a grant from the Volkswagen Stiftung. Golsteyn acknowledges support from Handelsbankens forskningsstiftelser. Dohmen acknowledges support from the Network for Studies on Pensions, Aging and Retirement (Netspar). In this article, we use data from the CentERdata databank and the SOEP. The data can be accessed by applying to the SOEP (DIW, Berlin) and to CentER Data (Tilburg University). The programs for replicating the results in this study are available online.

[1] In addition, we use macro-economic indicators from various other sources.

excluded from the model. When people grow older, they may become less willing to take risks due to biological ageing processes, as is suggested, for example, by evidence that cognitive ageing is associated with declining willingness to take risks (Bonsang and Dohmen, 2015). The period of observation may also affect risk attitudes. Calendar time effects might arise, for example, because events change expectations and thereby affect expected life-time wealth. Dohmen *et al.* (2006) show that unexpectedly good performance of the German soccer team in the FIFA World Cup 2006 improved economic perceptions and expectations. Likewise, events such as the financial crisis might affect the wealth level of many households, who as a consequence may have become more risk averse. Malmendier and Nagel (2011) provide evidence that recent experiences affect risk attitudes but they also report compelling evidence for cohort effects as people who experienced the Great Depression are less willing to take financial risks compared to those who did not experience the economic downturn. Falk and Kosse (2015) show that breastfeeding duration is related to the formation of attitudes and provide evidence suggesting that variation in breastfeeding patterns induces cohort effects in risk attitudes.

We address this age-period-cohort identification problem along the lines suggested by Heckman and Robb (1985) by substituting determinants of risk attitudes that depend on calendar time but do not change linearly with calendar time for period dummies. We assume that risk attitudes would be related to calendar time because of the business cycle. Bucciol and Miniaci (2013) demonstrate that willingness to take risk is positively correlated with fluctuations in GDP. In our main specification, we therefore use GDP growth to capture such period effects. We assume that period effects in risk attitudes are correlated with changes in GDP. Our identifying assumption is that there is no linear time trend in period effects. If GDP growth is correlated with these period effects in risk attitudes, we can identify age and cohort effects by age and cohort dummies when controlling for GDP growth as proxy for period effects. Since there is age variation that can be exploited for each observation period of the survey data and, since the non-linearity in period effects is captured by GDP growth, the model is identified.[2] As long as GDP growth is a valid proxy for risk attitudes across calendar time, age and cohort effects are estimated consistently. It should be noted, however, that period effects might not be precisely estimated if factors that are not captured by GDP growth and that we do not control for also drive period effects in risk attitudes. The main results of this exploration indicate that willingness to take risks decreases with age. The decreasing pattern is linear until approximately age 65, after which the slope becomes flatter. Various robustness analyses corroborate this finding.

Our article contributes to the literature by providing detailed age profiles for risk attitudes from young adulthood until old age. Negative cross-sectional relationships between risk taking and age have been reported in other studies (Barsky *et al.*, 1997; Donkers *et al.*, 2001; Dohmen *et al.*, 2011). Analyses of changes in risk attitudes with age based on panel data are, however, quite rare. One exception is Sahm (2012), who investigates the profile of risk attitudes among elderly birth cohorts (i.e. the 1931–47

[2] Any linear component of period effects on risk attitudes is not identified because a linear component of such a trend is collinear with age and cohort effects.

birth cohorts). She finds a modest decline in risk with age over this older age range. Our study is different in that it addresses the question of how risk attitudes vary over the entire age range starting from early adulthood.[3] Studying variation in risk attitude among youth is important because it adds perspective to the size of the variation in risk attitude among elderly. Looking at younger birth cohorts is also important in itself. So far, there is little and inconclusive evidence of the development of risk attitudes early in life. Tymula *et al.* (2012), for example, compare lottery choices of a sample of 33 young adolescents to lottery choices of 32 adults and find that adolescents are more risk averse. Moreover, Tymula *et al.* (2013) show that adolescents and elderly individuals are more risk averse than their midlife counterparts in a sample of 135 individuals but do not disentangle cohort, period and true age effects. We analyse the age pattern of risk attitudes using two large representative samples and control for cohort and period effects. Our results reveal that the willingness to take risks declines throughout life. This decline appears to become less pronounced from around age 65 onwards.

The remainder of the article is organised is as follows. Section 1 discusses the data. Section 2 reports the results. Section 3 analyses the robustness of the results. Section 4 concludes.

1. Data

We use two data sets. The first is the DNB Household Survey, a representative panel data set collected by CentER Data at Tilburg University in the Netherlands.[4] The second data set is the German Socio-Economic Panel Study (SOEP).[5] Using two data sets allows us to test the robustness of our results across two different samples. In addition, both data sets have specific benefits, which we exploit in the analyses.

The data collection of the DNB Household Survey takes place at the household level. Each member of the household who is above 16 years of age can participate. The data set is representative of the Dutch population. The data have been collected on a yearly basis since 1993. We use data from all available years, 1993–2011. Each year, on average around 5,100 people participate in the survey.[6]

To measure risk attitudes we use six questions that were posed to the participants in each of the 19 years that the survey took place. As far as we know, no other data set contains information on risk attitudes for such a long time period.[7] Participants in the survey were asked to indicate their levels of agreement with the following statements on a 7-point Likert scale, ranging from (1) 'totally disagree' to (7) 'totally agree':

[3] Our empirical approach also differs from Sahm's (2012) analysis in the sense that we use a flexible functional form (i.e. a set of dummies for age) to estimate age patterns.
[4] http://www.centerdata.nl/en/TopMenu/Projecten/DNB_household_study/.
[5] http://panel.gsoep.de/soepinfo2010/.
[6] The number of participants per survey year was lower during 1998–2000 than in the other years. Since 2000, the number of respondents has been fairly stable.
[7] Self-reported measures of risk attitudes are often used in the literature. Dohmen *et al.* (2011) find that self-reported willingness to take risks correlates significantly with risk aversion measured in a lottery choice experiment and with risky behaviour.

1 I think it is more important to have safe investments and guaranteed returns than to take a risk to have a chance to get the highest possible returns.
2 I would never consider investments in shares because I find this too risky.
3 If I think an investment will be profitable, I am prepared to borrow money to make this investment.
4 I want to be certain that my investments are safe.
5 I am becoming more and more convinced that I should take greater financial risks to improve my financial position.
6 I am prepared to take the risk to lose money, when there is also a chance to gain money.

We reverse the scales for statements 1, 2, and 4 so that for all statements a higher category on the scale is related to more willingness to take risks. The Appendix contains a frequency Table for each of the statements (Table A1). Next, we pool the data from all years and take the principal component of the answers to these 6 statements. Cronbach's alpha, a measure of the reliability of the six-item scale, is 0.68. Factor analysis reveals that the eigenvalue is above unity for only one factor, from which we conclude that one latent factor underlies the six statements. Our measure of risk attitudes is the principal component of the statements, standardised to have a mean of zero and a standard deviation (SD) of one. We standardise the variable so that we can compare the results of the analysis from the Dutch data to the analysis of the SOEP data.

We select participants who have non-missing answers on all six statements as well as on sex and birth year, and who were less than 80 years of age. This leaves us with 35,173 observations in the pooled sample. Most excluded observations are due to missing observations on the six statements. We discuss potential selectivity of this non-response with respect to age in Section 2. Of the sample, 57% is male and the average age is 48.9 years (SD 14.4).[8] On average, participants stay for 3.3 years in the sample (SD 3.2). Table 1(*a*) shows that panel attrition is high, but also that a considerable number of respondents remain in the panel for a longer time period.

The second data set we use is the SOEP, a large and representative panel study of the adult German population with more than 20,000 respondents per annual wave, living in more than 11,000 households. Of particular importance for our analysis is that six waves of the data contain survey measures of risk attitudes, which have been shown to be valid predictors of risk taking in a large-scale field experiment with a representative subject pool (Dohmen *et al.*, 2011). The measure of risk attitudes included in the data reads:

> How do you see yourself: are you generally a person who is fully prepared to take risks or do you try to avoid taking risks? Please tick a box on the scale, where the value 0 means: 'not at all willing to take risks' and the value 10 means: 'very willing to take risks'.

We standardise this measure to have a mean of zero and a SD of one.

[8] Average age increased each year by approximately one year but dropped in 2000 by approximately four years and in 2005 by two years due to refreshment of the sample.

Table 1

Panel Attrition By Starting Year

Year of first observation	Number of observations (after selections)	Percentage remaining in following years																		Average amount of times observed
		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	
Panel (*a*): DNB Household Survey																				
1993	2,775	72.5	53.0	38.2	24.9	9.8	9.3	5.0	8.0	6.8	5.5	6.0	5.4	5.3	5.2	4.6	3.7	3.6	3.3	3.7
1994	895		51.6	30.4	23.1	11.3	10.8	6.0	9.2	8.0	6.4	8.2	7.7	7.3	7.3	7.0	6.5	6.3	7.2	3.1
1995	807			44.9	30.7	17.0	15.4	7.7	11.5	8.6	8.3	9.3	8.3	7.6	7.7	6.3	5.6	5.0	5.1	3.0
1996	566				43.5	19.3	15.0	9.9	14.1	10.2	8.7	10.1	8.5	9.0	8.7	8.1	7.6	6.9	7.1	2.9
1997	373					31.4	22.0	12.9	17.7	14.5	12.6	13.9	11.5	12.9	12.3	11.3	11.0	7.5	8.3	3.0
1998	200						38.5	20.0	23.5	18.5	15.5	19.5	18.0	13.5	16.5	15.0	13.5	13.5	12.0	3.4
1999	215							28.4	36.3	26.5	22.3	25.1	23.7	22.3	22.3	19.5	20.0	17.7	15.8	3.8
2000	480								57.7	41.5	31.9	36.0	30.0	26.9	25.0	25.0	22.5	19.6	19.2	4.4
2001	931									48.2	37.9	40.3	33.9	29.4	29.4	27.4	24.2	22.0	20.5	4.1
2002	365										46.6	50.4	32.9	32.1	31.5	25.2	20.3	18.4	20.3	3.8
2003	384											65.6	49.5	41.1	38.5	36.7	32.8	29.4	29.2	4.3
2004	436												57.6	47.0	42.4	36.0	35.1	28.0	26.4	3.7
2005	506													51.0	45.5	33.8	28.9	24.3	22.5	3.1
2006	244														63.1	50.4	39.3	36.5	31.1	3.2
2007	237															48.1	35.9	35.0	32.5	2.5
2008	212																58.5	48.1	42.0	2.5
2009	195																	60.0	52.8	2.1
2010	445																		61.6	1.6
2011	300																			1.0

Year of first observation	Number of observations (after selections)	Percentage remaining in following years					Average amount of times observed
		2006	2008	2009	2010	2011	
Panel (*b*): SOEP							
2004 or earlier	21,425	84.0	72.0	65.7	60.0	55.1	4.4
2006	3,656		69.7	62.5	55.2	51.2	3.4
2008	1,103			83.9	72.0	64.8	3.2
2009	2,565				72.6	13.1	1.9
2010	865					36.6	1.6
2011	5,272						1.0

We select participants who have non-missing answers to the risk question, sex and birth year, and who were less than 80 years of age. This leaves us with 120,837 observations in the pooled sample. Of the sample, 48% is male and the average age is 48.4 years (SD 16.8).[9] Over the six years we use, participants are on average observed 3.5 times (SD 2.1). Table 1(*b*) shows that attrition is lower in the SOEP than in the DNB Household Survey. More than half of the respondents who started in 2004 or earlier are still in the panel in 2011.

We provide parallel analyses for the two data sets. This allows us to investigate whether the patterns we detect are robust across the two data sets. There are several specific advantages of each data set that we will exploit. The SOEP is a very large representative panel survey and it contains a measure for risk attitudes that has often been used in the literature. The Dutch data are also representative but contain fewer observations. The measure of risk attitudes in the Dutch data is not as general as the SOEP measure. The Dutch measure is more concerned with financial risk attitudes, while the German is concerned with risk attitudes in general, i.e. across domains of life.[10] An advantage of the Dutch data is that the risk questions have been asked every year since 1993, while in the SOEP the risk question has only been included in the 2004, 2006, 2008, 2009, 2010 and 2011 waves of the data.

2. Results

2.1. *Exploring the Risk Trajectories Across the Age Range*

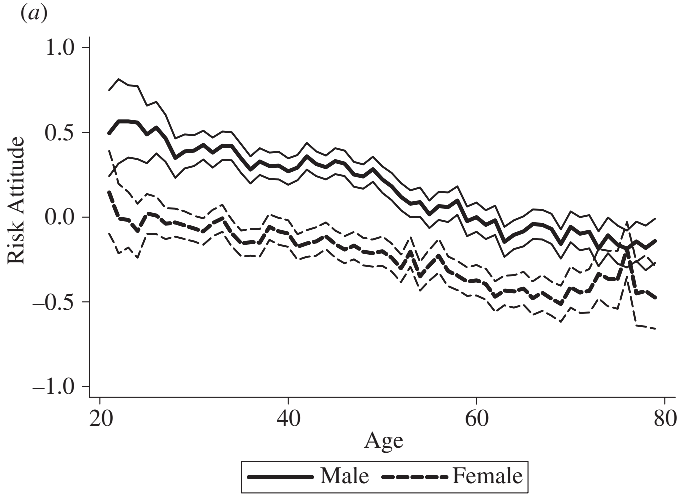
We first present the averages for risk attitudes by age. We pool all years available in the samples and plot the average risk attitude conditional on age and a 95% confidence interval. Figure 1(*a*) and (*b*) plot risk attitudes by age for men and women using the Dutch and the German data, respectively. The Figures show a clear negative age pattern that is approximately linear. At all ages, men are more willing to take risks than women.

As noted in Section 1, the response rate to the risk questions is lower in the Dutch data than in the German data. Investigating this non-response further, it appears that respondents below 30 years of age respond less often to the statements than older respondents.[11] The response rate is rather low for women younger than 30 years of age, but is stable over the life course for women older than 30 years of age. About 40% of women in the latter age range have non-missing observations on all six items of the risk scale. For men, the response rate increases linearly from 40% at age 30 to about 70% at age 80. Comparing these patterns with the results in Figure 1, it does not seem plausible that our results are driven by selective non-response. Our results on average willingness to take risks show no kinks below and above age 30 and do not show

[9] The samples in 2008 and 2009 were somewhat smaller than those in 2004 and 2006. Average age increases each year by approximately half a year due to refreshment of the sample.

[10] The German data also contain a question regarding financial risk attitudes but that measure is not included in all waves of the data, making it less suited for the analysis of this article. The 6th question in the Dutch data seems to correspond most closely to the question on financial risk attitudes in the SOEP. We find that both these questions yield downward sloping patterns across age, consistent with the patterns we report in Section 2.

[11] Those who do not respond to a statement typically skip the entire module of risk questions.



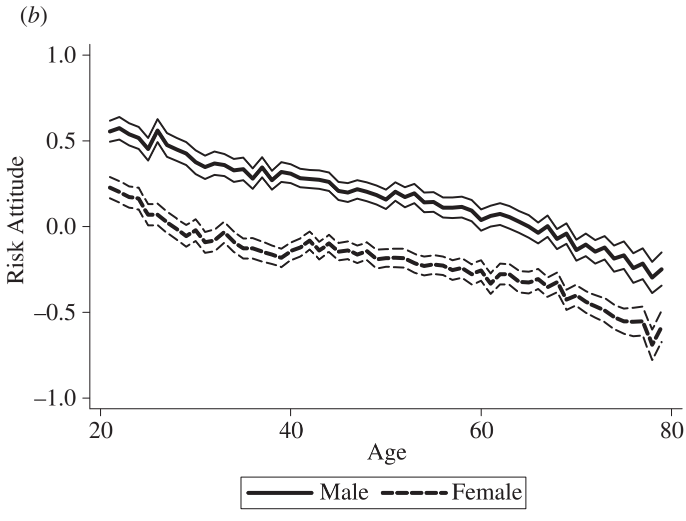


Fig. 1. *Risk Attitudes Across Age*

Notes. Both Figures show mean risk attitude conditional on age. The Figures also include 95% confidence intervals. In both Figures, risk attitude is standardised (using the full sample) to a mean of zero and a standard deviation of one.
Sources. (*a*) DNB Household Survey and (*b*) SOEP.

a diverging pattern between men and women across age, despite differences in non-response patterns by gender. For selective non-response to drive our results, older men would have to be more likely to answer the statements if they are more risk averse. This is highly unlikely.

Another indication that selective non-response is not likely to be important is the high similarity of the age patterns in the Dutch and German data. In the German data, the non-response rate does not vary with age as much as in the Dutch data but the

German and the Dutch age patterns are very similar. Furthermore, those who do not respond in one year often do respond in the next year. If we compare the distributions of their risk attitudes in that year to the risk attitudes of respondents who had also responded in the previous year, we do not find significant differences. This again indicates that it is implausible that there is selective non-response in the Dutch data.

In order to address the potential concern that our survey questions pick up age effects in risk perception rather than in risk attitude, we turn to a different data set, the SOEP Cross Sectional Study 2005, which contains data from an incentivised lottery choice experiment with a subject pool that is representative of the adult population living in Germany (Dohmen *et al.*, 2011). This experiment presents risk in terms of objective probabilities and stakes. We find similar age patterns when using the real-stakes lottery measure compared with the survey measure (see Table A2 in Appendix A). Reassuringly, but not surprisingly, the age pattern in this additional data set is also similar to the age patterns in the SOEP data.[12]

The SOEP Cross Sectional Study also allows the addressing of another potential concern, namely that changes in investment horizon over the life course might drive changes in risk attitude. The following question was asked in that survey: 'Some people think more and others less about their future. When making decisions, how often do you consider the future in one year, the future in five years, and the future in 10 years?' The answers ranged from 1 'very often' – 5 'never'. Using these measures to control for planning horizon, we estimate a significant negative age effect. In fact, life course trajectories of risk attitudes that are adjusted for differences in planning horizon are virtually identical to those that are not.[13]

A key question is whether the pattern in Figure 1 is due to a negative age effect on risk attitude or due to a positive cohort effect. Because of the identity age $\equiv$ calendar time $-$ birth date, it is not possible to discriminate between these potential effects and estimate unrestricted age effects on risk attitudes while controlling for time and cohort effects.

2.2. *Controlling for Period and Cohort Effects*

Heckman and Robb (1985) suggest substituting for age, period or cohort effects with variables that pick up the underlying reason for changes with age, period or cohorts.[14]

[12] For a comparison of the size of the age effects, see online Appendix B, in which we discuss the similarity of the age effects obtained from linear models, using the SOEP and DNB Household Survey.

[13] The fact that our estimates suggest at best a minor impact of the planning horizon on the development of risk attitudes over the life course is not surprising. We find that the planning horizon does not strongly depend on age until age 60. Only at an older age do we observe that individuals attach less weight to the future. Yet, in our samples, most individuals are still considerably younger than 60 (the average age is 49 years and 48 years in the Dutch and German data respectively; the fraction below 60 is 74% and 71% in the Dutch and German data respectively). In addition, it is very plausible that remaining life expectancy for the majority of individuals in our sample is sufficiently long, such that differences in expected amortisation periods do not play an important role.

[14] Heckman and Robb (1985) called this the proxy variable approach. O'Brien (2000) used proxies for cohorts and termed it the APC-characteristic model. Several other approaches to this identification problem have been proposed in the literature. In the Appendix, we show that these approaches have serious limitations.

Identification rests on the assumption that the proxies do not vary linearly with the excluded variable.

In our main specification, we estimate a model with risk attitudes as the dependent variable and as independent variables a full set of age and cohort dummies; we substitute calendar time effects with GDP growth rates.[15] Using the Dutch Household Survey data, Bucciol and Miniaci (2013) have documented that GDP growth is associated with risk attitudes measured by the same survey questions that we use.[16] Their finding is corroborated by Figure 2, which plots GDP growth and average risk attitudes. In both the Dutch and German data, there appears to be a positive relationship between GDP growth and average risk attitudes. It is clear that the cyclical pattern in GDP growth cannot be captured well by a linear time trend. We cluster the standard errors using respondents' ID.

Figure 3 presents the main result, plotting the estimates of the age patterns with a full set of age indicators, cohort dummies and controls for GDP growth. The slope is approximately linear until age 65, after which the slope becomes flatter.

In order to get a sense of the magnitude of the relationship between risk attitudes and age, Table 2 presents the estimates of a linear regression specification with independent variables: (*i*) age and cohort; and (*ii*) age, cohort and GDP growth. The results suggest that a one-year increase in age is related to a decrease in risk attitudes of 0.024 SDs in the Dutch data and 0.022 SDs in the German data. Controlling for GDP growth in the regression does not greatly affect the age coefficient in the Dutch or the German data. Both age coefficients remain significantly negative and of similar size. In the Dutch data, the coefficient on GDP growth is somewhat larger than the corresponding coefficient in the German data. The difference between men and women also remains similar.

Our results suggest that risk attitudes decrease by about 0.023 SDs for each additional year of age. The size of this effect is substantial: an increase of 10 years in median age of a society leads to a reduction in mean risk attitudes of 0.23 SDs.[17] Such a change amounts to approximately half of the difference in risk attitudes between men and women (see Table 2). We can also translate this age effect into an effect on life outcomes, using earlier studies that relate risk attitudes to life outcomes. For example, using Table 6 from Dohmen *et al.* (2011), an increase in median age of 10 years, and the resulting difference in risk attitudes, would imply 2.5% less investment in stocks

[15] GDP growth is measured in the same year as the survey was held. The Dutch and German GDP growth rates are taken from The World Bank (see http://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?cid=GPD_30, retrieved on October 22, 2013).

[16] While the focus of their work is on the relationship between risk attitudes and economic upturns and downturns, the focus of ours is on the pattern of risk attitudes across age. The authors note as a side result that age is related to risk attitudes but their analysis does not control for potential cohort effects.

[17] Median age in society varies substantially between countries and across time within countries. The Netherlands and especially Germany have high median ages. Currently, median age is 46 in Germany and 42.4 in the Netherlands (source: http://www.indexmundi.com/germany/demographics_profile.html, retrieved 20 December 2014). Median age has increased by 10 years in the last 30 years in the Netherlands (source: http://www.statista.com/statistics/276734/median-age-of-the-netherlands-population/, retrieved 20 December 2014) and projections show that median age in Germany will increase by nine years by the mid-2040s (source: https://www.destatis.de/EN/Publications/Specialized/Population/GermanyPopulation2060.pdf?__blob=publicationFile, retrieved 20 December 2014).

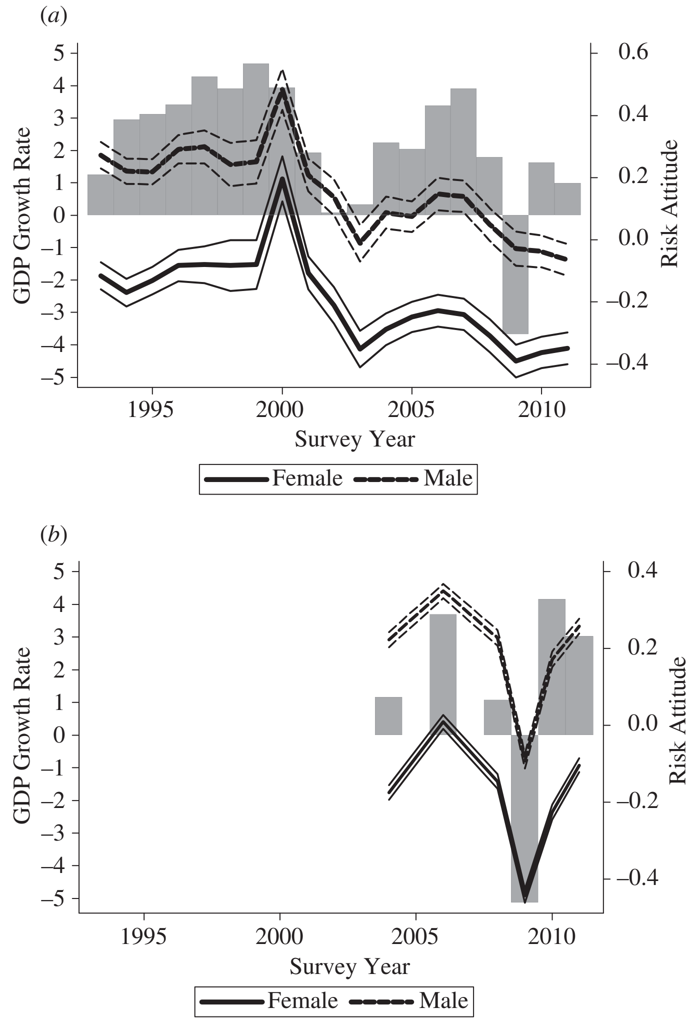
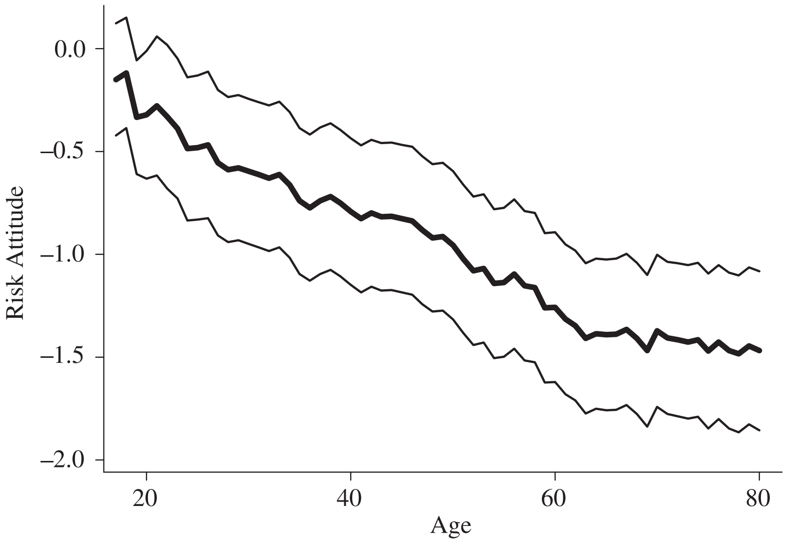


Fig. 2. *GDP Growth Rate and Risk-Taking Across Survey Years*
Notes. The Figures show GDP growth rates (bars) and average risk attitude conditional on survey year (lines). The lines also include 95% confidence intervals. In both Figures, risk attitude is standardised (using the full sample) to a mean of zero and a standard deviation of one.
Sources. (*a*) DNB Household Survey and (*b*) SOEP.

and about 6% less self-employment.[18] These calculations serve as an indication that the relationship between risk attitude and age is substantial. An obvious caveat is that the *ceteris paribus* assumption we implicitly make in the calculations may not hold. For instance, if a society becomes more risk averse, the demand for risk loving people may

[18] In their Table, all measures of risk attitudes are standardised, so we can multiply the coefficients with 0.23 in order to find how much a 10-year increase in median age would affect the variables. For example, for investment in stocks: $0.029 \times 0.23 = 0.007$, implying 0.7 percentage points less investment in stocks. Evaluated at the mean of 0.341, this implies $[(0.334 - 0.341)/0.341] \times 100 = 2.5\%$ less investment in stocks. Similarly, this would imply $[(0.079 - 0.084)/0.084] \times 100 = 6\%$ less self-employment.

(*a*)



(*b*)

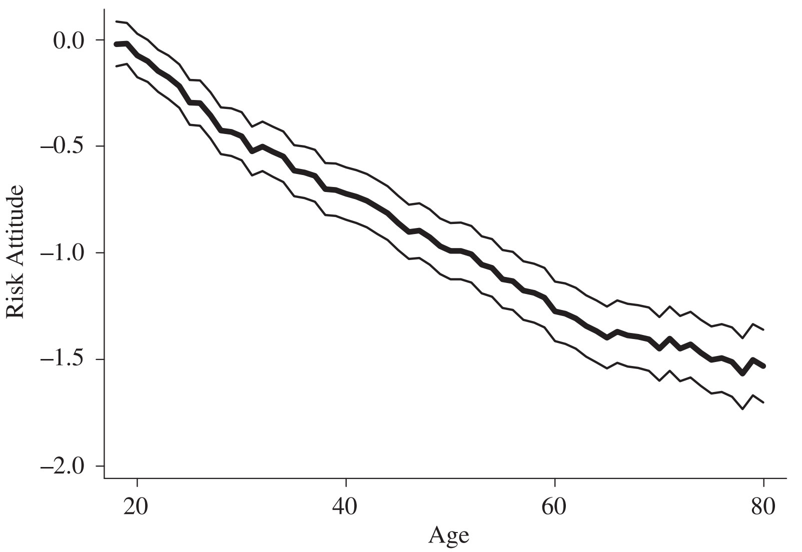


Fig. 3. *Age Pattern Estimated with Flexible Functional Form Controlled for Cohort and Period Effects*
Notes. In both Figures, risk attitude is standardised (using the full sample) to a mean of zero and a standard deviation of one. The Figures show the values of the age dummies of a linear regression model with risk attitude as the dependent variable and as independent variables a full set of age and cohort dummies and the annual GDP growth rate. The Figures also include 95% confidence intervals.
Sources. (*a*) DNB Household Survey and (*b*) SOEP.

Table 2

Linear Regressions of Risk Attitudes on Age, Cohort, and Period

	(1)	(2)	(3)	(4)
Panel (*a*): DNB Household Survey				
Age	−0.024***	−0.021***	−0.022***	−0.019***
	(0.001)	(0.001)	(0.001)	(0.001)
Birth year	−0.014***	−0.011***	−0.013***	−0.009***
	(0.001)	(0.001)	(0.001)	(0.001)
GDP growth		0.026***		0.026***
		(0.002)		(0.002)
Male			0.532***	0.534***
			(0.053)	(0.053)
Male × age			−0.003**	−0.003**
			(0.001)	(0.001)
Constant	29.169***	22.858***	25.361***	19.111***
	(2.422)	(2.433)	(2.322)	(2.334)
Observations	35,173	35,173	35,173	35,173
R^2	0.040	0.043	0.095	0.097

	(1)	(2)	(3)	(4)
Panel (*b*): SOEP				
Age	−0.022***	−0.022***	−0.022***	−0.021***
	(0.001)	(0.001)	(0.001)	(0.001)
Birth year	−0.010***	−0.010***	−0.010***	−0.009***
	(0.001)	(0.001)	(0.001)	(0.001)
GDP growth		0.039***		0.039***
		(0.001)		(0.001)
Male			0.426***	0.428***
			(0.025)	(0.025)
Male × age			−0.001**	−0.001**
			(0.001)	(0.001)
Constant	21.128***	20.169***	20.133***	19.169***
	(2.200)	(2.198)	(2.171)	(2.168)
Observations	120,837	120,837	120,837	120,837
R^2	0.044	0.058	0.078	0.093

Notes. ***p < 0.01, **p < 0.05, *p < 0.1. The dependent variable is risk attitudes, standardised to mean zero and standard deviation one (using the full sample). Robust standard errors clustered by respondent's ID in parentheses.

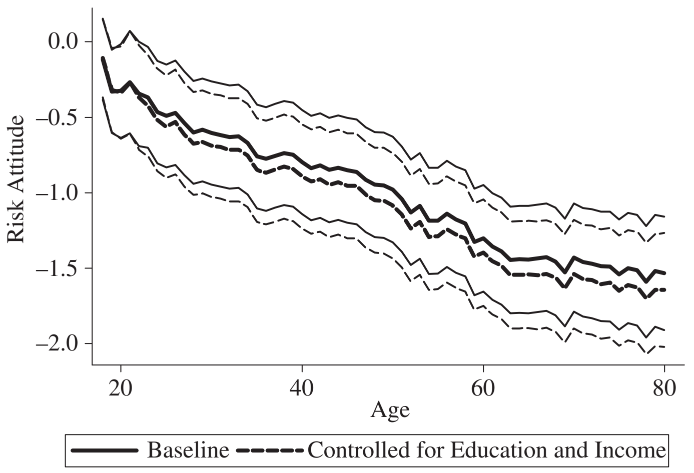
increase. Whether changes in society actually occur as the result of a decrease in aggregate risk attitudes is a subject for future research.

3. Robustness Checks

3.1. *Controlling for Education and Income*

In our main specification, we do not include education, income, wealth or other such factors for two reasons. First, previous work (Dohmen *et al.*, 2011) has shown that the relationship between age and risk attitude remains similar when controlling for a host of socio-economic characteristics, including education, income and wealth. Second, we prefer a specification without such controls, which are arguably endogenous, because we are interested in the sum of direct and indirect effects of age on risk attitudes. Yet, it

(*a*)



(*b*)

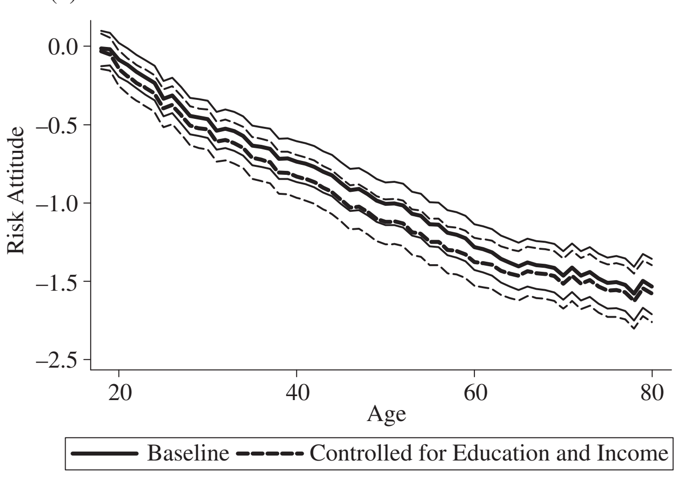


Fig. 4. *Controlling for Education and Income*

Notes. In both Figures, risk attitude is standardised to mean zero and standard deviation one (using the full sample). The Figures show the values of the age dummies of a linear regression model with risk attitude as the dependent variable and as independent variables a full set of age and cohort dummies and variants of the annual GDP growth rate. The dashed lines indicate regressions that additionally control for education and income. The Figures also include 95% confidence intervals.

Sources. (*a*) DNB Household Survey and (*b*) SOEP.

is interesting to assess whether the estimated life course trajectory of risk attitudes is robust to controlling for education or income.[19] In Figure 4, we plot the estimated age patterns in risk attitudes when controlling for education and income in the Dutch and

[19] Note that we do not attempt to answer the question why risk attitudes are related to age or whether risk attitude trajectories are heterogeneous (i.e. whether risk attitudes change more with age for some groups than for other groups).

German sample.[20] These estimated age patterns are remarkably similar to the age patterns in Figure 3, which are not adjusted for education and income.[21]

3.2. *Alternatives for GDP Growth*

We use GDP growth in our main specification. One may argue, however, that risk attitudes might be more strongly related to lagged GDP growth than to current GDP growth. In addition, 2009 (the recession) is an extreme value of GDP growth relative to the GDP growth rates in the other periods. Figure 5 shows that we obtain virtually identical results in the Dutch data and small (insignificant) changes in the German data if we:

(*i*) use lagged GDP growth; or
(*ii*) exclude the year 2009 from the estimation.

Instead of GDP growth we could also have used other indicators of economic conditions.[22] To investigate the robustness of our results, we use instead of GDP growth:

(*i*) stock market returns (i.e. the DAX or AEX index); and
(*ii*) yearly unemployment rates.[23]

[20] In the Dutch data, we use deflated net personal income in the year preceding the survey in euro and dummies for educational levels. We use the net income variable (*ntot*) given in the original data which is calculated using a large set of income and social assistance components. The full set of these components can be found in the questionnaire. The education variable includes the following categories:

(*i*) primary education or low secondary education (VMBO);
(*ii*) middle or high secondary education (HAVO/VWO);
(*iii*) low tertiary vocational education (MBO);
(*iv*) high tertiary vocational education (HBO); and
(*v*) university.

We include dummies for the last 4 categories in the regressions. In the German data, we include as a measure of income the combined income before taxes and government transfers of all individuals in the household age 16 or older in the year preceding the survey in euro (i.e. variable i1110104 for the year 2004 and the corresponding variables in further waves). We also include dummies for the school leaving degree variable. This variable has the following categories:

(*i*) secondary school degree;
(*ii*) intermediate school degree;
(*iii*) technical school degree;
(*iv*) upper secondary school degree;
(*v*) other school degree;
(*vi*) drop out, no school degree; and
(*vii*) currently in school.

[21] Schurer (2014) also investigates in a recent working article whether some groups are more likely to change risk preferences across age than others.

[22] We use GDP growth in our baseline estimation because of all the measures we investigated this indicator correlates most strongly with risk attitudes in the German data. In the Dutch data, the strength of the correlations is similar across the indicators. To be specific, the correlation between risk attitudes and GDP growth controlled for age and cohort effects is 0.120 in the German data and 0.046 in the Dutch data. The correlations between risk attitudes and lagged GDP growth, unemployment rates and stock market returns are 0.027, 0.025, 0.030 in the German data and 0.046, −0.045, 0.059 in the Dutch data, respectively. All correlations are highly statistically significant.

[23] We use the DAX and AEX index measured at the last day of the calendar year. Source DAX: http://www.boerse-frankfurt.de/en/equities/indices/dax+DE0008469008/price+turnover+history/historical+data#page=53, Source AEX: http://nl.wikipedia.org/wiki/AEX, Source unemployment rate: Bureau of Labor Statistics (http://www.bls.gov/fls/country/germany.htm). All retrieved on 25 December 2014. We also use the monthly DAX rates as a robustness check. The age trajectory of risk attitudes becomes more negative as a result.

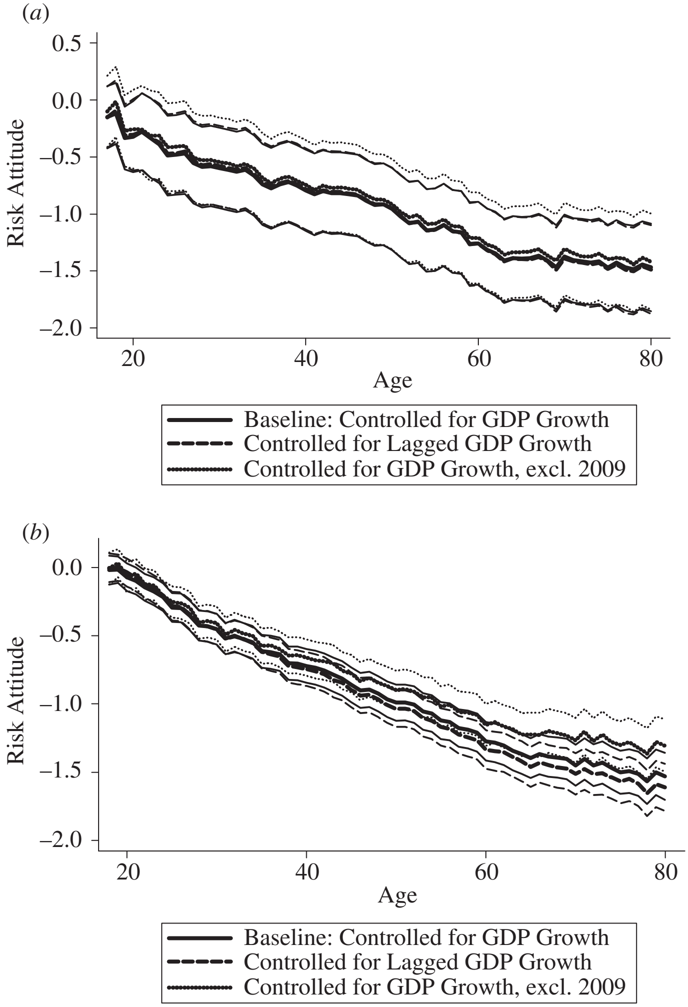


Fig. 5. *Variants of GDP Growth*

Notes. In both Figures, risk attitude is standardised to mean zero and standard deviation one (using the full sample). The Figures show the values of the age dummies of a linear regression model with risk attitude as the dependent variable and as independent variables a full set of age and cohort dummies and variants of the annual GDP growth rate. The Figures also include 95% confidence intervals.

Sources. (*a*) DNB Household Survey and (*b*) SOEP.

Figure 6 reveals that the estimates remain robust. The slope in the graphs remains significantly negative. Given that we only use six periods in the German data, it is not surprising that the German estimates seem more sensitive to changes in the specifications.

3.3. *Fixed Effect Estimations*

The longitudinal character of the data also allows us to estimate fixed effect models. In this analysis, the estimates of age effects are identified only from within person

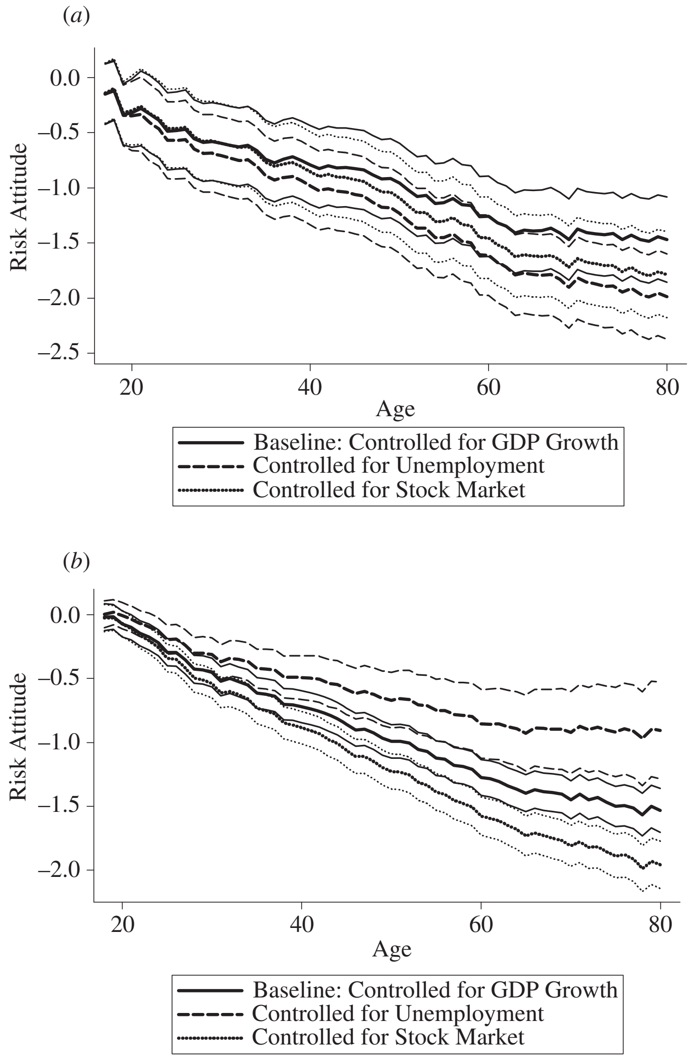


Fig. 6. *Using Unemployment or Stock Market Returns as Substitute for Economic Conditions*

Notes. In both Figures, risk attitude is standardised (using the full sample) to mean zero and standard deviation one. The Figures show the values of the age dummies of a linear regression model with risk attitude as the dependent variable and as independent variables a full set of age and cohort dummies and respectively the annual GDP growth rate (baseline), the annual unemployment rate, or the stock market returns. The Figures also include 95% confidence intervals.

Sources. (*a*) DNB Household Survey and (*b*) SOEP.

changes. By construction, the fixed effect specification controls for cohort effects so we do not include these in the model.

Table 1 already gave descriptive information about the data; but for the fixed effect estimation it is relevant to show information about the number of times individuals were observed in the panels and the average number of calendar years between their

Table 3

Number of Times and Years Individuals are Observed in the Panels

	DNB		SOEP	
Number of times observed in panel	Number of individuals	Average number of years from first to last year of observation	Number of individuals	Average number of years from first to last year of observation
6 or more	1,760	10.8	11,106	8.0
5	575	5.8	3,537	6.7
4	922	4.8	2,304	5.4
3	1,251	3.5	2,087	4.5
2	2,287	2.3	5,187	2.6
1	3,771	1.0	10,665	1.0

entrance and exit. Table 3 gives the statistics. In the Dutch data, 1,760 individuals were observed six times or more. On average the difference between their entrance and exit is 10.8 years. In the German data, 11,106 individuals were observed six times (six is the maximum number: the number of waves in which the risk attitude question was asked). They stayed from 2004 to 2011 (i.e. eight years) in the panel.

Figure 7 documents that the age effects are also significantly negative in this model. They are similar in the German sample but smaller in the Dutch sample relative to the earlier analyses in which we pooled the data across years. Figure 7 also shows the fixed effects estimates for the restricted sample of respondents who were continuously interviewed for eight years in the German data and at least eight years in the Dutch data. The age gradient for the 'long-term' respondents is similar to that for the full sample of respondents in both data sets.

3.4. *Two Alternative Models*

We also follow two alternative approaches to identify parameters in an age-period-cohort model, which have been suggested by Deaton and Paxson (1994) and Browning *et al.* (2012). Deaton and Paxson (1994) impose the restrictions that the period effect is orthogonal to a trend and sums to zero. Browning *et al.* (2012) build on a set-identification result in the linear age-period-cohort model with a bounded dependent variable. Intuitively, only a set of parameters can explain an outcome variable that has a bounded range because conditional probabilities are bounded by the law of iterative expectations. Browning *et al.* (2012) propose using the maximum-entropy method to point identify the parameters.

In Figure 8, we show that the patterns using either of the two techniques corroborate our earlier findings. The patterns using these two methods are quite similar to the patterns in the baseline estimation in the Dutch data. In the German data, the two methods yield a smaller but still significantly negative slope.

3.5. *Using Substitutes for Cohort Effects*

In our baseline estimations, we use a proxy for period effects. We could also have chosen to use a proxy for cohort effects instead, in order to allow for linear trends in

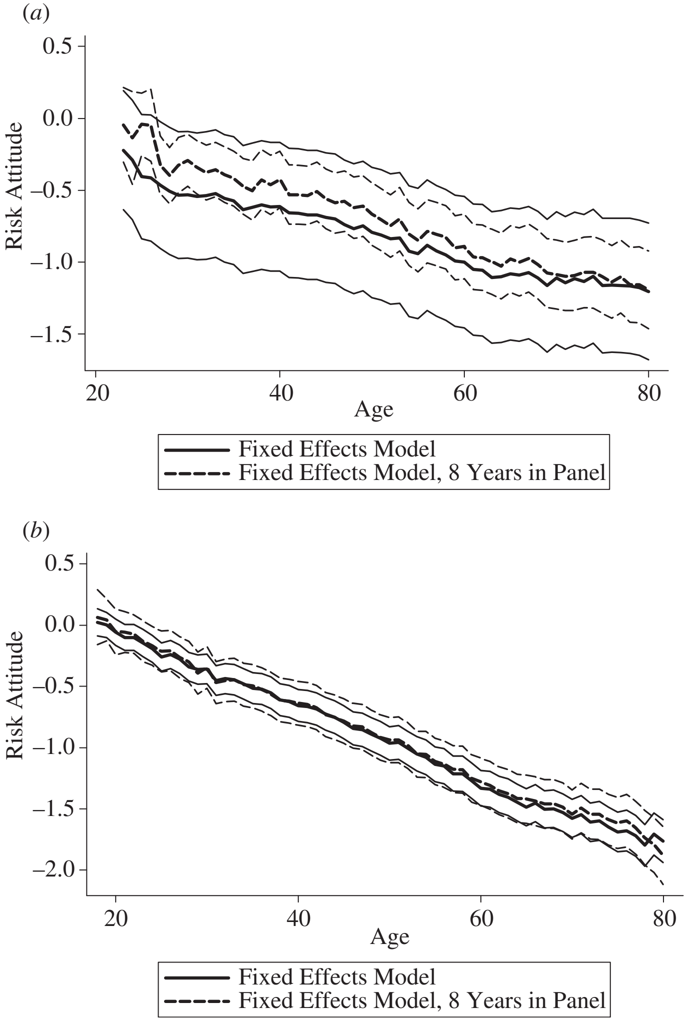


Fig. 7. *Fixed Effect Estimates*

Notes. In both Figures, risk attitude is standardised (using the full sample) to mean zero and standard deviation one. The Figures show the values of the age dummies of a linear regression model with risk attitude as the dependent variable and as independent variables a full set of age dummies and the annual GDP growth rate with person fixed effects. The solid line shows the trajectory for the full sample. The dashed line shows the trajectory for those who stay at least eight years in the sample. The Dutch graph shows the results from age 23 onward, as there were not enough observations below the age of 23 when selecting on those who stayed eight years or more in the panel. The Figures also include 95% confidence intervals.
Sources. (*a*) DNB Household Survey and (*b*) SOEP.

period effects. We took the former approach because it is natural to think that risk attitudes in periods are affected non-linearly by macro-economic conditions, while this is not obvious for risk attitudes across cohort. It is also difficult to establish at which time in their lives cohorts may be affected by macro-economic circumstances. Nevertheless, in Figure 9, we use inflation at age 18 as a substitute for cohort effects.

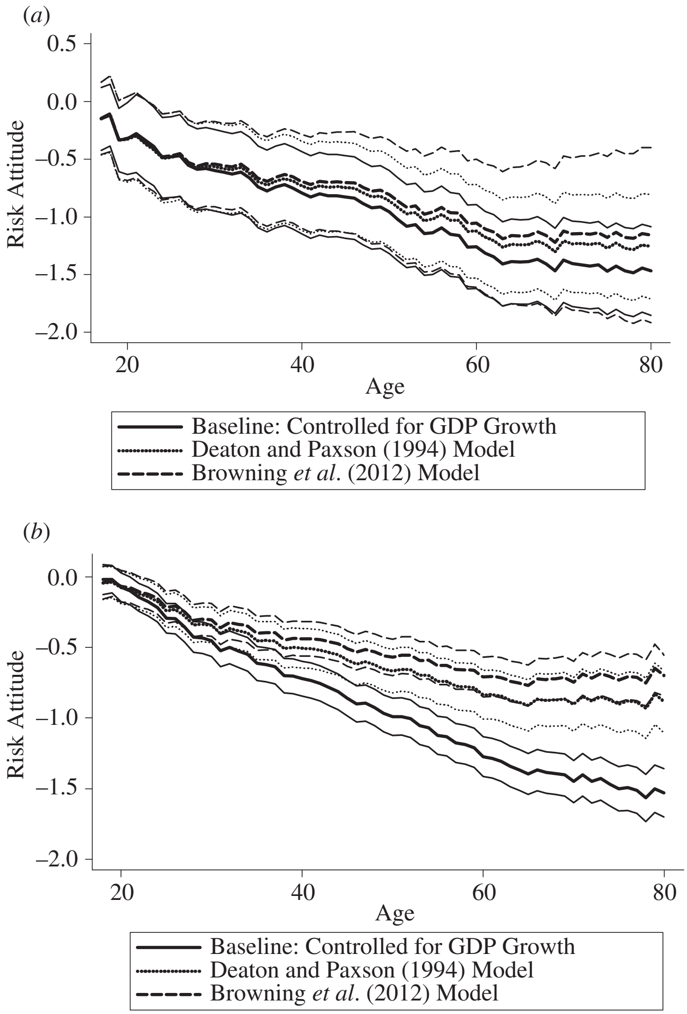


Fig. 8. *Two Alternative Estimation Techniques*

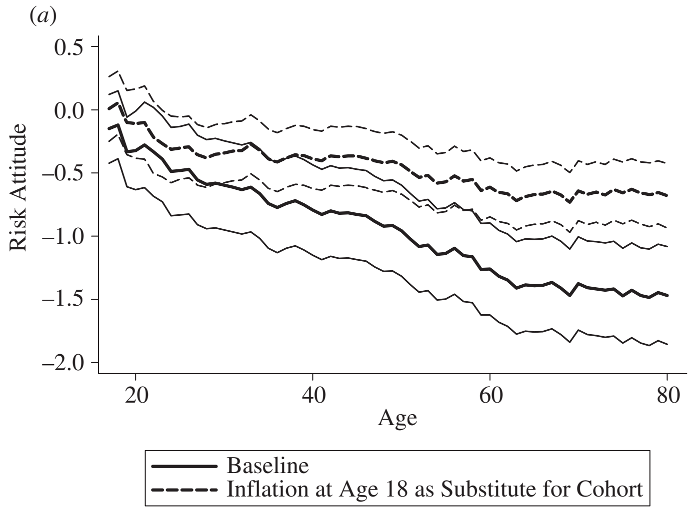
Notes. In both Figures, risk attitude is standardised (using the full sample) to mean zero and standard deviation one. The solid lines show the values of the age dummies of a linear regression model with risk attitude as the dependent variable and as independent variables a full set of age and cohort dummies and the annual GDP growth rate. The dotted and dashed lines show the Deaton and Paxson (1994) and Browning *et al.* (2012) models, respectively. The Figures also include 95% confidence intervals.

Sources. (*a*) DNB Household Survey and (*b*) SOEP.

In this analysis, we include dummies for each survey year. The analysis delivers qualitatively similar results in the sense that risk attitudes decline across age.

4. Conclusions

This article investigates how risk attitudes change over the life course. Understanding the relationship between risk attitudes and age is important for making predictions about



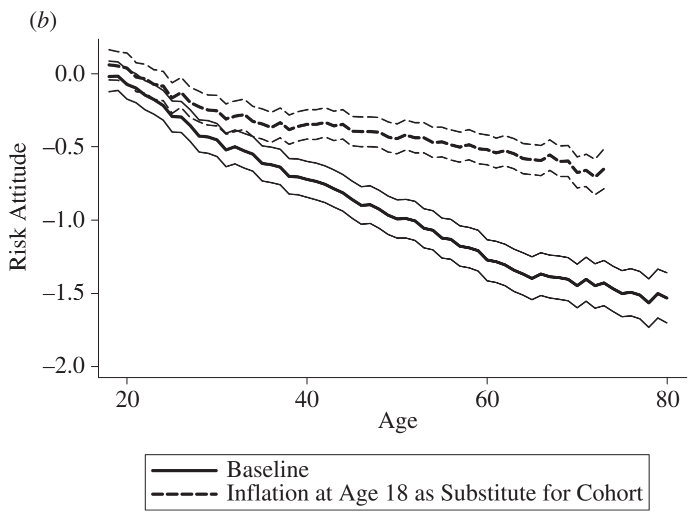


Fig. 9. *Using Inflation at Age 18 as a Substitute for Cohort Effects*
Notes. In both Figures, risk attitude is standardised (using the full sample) to mean zero and standard deviation one. The solid lines show the values of the age dummies of a linear regression model with risk attitude as the dependent variable and as independent variables a full set of age and cohort dummies and the annual GDP growth rate. The dashed lines show the values of the age dummies of a linear regression model with risk attitude as the dependent variable and as independent variables a full set of age and period dummies and the inflation rate at age 18. For Germany, inflation rates were available only from the year 1956 onward. The Figures also include 95% confidence intervals.
Sources. (*a*) DNB Household Survey and (*b*) SOEP.

what happens in society when its population is ageing. Age patterns are generally difficult to identify because they may also reveal changes across cohorts or periods of observation. Our results indicate that risk attitudes decline with age when taking calendar time and cohort effects into consideration. A possible implication of this finding is that societies become more risk averse as a consequence of population ageing.

Appendix A. Additional Tables

Table A1

Raw Scores of the Risk Questions in the DNB Household Survey

Answer categories	Q1 (%)	Q2 (%)	Q3 (%)	Q4 (%)	Q5 (%)	Q6 (%)
1 Totally disagree	23.4	20.9	42.0	25.4	28.1	31.1
2	26.9	15.4	19.0	29.8	20.9	21.5
3	17.8	11.8	10.9	22.2	14.0	14.7
4	15.0	16.5	12.7	14.7	19.8	18.5
5	6.8	12.4	8.4	3.5	10.0	9.5
6	4.0	11.4	4.9	1.5	5.1	3.5
7 Totally agree	6.1	11.6	2.2	2.8	2.1	1.3

Note. The order of questions 1, 2 and 4 was reversed.

Table A2

Age Patterns in a Pre-test Sample Using the Survey Risk Question and a Real-stakes Lottery Risk Measure

	(1)	(2)	(3)	(4)	(5)	(6)
					SOEP	
	Survey risk measure	Experimental risk measure	Survey risk measure	Experimental risk measure	Survey risk measure	Survey risk measure
	Men	Men	Women	Women	Men	Women
Age	−0.010***	−0.009**	−0.016***	−0.013***	−0.013***	−0.012***
	(0.003)	(0.004)	(0.004)	(0.003)	(0.000)	(0.000)
Constant	0.564***	0.493**	0.637***	0.568***	0.822***	0.395***
	(0.183)	(0.192)	(0.179)	(0.174)	(0.012)	(0.012)
Observations	215	215	237	237	57,960	62,877
R^2	0.038	0.030	0.080	0.054	0.049	0.041

Notes. ***p < 0.01, **p < 0.05, *p < 0.1. Columns 1–4 report evidence from a pre-test sample (Dohmen *et al.*, 2011). Columns 5–6 use the SOEP. The dependent variables are risk attitudes measured by the survey question and a real-stakes lottery measure. Both are standardised to a mean of zero and a standard deviation of one (using the full sample). Standard errors are reported in parentheses.

University of Bonn and Maastricht University
University of Bonn
Maastricht University and SOFI, Stockholm University
University of Oxford
University of Munich

Additional Supporting Information may be found in the online version of this article:

Appendix B. Two Alternative Approaches to the Age-period-cohort Identification Problem.
Data S1.

References

Barsky, R., Juster, F.T., Kimball, M. and Shapiro, M. (1997). 'Preference parameters and behavioral heterogeneity: an experimental approach in the health and retirement study', *Quarterly Journal of Economics*, vol. 112(2), pp. 537–79.

Bonsang, E. and Dohmen, T. (2015). 'Cognitive ageing and risk attitude', *Journal of Economic Behavior and Organization*, vol. 112, pp. 112–26.

Browning, M., Crawford, I. and Knoef, M. (2012). 'The age-period-cohort problem: set identification and point identification', cemmap Working Paper CWP02/12.

Bucciol, A. and Miniaci, R. (2013). 'Financial risk attitude, business cycles and perceived risk exposure', Netspar Discussion Paper DP 02/2013-050.

Deaton, A. and Paxson, C. (1994). 'Saving, growth, and ageing in Taiwan', in (D. Wise, ed.), *Studies in the Economics of Ageing*, pp. 331–62, Chicago: The University of Chicago Press.

Dohmen, T., Falk, A., Huffman, D. and Sunde, U. (2006). 'Seemingly irrelevant events affect economic perceptions and expectations', IZA Discussion Paper 2275.

Dohmen, T., Falk, A., Huffman, D., Sunde, U., Schupp, J. and Wagner, G. (2011). 'Individual risk attitudes: measurements, determinants and behavioral consequences', *Journal of the European Economic Association*, vol. 9(3), pp. 522–50.

Donkers, B., Melenberg, B. and van Soest, A. (2001). 'Estimating risk attitudes using lotteries – a large sample approach', *Journal of Risk and Uncertainty*, vol. 22(2), pp. 165–95.

Falk, A. and Kosse, F. (2015). 'Breastfeeding duration, early life circumstances and the formation of human preferences', Unpublished Manuscript, University of Bonn.

Heckman, J. and Robb, R. (1985). 'Using longitudinal data to estimate age, period, and cohort effects in earnings equations', in (W. Mason and S. Fienberg, eds.), *Cohort Analysis in Social Research: Beyond the Identification Problem*, pp. 137–50, New York: Springer Verlag.

Malmendier, U. and Nagel, S. (2011). 'Depression babies: do macroeconomic experiences affect risk-taking?', *Quarterly Journal of Economics*, vol. 126(1), pp. 373–416.

O'Brien, R. (2000). 'Age period cohort characteristic models', *Social Science Research*, vol. 29, pp. 123–39.

Sahm, C. (2012). 'How much does risk tolerance change?', *Quarterly Journal of Finance*, vol. 2(4): 1250020-1–38.

Schurer, S. (2014). 'Lifecycle patterns in the socioeconomic gradient of risk preferences', IZA Discussion Paper 8821.

Tymula, A., Rosenberg Belmaker, L., Roy, A., Ruderman, L., Manson, K., Glimcher, P. and Levy, I. (2012). 'Adolescents' risk taking behavior is driven by tolerance to ambiguity', *Proceedings of the National Academy of Sciences*, vol. 109(42), pp. 17135–40.

Tymula, A., Rosenberg Belmaker, L., Ruderman, L., Glimcher, P. and Levy, I. (2013). 'Like cognitive function, decision making across the life span shows profound age-related changes', *Proceedings of the National Academy of Sciences*, vol. 110(42), pp. 17143–8.