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Financial Risk Taste, Business Cycles and Perceived Risk Exposure

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FINANCIAL RISK TASTE, BUSINESS CYCLES AND PERCEIVED RISK EXPOSURE*

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Abstract

We use a panel dataset from the Dutch Household Survey, covering annually the period 1995-2012, to analyse whether individual financial risk taste changes over time with the background macroeconomic and financial conditions, as well as personal and subjective exposure to portfolio risk. Considering six different self-assessed facets, we find that risk appetite is higher during periods of economic growth and lower during periods of recession. Risk taste is however unrelated to time when it refers to safe investments. Risk appetite is also higher when perceived risk exposure in past investments is generally large or falls from one year to another.

Keywords: risk taste, household finance, business cycle, risk exposure, financial crisis.

JEL codes: D81, G11, D14.

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1. Introduction

In the current economic scenario, with the world facing an unprecedented crisis, people are quickly changing their behaviour and lifestyle: they spend less money for holidays, they share cars and use public transportation more frequently, and they eat cheaper, lower-quality food (e.g., Crossley et al., 2013). The crisis is having dramatic impact on everyday life, and in particular it hits some groups of individuals (e.g., the young, the elderly, and those with low education levels) that are more likely excluded from the labour market in periods of recession. In this work we aim to study empirically whether the external macroeconomic environment (the business cycle) and its impact on personal investment experience have had an impact also on household attitude toward financial risk.

There is growing evidence on the impact of the current crisis in household finance. Hudomiet et al. (2011) study the effect of the recent stock market crash on households' expectations about future stock returns. They find that expectations on average returns and return volatility tend to increase right after a market crash, although the answers are also more widely spread among the respondents. Having different expectations about future market returns clearly has a large impact on portfolio choice. Malmendier and Nagel (2011) find that cohorts that have experienced low stock market returns in the past are less likely to participate in the stock market and, if they participate, they invest a lower fraction of their wealth in stocks. This suggests that the recent shocks to financial market returns might have a persistent impact on investors' behaviour and persistently lower future stock market participation. Bucciol and Miniaci (2014) show that the observed changes in portfolio risk taking are due to a time effect more than a cohort effect. Guiso et al. (2013) also find evidence of a time-varying pattern for subjective and hypothetical measures of risk aversion.

Some works focus on the impact of the business cycle – and in particular the current financial crisis – on the subjective perception of risk. Hoffmann et al. (2013) find that clients of a brokerage firm significantly increased risk perception during the worst period of the crisis, but also promptly reduced it after few signals of recovery. In general the effect seems temporary, as risk perception looks stable over long time intervals (Bateman et al., 2011; Hoffmann et al., 2013; Weber et al, 2013). There may be a psychological reason for this evidence: prior outcomes – either good or bad – affect the way individuals perceive the risk of a situation and induce an emotional response (the "risk-as-feelings" hypothesis of Loewenstein et al., 2001). In addition, risk perception may vary with the crisis due to poor financial literacy. Sachse et al. (2012) find that financial risk perception correlates with

financial literacy, but not with the socio-demographic characteristics of the investor. A possible explanation is that the crisis makes investors aware of the "true" risk of investing in financial assets, temporarily increasing risk perception. Investors who had been losing money might have concluded that they are greater risk taker than they had previously thought.

While there seems to be consensus in the literature on the relationship between risk taste and the common macroeconomic environment the link between risk taste, common and personal experience is not as clear. Some works find that experiencing consecutive losses reduces the subsequent willingness to take risk (see the review in Barberis, 2013); others find that investors have difficulty learning from their past experience (Barber and Odean, 2001) and, if they learn, the process is slow (Gervais and Odean, 2001).

In light of the mixed evidence, the goal of this analysis is to study empirically this relation, using a generic measure of risk taste and separate, specific facets of risk taste. Our hypothesis is that risk taste evolves in response to economic and market conditions (*common experience*) and, once we control for it, it also varies after observing the past performance of the personal portfolio (*personal and subjective experience*.) We contribute to the literature by studying the role of common as well as personal and subjective experience in a representative sample observed over a long period including two business cycles.

We use the panel survey dataset called Dutch Household Survey (DHS), which provides repeated information on the household as a whole and on individuals residing within the household, concerning aspects of household economy, demography, and health, for a sample representative of the population in the Netherlands. Overall, our sample regards 2,074 households covering annually the period from 1995 to 2012. There are at least three advantages to use DHS data in our exercise. First, the dataset contains detailed information on portfolio composition as well as six self-assessed measures of risk taste and one measure of self-assessed past risk exposure, all collected regularly over time. In the analysis we will use all these measures, together with a synthetic measure capturing risk taste as a whole. Second, this is a long panel dataset, which allows us to effectively use panel regression methods and control for (observable and unobservable) individual heterogeneity over a longer time range than usually considered in the literature of household finance: our sample period indeed covers two business cycles, whereas previous works focus on the years immediately before and immediately after the 2008 crisis. Third, the dataset is a representative sample of the population in a country, the Netherlands, whose economy is seriously exposed to external developments due to some structural vulnerabilities – noticeably its considerable export

sector, its internationally-oriented financial sector and its vast pension fund system (Masselink and Van den Noord, 2009). In fact we can easily detect two periods of growth and two periods of recession in our sample.

Our analysis suggests that the six risk taste measures capture different facets of financial risk attitude. In general risk appetite is higher during periods of economic growth, and lower during periods of recession. The only exception regards two measures explicitly referring to "safe investment" in their wording: for these two measures the time trend looks flat and does not seem influenced by the business cycle. Once controlled for unobserved time-invariant heterogeneity, wealth, financial knowledge and other observable characteristics do not seem to correlate with risk taste. In contrast, perception of past large risk exposure and transitions in the perception from large to small risk exposure positively correlate with risk taste.

The remainder of the paper is organised as follows. Section 2 presents the historical economic background and the data used in our analysis; Section 3 discusses our main findings; finally, Section 4 concludes. An appendix provides details on the econometric approach.

2. Data and Environment

Our analysis is based on the DNB Household Survey (hereafter DHS), a panel survey managed by CentERdata on behalf of the Dutch National Bank. The survey is meant to study primarily psychological and economic aspects of financial behaviour, and includes information on work and pensions, housing and mortgages, income, assets and debts, health, as well as demographic characteristics of a representative sample of Dutch individuals. The interview is performed over the Internet, at the convenience of the respondent and without the intervention of an interviewer; participants who do not have Internet access are provided with a device and technical support. Data are collected on about 2,000 households representative of the Dutch population, annually since 1993. Although questionnaires have changed gradually over the years, they are comparable across waves. However, we concentrate on the waves since year 1995, therefore excluding the first two waves that were part of another project (VSB-Center Saving Project), and whose questionnaire structure and sampling strategies were different.

We focus on the economically relevant part of the sample, in the age range 20-80, with positive financial wealth and household income from any source[1]. We exclude from these households those with financial wealth always below 10,000 euros in every wave. Until year 1999 the sample contained a sub-sample of wealthier individuals, that we also exclude from the analysis. Our final dataset is then made of 11,552 observations on 2,074 households interviewed annually for at least 3 waves and in up to 18 waves, between 1995 and 2012.[2]

During the 1995-2012 period the Netherlands witnessed phases of both economic growth and recession. Figure 1 plots for this country the time trend between 1995 and 2012 in annual variations of the real per capita GDP, the unemployment rate (source: OECD), annual variations of the Amsterdam Stock Exchange (AEX) stock price index and the annual volatility of the AEX daily returns (raw data source: Yahoo Finance). The indicators follow a similar pattern; in particular the GDP and the AEX index seem to track each other, with the latter slightly anticipating the former. The figure clearly highlights four periods: one of prolonged growth and reduction of unemployment (in the late 90s), one of stagnation (in the early 2000s, following international events such as the Internet bubble in the stock market, terrorism attacks, the war in Iraq, and the SARS outbreak), another period of moderate growth (in the middle of the 2000s) and a major recession (starting at the end of the 2000s). The Dutch economy was severely exposed to the recent worldwide financial crisis because of its developed stock market and large international trade sector. In particular, in such period banks suffered from heavy financial losses: the government had to provide loans to one of the main national banks, ING, while it had to nationalise the Dutch branch of Fortis bank. The economy started recovering in year 2011, driven by the export sector. The financial market anticipated this trend by earning positive returns already in 2010.

FIGURE 1 ABOUT HERE

Our dataset includes a set of six self-assessed qualitative variables covering different facets of risk taste. The questions ask respondents to declare how much they agree with a given statement, on a discrete scale from 1 ("totally disagree") to 7 ("totally agree"). The statements are listed in Table 1, in the same order as in the questionnaire.

[1] Monetary values are reported to 2010 prices using the Consumer Price Index, all items. The source is OECD.

[2] This panel dataset is unbalanced, because new participants entered the panel in between the years, and other participants left the panel for death or other unknown reasons. This is possibly causing attrition. To check for the relevance of this phenomenon in our sample, we followed Nijman and Verbeek (1992) and repeated our benchmark analysis including in the specification an "attrition" dummy variable equal to 1 if there is no observation for the household in the subsequent wave, and 0 otherwise. The coefficient associated to this variable is always insignificantly different from zero, which suggests that attrition is not a problem in our analysis.

TABLE 1 ABOUT HERE

Notice that the direction of the questions is different. Three out of the six statements ((c), (e) and (f)) concern risk taste, while the remaining three ((a), (b) and (d)) concern risk distaste. For the sake of comparability, we convert all the variables to measure risk taste.[3] As a result of this transformation, a higher value in each of the six variables denotes higher risk appetite. Panels (a)-(f) of Figure 2 show the time series of the average of these transformed variables.

FIGURE 2 ABOUT HERE

Most variables show a roughly similar trend, with high levels from 1995 to 2000 and then a progressive fall, more pronounced in the most recent years. From the figure, however, it is clear that two facets ((a) and (d)) exhibit a relatively flat pattern. These facets are the only explicitly referring to *safe investments* in their sentences. This suggests that, when it comes to safe investments, individuals are less inclined to change their risk taste over time. We can also divide the remaining four facets in two groups: one explicitly referring to financial investments or investment in shares (facets (b) and (e)) and one explicitly referring to the possibility to borrow or lose money (facets (c) and (f)). Answers to these two groups of variables, however, do not show a similar pattern, although on average they are all lower at the end than at the beginning of the sample period.

The six facets exhibit a Cronbach's alpha of 0.75 (average of the wave-specific measures), which indicates that the variables are interrelated and tend to measure the same thing, although not completely[4]. In fact, pairwise polychoric correlation between the measures is only moderately high (on average across waves and facets 0.48 within the group of risk taste measures, 0.50 within the group of risk distaste measures and 0.28 between the two groups); this confirms that the variables indeed convey information on different facets of risk taste. Since each has its own specificity, in our analysis we consider all the six indicators separately. In addition we summarise their information in one single variable, constructed as the sum of the six indicators. Panel (g) of Figure 2 shows the time trend of the annual average of this variable, compared with the time trend of two alternative measures derived from

[3] Specifically, we transform the variables on statements (a), (b) and (d) to take a value of 7 instead of a declared 1, 6 instead of a declared 2, 5 instead of a declared 3, and vice versa.

[4] The alpha coefficient reaches a maximum of 1 when there is perfect interrelatedness among the items.

polychoric factor analysis.[5] For the sake of comparability the three variables are divided by their mean and rescaled to 0 in 1995. The three measures show a similar pattern, as they all move together with the business cycle: we indeed see that risk appetite rose during periods of growth (late 1990s, middle of 2000s) and fell during periods of recession (early 2000s, late 2000s).[6] In what follows we focus on the sum of the facets only. This measure shows a between-group standard deviation of 5.51 and a within-group standard deviation of 3.54. The variation in risk taste for the same individual in two years is then around two-thirds of the variation in risk taste between two individuals.

Table 2 reports the sample averages of the risk taste indicators, separately by portfolio composition. In the table we consider the most frequent portfolio types, which are made of different combinations of cash, debt, real estate and risky financial assets. Averages are in line with the common sense, as they suggest that individuals holding riskier assets in their portfolios generally exhibit more risk appetite.

TABLE 2 ABOUT HERE

The DHS dataset also includes one variable on the self-perception of the risk exposure in past investment decisions. The text of the question is reported in the bottom part of Table 1. If the respondent made no investment in the past, she is asked to answer "not applicable". In contrast, if she thinks she had made investments of any type, she has to judge the degree of riskiness of her past investments on a scale from 1 ("no risk") to 5 ("great risk"). The wording of the question can be interpreted with ambiguity, for instance because different respondents may have different opinions on the number of years to consider as "past few years", or they may answer "not applicable" even if they had kept the same investments repeatedly over time, without making further rebalancing. This notwithstanding, it is useful to use this information as a proxy for the individual perception of past risk bearing.

We use this variable to distinguish between three groups of individuals: those who made no investments (they answered "not applicable"), those who believe they made small-risk investments (they answered 1 or 2) and those who believe they made large-risk investments (they answered 3, 4 or 5). Overall, 38 percent of the sample consider themselves as non-

[5] One measure is the common factor from the whole dataset; the other is the common factor from the set of data in each wave. Factor analysis is performed using the polychoric correlation matrix because of the discrete nature of the input variables. The two measures correlate mostly with the risk taste facets (b) and (f), and are almost perfectly correlated with the sum of the facets (the correlation is around 0.98 for both.)

[6] Bricker et al. (2011), using US data, also found that the recession and other economic developments arisen between 2007 and 2009 have made households less willing to take financial risk in aggregate.

investors, while 35 and 27 percent consider themselves as small-risk and large-risk investors, respectively. Table 3 shows the distribution of past risk exposure in the sample, conditional on portfolio type. Compared to the overall sample distribution, those who declare no investment are observed more frequently among those with only cash, and less frequently among those with risky assets. Similarly, those who declare large risk exposure are more frequently observed among the holders of risky assets. Past risk exposure then seems related to actual current investment habits.

TABLE 3 ABOUT HERE

Panel (a) of Figure 3 depicts the distribution over time of the three groups of individuals with different past risk exposure. Of course the same individual may change her opinion on risk exposure from one year to another; panel (b) of the figure reports the fraction of transitions from small to large risk and vice versa arisen in the sample, which are overall nearly 10 percent. We see that transitions to large risk exposure were more frequent in the first part of the time period considered, while transitions to small risk exposure were more frequent in the second part of the period. Again, this is possibly related to the phases of growth and recession of the economy. Overall, 26.28% of the respondents changed over time their answer to the question, and roughly half of them reported both increases and decreases of past risk exposure.

FIGURE 3 ABOUT HERE

3. Analysis

Our goal is to understand if individual risk taste changes over time with different background economic conditions and personal investment experience, after controlling for the standard socio-demographic characteristics. We therefore perform several regression analyses, where the dependent variables are each of our risk taste measures. The specification includes macro-economic indicators (on GDP change, unemployment rate, AEX market returns and volatility in the previous year), and control variables on socio-demographic characteristics (age, marital status, employment status, living in a highly urbanised city), financial status (financial wealth, home ownership, holding of debt or risky assets[7]) as well as financial sophistication (self-

[7] By risky assets we mean bonds, funds and stocks.

assessed knowledgeable with financial matters, use of a professional advice for investments). Table 4 shows summary statistics on the variables we consider.

TABLE 4 ABOUT HERE

We first focus on the measure of overall risk. Columns (1)-(3) of Table 5 show the output of several fixed-effect panel regression analyses; in all the cases we report Driscoll-Kraay standard errors to control for heteroskedasticity and cross-sectional correlation (see Driscoll and Kraay, 1998.) The three columns differ in the specification. Column (1), which includes the control variables and the macroeconomic indicators, shows standard results that are common in the literature, such as the negative effect of age and the positive effect of financial sophistication (for instance see Bucciol and Miniaci, 2011). Interestingly, there is no effect of either financial wealth, home ownership or debt holding, while risk taste is positively correlated with the holding of risky assets. In addition we find significant time effects: risk appetite grows with GDP and market returns, while it falls with the unemployment rate.

Self-assessed risk appetite might be influenced by past investments and the perception of past risk exposure. For this reason in Column (2) of Table 5 we add four more variables to the specification: two variables on the perceived small risk or large risk exposure of past investments, and two variables informing on the annual transition from small to large risk exposure and vice versa, from one year to another. It is difficult that investment habits change dramatically (Calvet et al., 2009), especially in two consecutive years. Transitions might therefore reflect that the individual has changed her perception of risk about the same investments. We therefore interpret a transition to large risk exposure as an indication of disappointment with past investments, and a transition to small risk exposure as an indication of satisfaction with past investments, which may generate optimism bias for the future.

Not surprisingly we see that households declaring large risk exposure have higher risk appetite. The same does not apply to small risk investors, that therefore show a risk taste insignificantly different from non-investors. It should be noticed, though, that individuals declaring small risk exposure could be making no or minimal investments. Regarding transitions, we find a positive effect of going from perceived large to small risk exposure, and an insignificant effect of that going from small to large risk exposure. This evidence then suggests that small-risk investors who think their investments in the further past were riskier are more risk prone than those who did not change their opinion about the small riskiness of

their portfolio. All the other coefficient estimates are in line with Column (1); in particular the macroeconomic indicators on GDP and market growth show similar coefficients.

Column (3) of Table 5 further includes in the specification the interaction between the dummy variable on the holding of risky assets and the four measures of past risk exposure. The purpose is to disentangle the effect of the perceived portfolio risk from the actual riskiness of the portfolio. Household holding risky assets are, *ceteris paribus*, more risk prone than those either not investing or investing only in safe assets. The estimated interaction term shows that such a difference is significantly reduced if the investor holding risky assets perceives this position as carrying small risk exposure.

Our dependent variable can take a large number of values (between 6 and 42), but is discrete in nature. Models better suited to deal with such variables belong to the class of fixed-effect ordered logit models that, however, are difficult to estimate consistently. In Column (4) we therefore run a regression based on the same specification as Column (3), using a Blow-Up and Cluster (BUC) fixed-effect logit method. This estimation technique, described in the Appendix, generates 36 replicas of the genuine observations (as many as the number of potential realizations minus one), removing observations and households that show no time variation in the dependent variable. The number of households with variations, shown in the bottom part of the column, indicates that 2,033 out of the 2,074 households indeed change over time the answer to the overall risk measure. With this new estimation method, most of the previous findings are confirmed. In particular, we again find significantly positive effects of GDP and market growth, large risk exposure, and transitions from large to small risk.

TABLE 5 ABOUT HERE

We then look for potential composition effects of the overall risk taste indicator, and replicate in Table 6 the same analysis of Column (4) in Table 5 over each of the six risk taste facets. In all the cases we therefore run a BUC regression. Indeed there is heterogeneity, as not all the variables are steadily significant or insignificant across facets. There is a general age-declining trend, which instead is flat regarding Columns (1) and (4), i.e., the facets related to safe investments (on this regard see the Appendix Figure A1.) We persistently observe a positive relation between each facet, large risk exposure, market growth and (with the exception of Column (4)) GDP growth.

Small risk exposure is positively correlated with risk taste (although not as much as large risk exposure) on the facets of Columns (2) and (3). We notice that this variable is also significant, but with the negative sign, on the facet of Column (1). This indicates that those with small risk exposure have lower risk appetite than those who made no investment. This outcome is not surprising for the facet of Column (1), which regards the volatility of returns as opposed to safe investments. In fact, individuals reporting small risk exposure are investors who actively implemented a prudent strategy, typically aimed at limiting returns volatility, and therefore we expect them to overweigh the safety of the investment.

TABLE 6 ABOUT HERE

Figure 4 plots the estimated time profile of the latent variables from these models, normalised to 0 in 1995. The profile is clearly conditional on the dependent variable and, as already found in Figure 2, is relatively flat in the two facets (a) and (d) related to safe investments. The remaining four facets show more similar patterns, with the highest levels between 1998 and 2000, and two main drops in 2003 and 2009 (two years of large market falls.) When pooling together the facets in the overall risk measure (panel (g) of Figure 4), we again observe the same pattern as the majority of the facets.[8] The general impression is that time changes in risk taste are only temporary, as in Hoffmann et al. (2013). In particular households react to observed market returns, which may be consistent with the "risk-as-feeling" hypothesis of Loewenstein et al. (2001).[9]

FIGURE 4 ABOUT HERE

4. Conclusions

The goal of this paper was to investigate whether individual risk taste changes over time reacting to changes in the background economic conditions as well as personal and subjective

[8] The concavity of the time profile is coherent with the one emerging from the second-order time differences of the data, obtained without imposing restrictions on age and cohort effects and following the approach of McKenzie (2006).

[9] We also notice that risk taste is correlated to the answer to the question (included since wave 2004): "How do you think the economic situation of your household will be in five years' time in comparison to the current situation?". Those who answer "better" or "much better" report an average overall risk taste of 18.28, significantly larger than the average overall risk taste of those who answer "worse" or "much worse" (15.60. Two-sample mean comparison test: 11.12, p-value <0.01.) We see this variable as an indicator of optimism toward the economy in the future, which may correlate with return expectations.

exposure to portfolio risk, controlling for socio-demographic characteristics. The analysis was performed using fixed-effect models on a panel sample of 2,074 Dutch households interviewed annually in up to 18 waves between 1995 and 2012.

Using a set of six measures of self-assessed risk taste covering different aspects of risk, we find that risk appetite is not stable over time, and in general it is higher during periods of economic growth, and lower during periods of recession. The exception is given by two facets of risk taste, explicitly referring to safe investments, that show a flat time profile. Once controlled for unobserved time-invariant heterogeneity, wealth, financial knowledge and other observable characteristics do not correlate with risk attitude. In contrast, perception of past risk exposure and transitions in the perception from large- to small-risk exposure positively correlate with risk taste.

In addition to their intrinsic interest, findings of this research are important for professionals, to offer financial products better suited to the investor's needs[10], and for policy makers, to help stabilizing the economy. Sharp fluctuations in risk attitude lead to changes in portfolio decisions (massive purchase or selling of assets), cause variations in asset prices, put the financial system under pressure, and ultimately affect the macroeconomy (Korniotis and Kumar, 2011). Being able to understand, anticipate and possibly contrast modifications of risk attitude is an important challenge to guarantee long-run economic development.

This is a first attempt to understand whether risk taste is influenced by external (common as well as personal and subjective) financial experience. In addition to financial shocks, individuals experience idiosyncratic shocks (economic or not) that are not shared with others, such as the loss of a job or the death of a child. Few works find evidence that these shocks also affect financial risk taste (e.g., Bucciol and Zarri, 2013, on child death). Future research will investigate whether the impact of non-financial idiosyncratic shocks on risk taste is larger, equivalent or smaller than the impact of financial shocks.

[10] Professionals are more and more interested in detecting an investor's risk profile given some basic inputs. For instance see www.riskalyze.com.

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Appendix: The econometric model

The single facets of risk taste are measured on a seven-point Likert scale. To limit biases due to the possible endogeneity in the regression equation, we exploit the panel dimension of the data. However, estimation of panel models for discrete variables carries some shortcomings. Our estimates are then based on a fixed-effect ordered logit model in the variant proposed by Baetschmann et al. (2011) and labelled as Blow-Up and Cluster (BUC) estimator. We briefly describe the problem and our estimator in the remainder of this section.

Consider a model for the unobserved latent variable $y_{i,t}^{*}$ for individual $i = 1,...,N$ at time $t = 1,...,T$ as a function of the explanatory variables $x_{i,t}$, an individual fixed effect α_i and a random component $\varepsilon_{i,t}$:

$$y_{i,t}^{*} = x_{i,t}'\beta + \alpha_i + \varepsilon_{i,t}.$$

We observe the variable $y_{i,t}$, with possible realizations $k = 1,...,K$ and individual-specific thresholds strictly increasing $\left(\tau_{i,k} < \tau_{i,k+1}\right)$ with $\tau_{i,1} = -\infty$ and $\tau_{i,K+1} = \infty$:

$$y_{i,t} = k \quad \text{if } y_{i,t}^{*} \in \left(\tau_{i,k}, \tau_{i,k+1}\right].$$

Assuming a logistic distribution for $\varepsilon_{i,t}$, the probability of observing $y_{i,t} = k$ conditional on the explanatory variables $x_{i,t}$ and the individual fixed effect α_i is

$$\Pr\left(y_{i,t} = k \middle| x_{i,t}, \alpha_i\right) = \Lambda\left(\tau_{i,k+1} - x_{i,t}'\beta - \alpha_i\right) - \Lambda\left(\tau_{i,k} - x_{i,t}'\beta - \alpha_i\right).$$

There are two problems with the estimation of this fixed-effect ordered logit model. First, the threshold $\tau_{i,k}$ cannot be distinguished from α_i. Second, there is an incidental parameter problem, in that too many individual effects have to be estimated. A common solution consists in estimating a fixed-effect logit model. For each of the possible realizations $k = 1,...,K$ the variable $y_{i,t}$ can be collapsed into a binary variable:

$$d_{i,t}^{k} = \begin{cases} 1 & \text{if } y_{i,k} \geq k \\ 0 & \text{if } y_{i,k} < k. \end{cases}$$

A consistent estimate for β, $\hat{\beta}^k$, is found from the maximization of a conditional log-likelihood function, where $j_{i,t} \in \{0,1\}$ is the realization of $d_{i,t}^k$ and the corresponding sequences for the *T* periods are $j_i = (j_{i,1},\ldots,j_{i,T})$ and $d_i^k = (d_{i,1}^k,\ldots,d_{i,T}^k)$:

$$\hat{\beta}^k = \arg\max_{\beta}\left\{\ln L^k(\beta)\right\} = \arg\max_{\beta}\left\{\sum_{i=1}^{N}\ln \Pr\left(d_i^k = j_i \left| \sum_{t=1}^{T} d_{i,t}^k = \sum_{t=1}^{T} j_{i,t}\right.\right)\right\}.$$

Conditioning on $\sum_{t=1}^{T} d_{i,t}^k$ causes all the time-invariant elements (in particular α_i and $\tau_{i,k}$) to cancel. This solves the incidental parameter problem, but it comes at the cost of dropping from the estimation sample those individuals with $d_{i,t}^k$ constant over t, because they do not contribute to the likelihood[11]. Moreover, estimates are sensitive to the choice of the cut-off point k, which is arbitrary. A possible remedy is to pick a different cut-off point for each individual (Ferrer-i-Carbonell and Frijters, 2004). However, an individual-specific cut-off point brings endogeneity into the problem. An alternative is to estimate β on all the K possible cut-off points, and combine the resulting estimates (Das and Van Soest, 1999) through a minimum distance approach. Ferrer-i-Carbonell and Frijters (2004), however, found that the weighting matrix in the distance measure could be estimated imprecisely in small samples.

Another approach is to estimate β jointly from the maximization of the sum of all the conditional log-likelihood functions. This is the BUC estimator:

$$\beta^{BUC} = \arg\max_{\beta}\left\{\sum_{k=2}^{K}\ln L^k(\beta)\right\}.$$

The name of the estimator originates from a two-step algorithm. First, "blow-up": replace every observation by $K-1$ copies of itself, dichotomizing each at a different cut-off point. Second, "cluster": use cluster-robust variance allowing for correlation within the observations of the same individual. The BUC estimator, which provides consistent estimates of the fixed-effect ordered logit model, does not have the problems mentioned above, and is found to have better small-sample properties than the estimator proposed by Das and Van Soest (1999).

[11] Indeed in this case $\Pr\left(d_i^k = (1,\ldots,1)\left|\sum_{t=1}^{T} d_{i,t}^k = T\right.\right) = \Pr\left(d_i^k = (0,\ldots,0)\left|\sum_{t=1}^{T} d_{i,t}^k = 0\right.\right) = 1.$

Table 1. Self-assessed questions on risk taste

	Label in our analysis	Question
		Risk taste
(a)	Return volatility	*"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."*
(b)	Share investment	*"I would never consider investments in shares because I find this too risky."*
(c)	Borrowing	*"If I think an investment will be profitable, I am prepared to borrow money to make this investment."*
(d)	Investment safety	*"I want to be certain that my investments are safe."*
(e)	Financial risk	*"I get more and more convinced that I should take greater financial risks to improve my financial position."*
(f)	Money loss	*"I am prepared to take the risk to lose money, when there is also a chance to gain money."*
		Past risk exposure
		"What would you say was the risk factor that you have taken with investments over the past few years? If you haven't made any investments, choose 'not applicable'."

Note. Answers to the "risk taste" questions are provided on a discrete scale from 1 ("totally disagree") to 7 ("totally agree"); In the analysis we transform the answers to statements (a), (b) and (d) in such a way that higher values indicate more risk taste.. Answers to the "past risk exposure" question are provided on a discrete scale from 1 ("I have taken no risk at all") to 5 ("I have often taken great risks"). In addition it is possible to answer "not applicable", meaning that no investment has been made. In the analysis we combine the answers in three categories: no investment (if "not applicable"), small risk (answers 1-3) and large risk (answers 4-5).

Table 2. Average risk taste by portfolio type

Portfolio type	Obs.	Return volatility	Share investment	Borrowing	Investment safety	Financial risk	Money loss	Overall risk
C only	2,854	2.775	2.976	2.025	2.484	2.563	2.255	15.077
C and RE	717	2.623	3.056	2.197	2.411	2.587	2.291	15.169
C and D	603	3.071	3.217	2.381	2.645	2.814	2.463	16.592
C, RE and D	3,363	2.596	3.130	2.287	2.476	2.792	2.455	15.735
C and R	1,059	2.994	4.688	2.256	2.643	3.195	3.329	19.106
C, RE and R	557	2.693	4.817	2.246	2.366	3.081	3.149	18.352
C, R and D	244	3.480	4.914	2.725	2.811	3.336	3.635	20.902
All assets	2,155	3.202	5.077	2.643	2.744	3.270	3.574	20.510
Sample	11,552	2.840	3.717	2.292	2.550	2.875	2.743	17.017

Note. C: Cash; RE: Real estate; D: Debt; R: Risky financial assets. The "overall risk" indicator is the sum of the six risk taste measures.

Table 3. Distribution of past risk exposure by portfolio type

Portfolio Type	Obs.	No investment	Small risk	Large risk
C only	2,854	0.580	0.327	0.094
C and RE	717	0.464	0.365	0.170
C and D	603	0.667	0.239	0.095
C, RE and D	3,363	0.489	0.348	0.162
C and R	1,059	0.119	0.393	0.488
C, RE and R	557	0.115	0.365	0.520
C, R and D	244	0.075	0.417	0.509
All assets	2,155	0.066	0.352	0.582
Sample	11,552	0.379	0.347	0.275

Note. C: Cash; RE: Real estate; D: Debt; R: Risky financial assets.

Table 4. Summary statistics (11,552 observations)

Variable	Mean	Std. dev.	Minimum	Maximum
	Risk taste			
Return volatility	2.840	1.678	1	7
Share investment	3.717	2.058	1	7
Borrowing	2.292	1.590	1	7
Investment safety	2.550	1.344	1	7
Financial risk	2.875	1.659	1	7
Money loss	2.743	1.579	1	7
Overall risk	17.017	6.380	6	42
	Control variables			
Age	53.654	13.286	20	80
With a partner	0.769	0.421	0	1
Highly urbanised city	0.386	0.487	0	1
Employee	0.562	0.496	0	1
Self-employed	0.031	0.174	0	1
Financially knowledgeable	0.260	0.439	0	1
With prof. advice	0.261	0.439	0	1
With media advice	0.340	0.474	0	1
Financial assets (thousand euros)	47.396	107.351	0.001	3,702.125
Homeowner	0.578	0.494	0	1
If debt	0.551	0.497	0	1
If risky assets	0.348	0.476	0	1
	Macroeconomic indicators			
GDP annual change (%)	1.682	1.901	-4.167	3.985
Unemployment rate (%)	4.363	1.234	2.558	7.067
AEX annual return (%)	4.164	24.227	-52.316	40.947
AEX daily return volatility (%)	1.357	0.598	0.579	2.687
	Past risk exposure			
Small risk exposure	0.347	0.476	0	1
Large risk exposure	0.275	0.446	0	1
Small to large risk	0.048	0.215	0	1
Large to small risk	0.048	0.214	0	1
Small risk exposure * If risky assets	0.129	0.336	0	1
Large risk exposure * If risky assets	0.189	0.391	0	1
Small to large risk * If risky assets	0.030	0.171	0	1
Large to small risk * If risky assets	0.030	0.171	0	1

Table 5. Overall risk taste

	(1)	(2)	(3)	(4)
Age	-0.206***	-0.248***	-0.247***	-0.129***
	(0.046)	(0.041)	(0.041)	(0.038)
Age^2	0.001*	0.001***	0.001***	0.001*
	(0.000)	(0.000)	(0.000)	(0.000)
With a partner	0.384***	0.299**	0.309**	0.145
	(0.145)	(0.137)	(0.137)	(0.156)
Highly urbanised	0.023	0.067	0.074	0.038
City	(0.247)	(0.241)	(0.243)	(0.163)
Employee	0.497***	0.545***	0.536***	0.244
	(0.137)	(0.141)	(0.142)	(0.178)
Self-employed	-1.150*	-0.970*	-0.991*	-0.207
	(0.634)	(0.573)	(0.574)	(0.384)
Financially	0.239***	0.196**	0.200**	0.092
Knowledgeable	(0.090)	(0.086)	(0.087)	(0.072)
With prof. advice	-0.059	-0.060	-0.059	-0.028
	(0.105)	(0.104)	(0.104)	(0.063)
With media advice	0.247***	0.241***	0.240***	0.134**
	(0.065)	(0.070)	(0.068)	(0.059)
Log(fin. assets)	-0.041	-0.058	-0.060	-0.033
	(0.041)	(0.036)	(0.037)	(0.022)
Homeowner	-0.118	-0.141	-0.141	-0.076
	(0.103)	(0.102)	(0.101)	(0.091)
If debt	-0.016	-0.011	-0.012	-0.014
	(0.095)	(0.089)	(0.088)	(0.081)
If risky assets	0.839***	0.587***	0.831***	0.421***
	(0.088)	(0.091)	(0.112)	(0.143)
GDP annual change (%)	0.186***	0.191***	0.192***	0.095***
	(0.025)	(0.029)	(0.029)	(0.013)
Unemployment rate (%)	-0.156**	-0.122	-0.121	-0.060**
	(0.078)	(0.085)	(0.085)	(0.027)
AEX annual return (%)	0.021***	0.022***	0.022***	0.011***
	(0.003)	(0.003)	(0.003)	(0.001)
AEX daily return	0.146	0.145	0.145	0.065
volatility (%)	(0.126)	(0.138)	(0.138)	(0.055)
Small risk exposure		0.082	0.189	0.091
		(0.141)	(0.136)	(0.067)
Large risk exposure		1.969***	1.747***	0.811***
		(0.189)	(0.102)	(0.114)
Small to large risk		-0.324	0.063	0.041
		(0.220)	(0.342)	(0.177)
Large to small risk		0.648***	0.706***	0.345**
		(0.228)	(0.268)	(0.153)
Small risk exposure			-0.519***	-0.283*
* If risky assets			(0.186)	(0.158)
Large risk exposure			0.109	0.068
* If risky assets			(0.241)	(0.181)
Small to large risk			-0.609*	-0.301
* If risky assets			(0.359)	(0.205)
Large to small risk			0.021	0.019
* If risky assets			(0.253)	(0.200)
Constant	25.498***	26.110***	26.067***	
	(1.235)	(1.194)	(1.192)	
Observations	11,552	11,552	11,552	11,552
Households	2,074	2,074	2,074	2,074
Hhs. with variations				2,033
Within R^2	0.051	0.070	0.071	
Pseudo-R^2				0.056

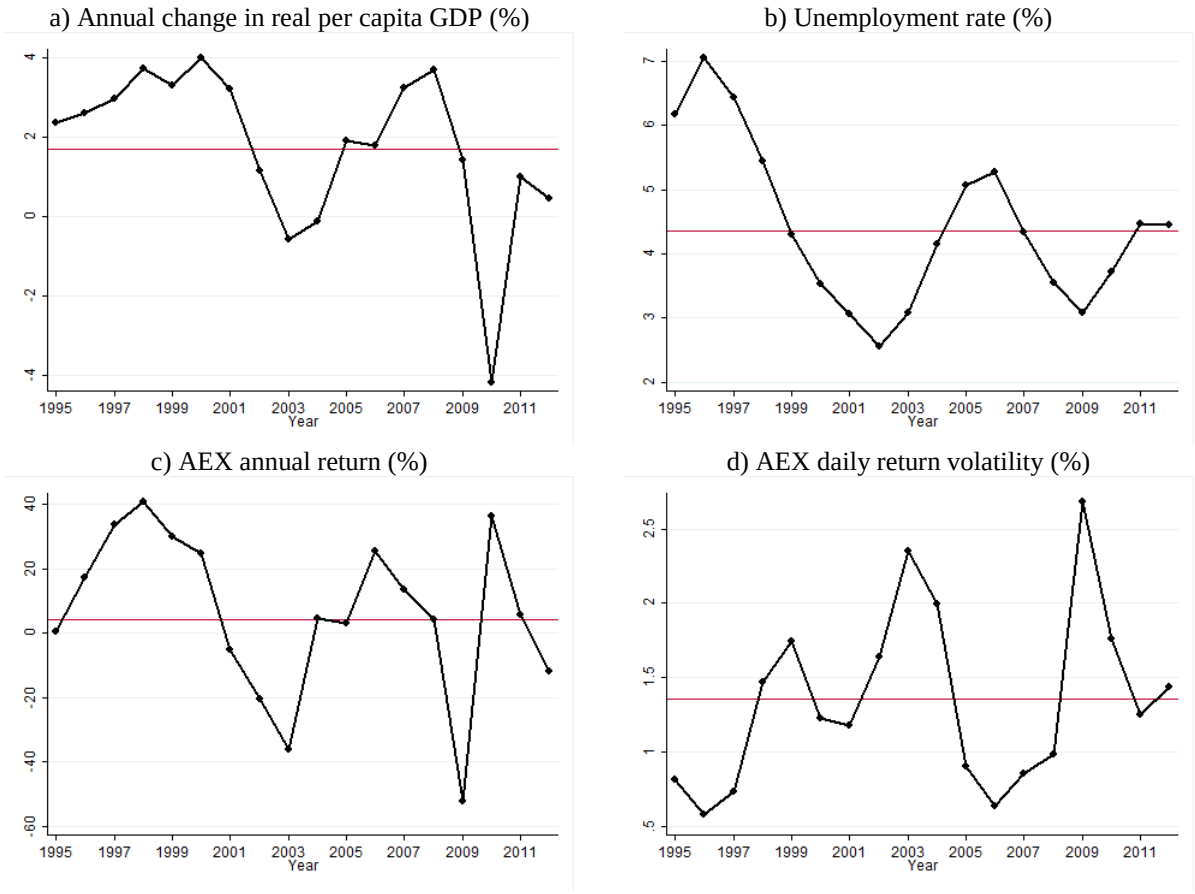
*Note. Columns (1)-(3) show the estimates from a fixed-effect panel regression with Driscoll-Kraay standard errors to control for cross-sectional correlation; Column (4) shows the estimates from a Blow-Up and Cluster fixed-effect logit regression. "Hhs. with variations" denotes the number of households who exhibit time variation in the dependent variable. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1*

Table 6. Single facets of risk taste

Dep.var.	(1) Return volatility	(2) Share investment	(3) Borrowing	(4) Investment safety	(5) Financial risk	(6) Money loss
Age	-0.141***	-0.090**	-0.103***	-0.115***	0.012	-0.030
	(0.037)	(0.041)	(0.038)	(0.036)	(0.034)	(0.037)
Age^2	0.001***	0.000	0.000	0.001***	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
With a partner	-0.072	0.175	0.100	0.106	0.142	0.067
	(0.152)	(0.149)	(0.157)	(0.153)	(0.145)	(0.168)
Highly urbanised	-0.162	0.222	-0.027	0.315	-0.277*	0.013
City	(0.255)	(0.194)	(0.180)	(0.206)	(0.168)	(0.194)
Employee	0.162	0.164	0.158	0.296*	0.020	0.118
	(0.187)	(0.172)	(0.180)	(0.154)	(0.167)	(0.200)
Self-employed	-0.092	0.484	-0.757**	0.182	-0.337	-0.173
	(0.334)	(0.371)	(0.308)	(0.347)	(0.369)	(0.427)
Financially	0.015	0.045	0.043	0.050	0.116	0.079
Knowledgeable	(0.081)	(0.081)	(0.082)	(0.076)	(0.080)	(0.073)
With prof. advice	0.059	-0.013	-0.115	-0.003	-0.062	0.017
	(0.070)	(0.068)	(0.077)	(0.071)	(0.063)	(0.068)
With media advice	0.064	0.128*	0.009	0.055	0.085	0.106
	(0.067)	(0.067)	(0.074)	(0.065)	(0.065)	(0.065)
Log(fin. assets)	-0.027	0.015	-0.033	-0.060**	-0.009	-0.014
	(0.026)	(0.027)	(0.024)	(0.026)	(0.022)	(0.024)
Homeowner	-0.206**	0.117	-0.031	0.039	-0.106	-0.063
	(0.096)	(0.108)	(0.104)	(0.093)	(0.100)	(0.102)
If debt	0.029	-0.153	0.075	0.017	0.007	-0.006
	(0.088)	(0.096)	(0.087)	(0.083)	(0.088)	(0.092)
If risky assets	0.292	0.478***	0.174	0.072	0.027	0.463***
	(0.178)	(0.153)	(0.162)	(0.164)	(0.138)	(0.171)
GDP annual change (%)	0.044***	0.032**	0.058***	0.015	0.087***	0.104***
	(0.015)	(0.016)	(0.015)	(0.016)	(0.014)	(0.015)
Unemployment rate (%)	-0.035	-0.092***	0.013	-0.066**	0.013	-0.081***
	(0.032)	(0.032)	(0.033)	(0.029)	(0.029)	(0.031)
AEX annual return (%)	0.003***	0.010***	0.005***	0.004***	0.007***	0.009***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
AEX daily return	0.067	-0.025	0.034	-0.005	-0.003	0.138**
volatility (%)	(0.060)	(0.063)	(0.065)	(0.060)	(0.060)	(0.063)
Small risk exposure	-0.220***	0.199***	0.227***	-0.044	0.066	0.099
	(0.081)	(0.071)	(0.078)	(0.075)	(0.073)	(0.078)
Large risk exposure	0.313**	0.782***	0.454***	0.299**	0.306***	0.692***
	(0.127)	(0.114)	(0.120)	(0.120)	(0.117)	(0.116)
Small to large risk	-0.188	0.191	-0.036	0.107	-0.064	0.113
	(0.171)	(0.179)	(0.181)	(0.199)	(0.169)	(0.178)
Large to small risk	0.300*	0.282*	0.280	0.390**	-0.135	0.132
	(0.156)	(0.157)	(0.182)	(0.184)	(0.160)	(0.173)
Small risk exposure	-0.311	0.000	-0.260	-0.125	-0.047	-0.424**
* If risky assets	(0.194)	(0.163)	(0.183)	(0.167)	(0.159)	(0.188)
Large risk exposure	0.074	0.241	-0.203	0.042	0.057	-0.077
* If risky assets	(0.213)	(0.187)	(0.195)	(0.190)	(0.172)	(0.202)
Small to large risk	-0.135	-0.478**	-0.268	0.005	0.147	-0.260
* If risky assets	(0.211)	(0.219)	(0.230)	(0.234)	(0.206)	(0.206)
Large to small risk	-0.164	0.008	-0.065	-0.340	0.252	0.318
* If risky assets	(0.209)	(0.208)	(0.237)	(0.229)	(0.211)	(0.219)
Observations	11,552	11,552	11,552	11,552	11,552	11,552
Households	2,074	2,074	2,074	2,074	2,074	2,074
Hhs. with variations	1,857	1,838	1,749	1,832	1,848	1,831
Pseudo-R^2	0.016	0.048	0.041	0.010	0.025	0.050

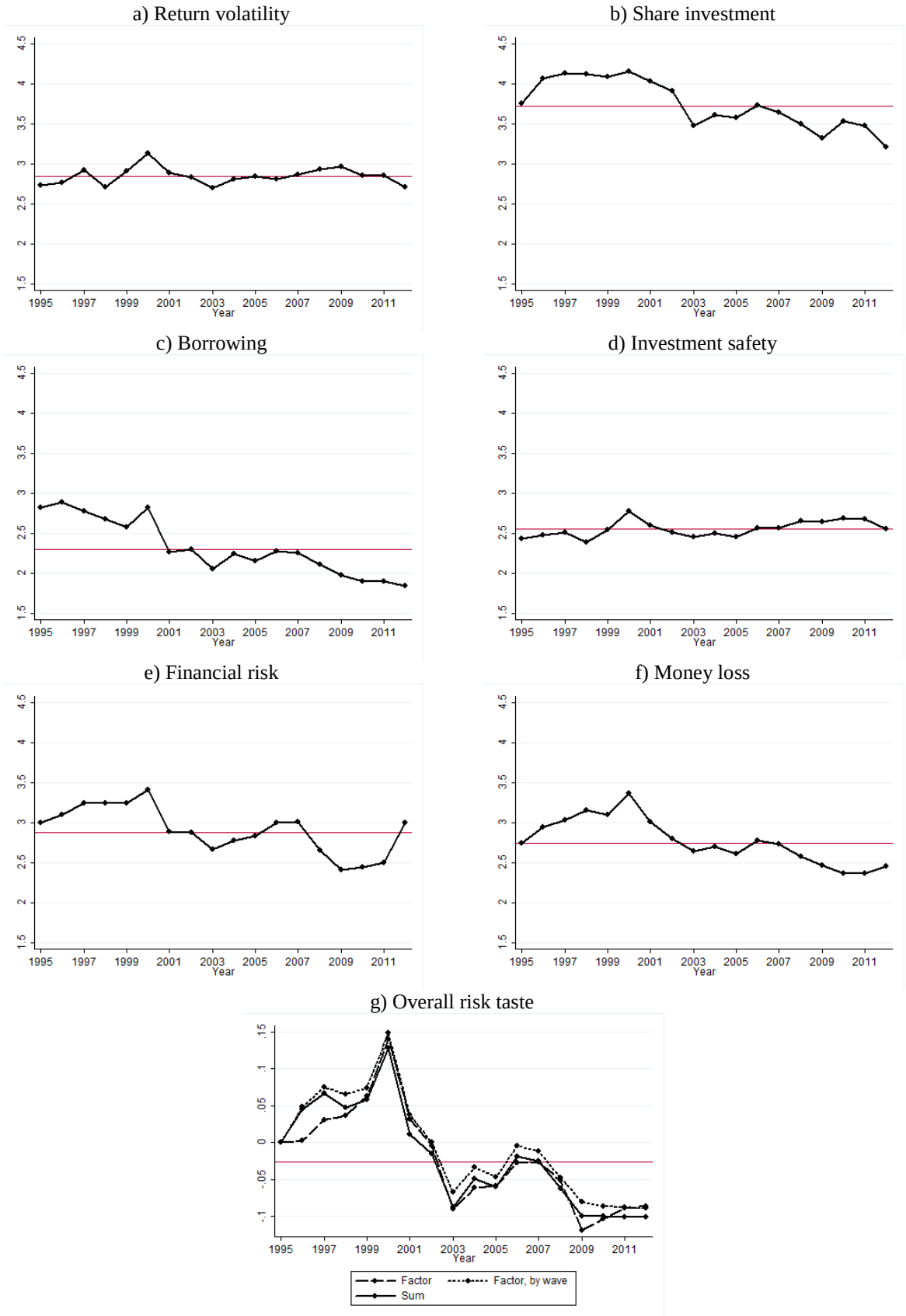
*Note. Columns (1)-(6) show the estimates from a Blow-Up and Cluster fixed-effect logit regression. "Hhs. with variations" denotes the number of households who exhibit time variation in the dependent variable. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1*

Figure 1. Macroeconomic indicators



Note: The straight line in each panel shows the average value of the variable in the sample.

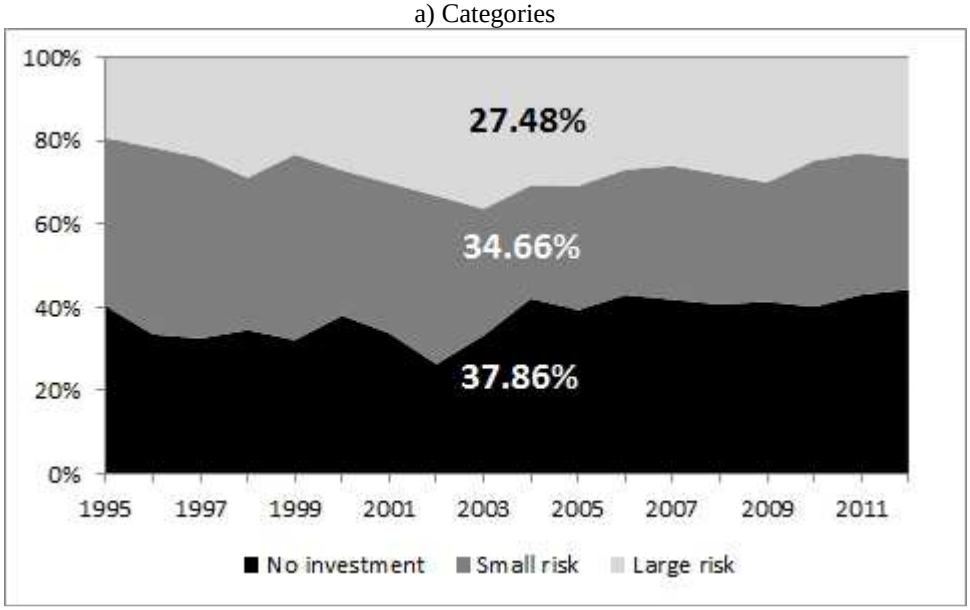
Figure 2. Trend in risk taste



Note: Values in panel (g) are divided by their mean and rescaled to 0 in 1995. The straight line in each panel shows the average value of the variable in the sample. For panel (g), the straight line refers to the "Sum" variable.

Figure 3. Trend in the distribution of past risk exposure

a) Categories



b) Transitions

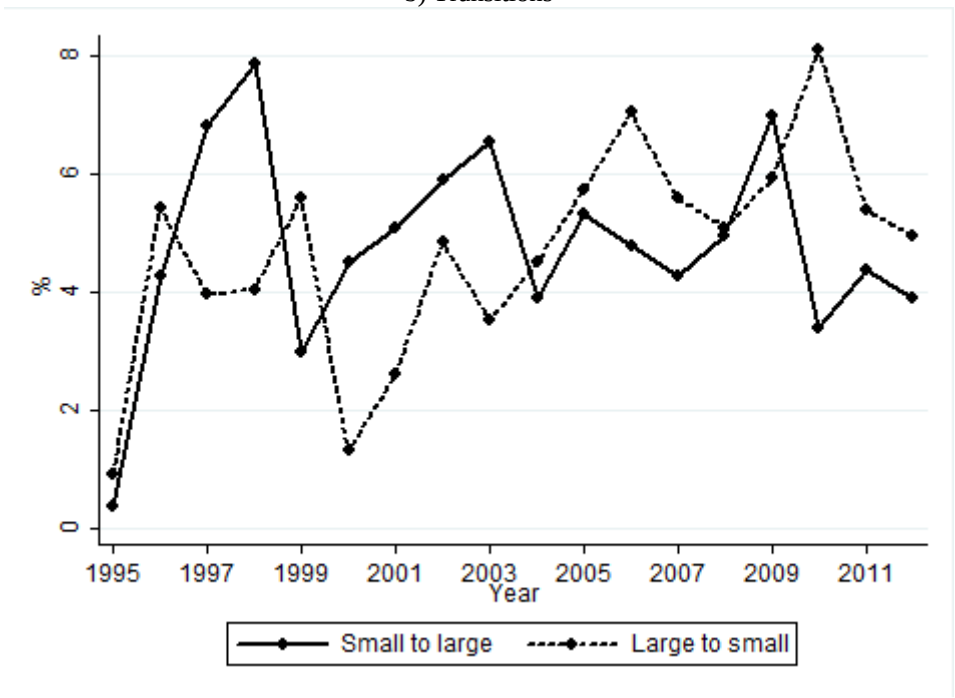
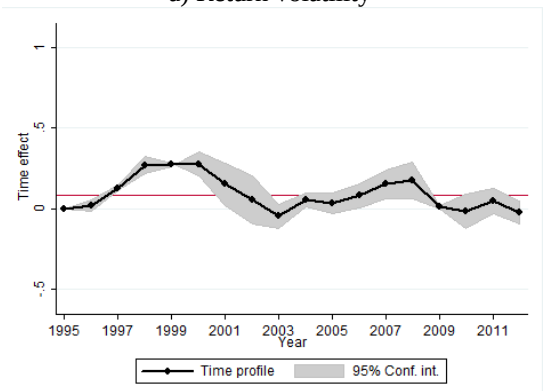
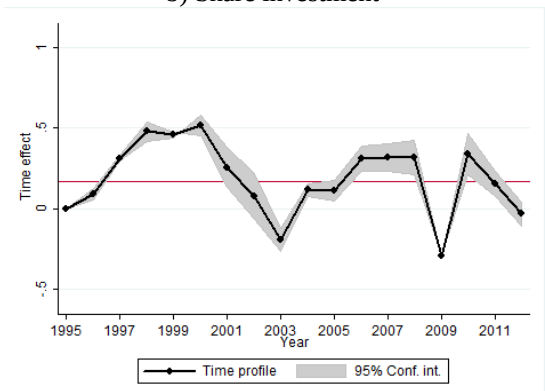


Figure 4. Estimated time profile

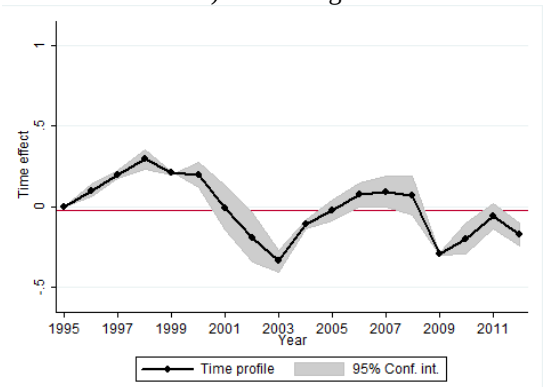
a) Return volatility



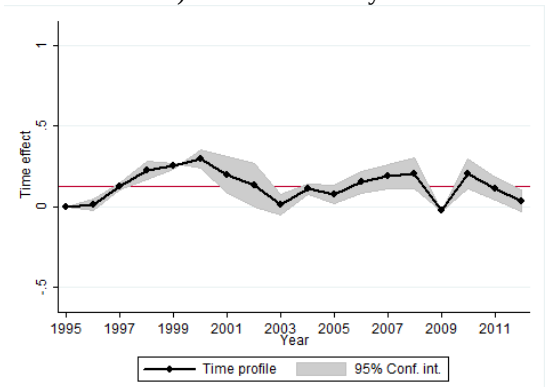
b) Share investment



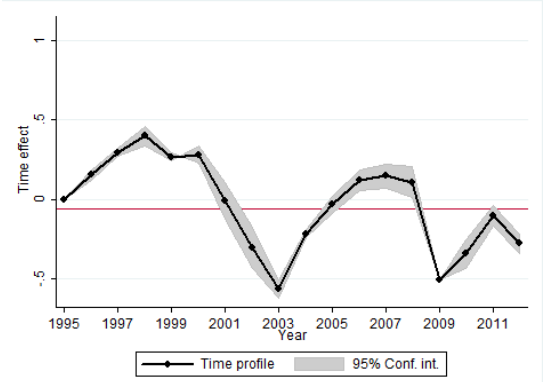
c) Borrowing



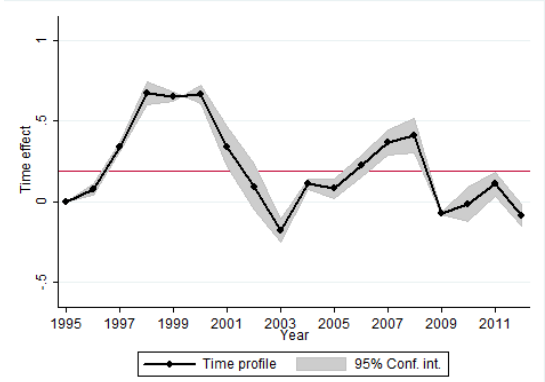
d) Investment safety



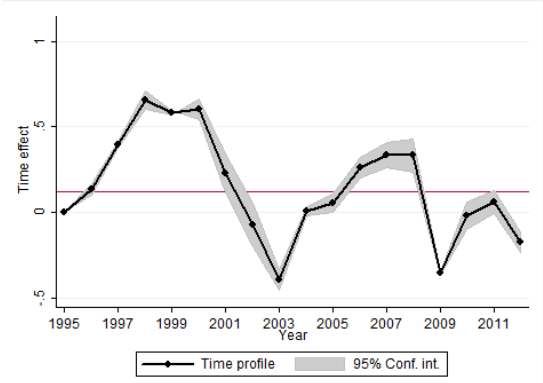
e) Financial risk



f) Money loss



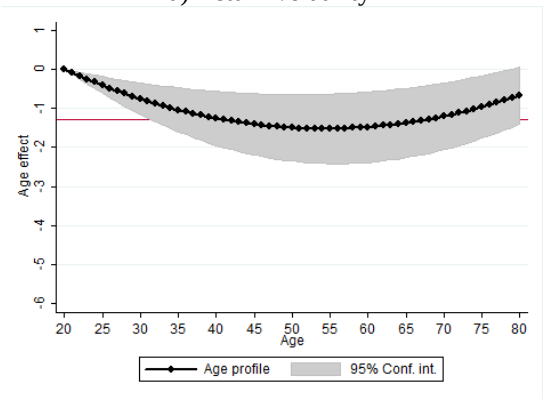
g) Overall risk taste



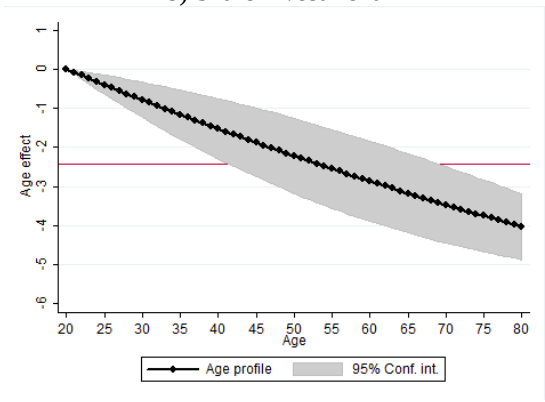
Note: Values are normalised to 0 in 1995. Profiles are based on the regression output of Tables 5 (Column (4)) and 6 (Columns (1)-(6)).

Appendix Figure A1. Estimated age profile

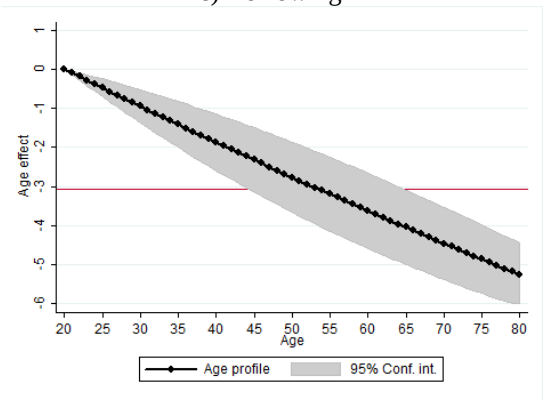
a) Return volatility



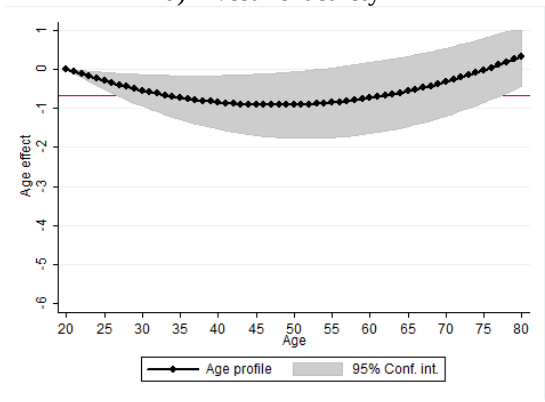
b) Share investment



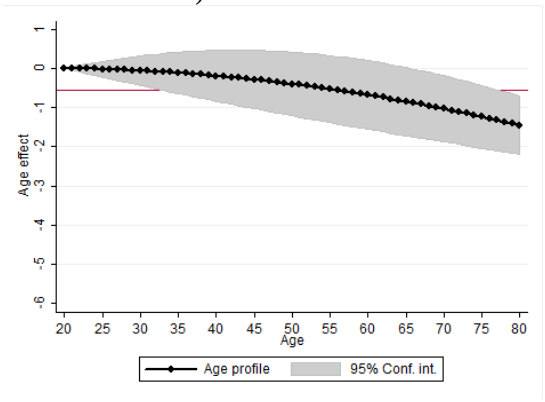
c) Borrowing



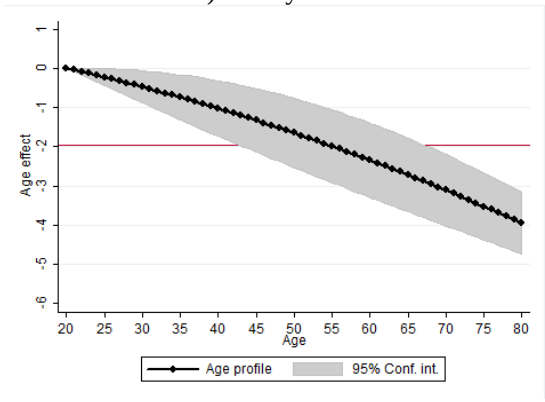
d) Investment safety



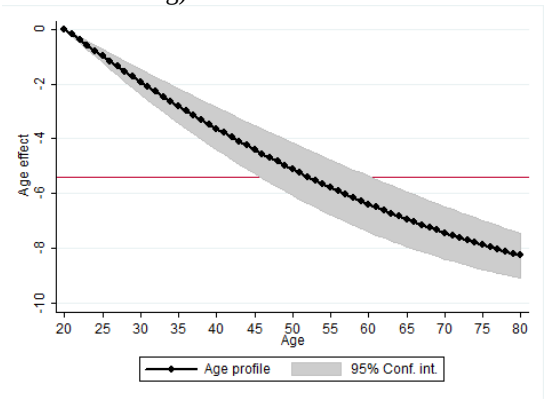
e) Financial risk



f) Money loss



g) Overall risk taste



Note: Values are normalised to 0 at age 20. Profiles are based on the regression output of Tables 5 (Column (4)) and 6 (Columns (1)-(6)).