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Financial Risk Aversion and Household Asset Diversification

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Financial Risk Aversion and Household Asset Diversification *

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Financial Risk Aversion and Household Asset Diversification

Abstract

This paper explores the relationship between risk attitude and asset diversification in household portfolios. We first examine the impact of manifested risk aversion on the total number of distinct assets held in a portfolio (naive diversification). The second part of the paper focuses on a more sophisticated strategy of diversification and asks whether financial theory is compatible with observed diversification patterns. Based on the German Socioeconomic Panel which provides unique measures of individual propensity for taking risk, the results of the regression analysis show that, along with some socioeconomic characteristics, the propensity for taking investment risk is an important predictor of a household's diversification strategy. However, some of our findings are strongly at odds with what the concept of mean-variance utility suggests.

JEL: D14, G11

Keywords: household finances, diversification, financial portfolio

1 Introduction

Knowing what affects the propensity of nonprofessional investors to diversify their financial portfolios is highly relevant for policymakers and the financial services industry. For example, the Markets in Financial Instruments Directive (MiFiD) of the European Commission requires financial advisors to identify customer risk preferences and to customize their advice according to these preferences (EC, 2006). Typically, this identification takes place by way of self-disclosure of the individual's risk attitude. Therefore, it is crucial to know whether subjective risk aversion is indeed the dominating factor in a household's investment diversification strategy. Our study intends to shed new light on this issue. We use high-quality survey data about both a household's risk attitude and its actual investment behavior to analyze how the perceived risk attitude shapes the structure of the financial portfolios.

In the theoretical literature, it is generally thought that an investor with high risk aversion will maintain a more diversified portfolio in order to minimize the variance of returns (e.g. Friend and Blume (1975) and Morin and Suarez (1983)). However, empirical studies do not always support this view. For example, Campbell, Chan and Viceira (2003) find that demand for risky assets is a positive hump-shaped function of risk tolerance. Fellner and Maciejovsky (2007) show that self-declared risk tolerance has a positive effect on willingness to diversify into risky assets. Moreover, some studies investigating the question of how households diversify argue that classical portfolio theory is inapplicable in this context.[1]

These discrepancies between empirical findings and theoretical expectations may be explained, at least to some extent, by how individual risk attitude is measured. In the majority of empirical studies, the level of risk aversion is measured either experimentally in hypothetical lotteries, and thus depends on the specific design of the experiment, or is inferred from relevant information about individual behavior in different socioeconomic contexts (e.g. Guiso and Pistaferri (2002), Hartog and Jonker (2000)). To date, a lack of high-quality survey data about household risk attitude, together with insufficient

[1] Guiso, Haliassos and Jappelli (2002), p.2.

information on asset holdings, has made it difficult to conduct a true test of the impact of risk aversion on the allocation of wealth across assets.

The conflicting findings and the absence of empirical evidence are strong motivation for further analysis of the role of risk attitudes in investment behavior. In this paper, we test two hypotheses involving this topic. Our main conjecture reflects the predictions of portfolio theory and can be stated as follows: *there is a statistically significant positive relationship between subjective risk aversion and the level of diversification in a household's financial portfolio.* Additionally, we investigate the suggestion that precautionary and transactions motives dominate household investment activity (Keynes (1936)), and that the probability of holding risky assets is higher for households that already have some safe assets in their portfolios.

The analysis is based on the German Socioeconomic Panel (GSOEP). We use three subsequent waves – 2004 through 2006 – resulting in a panel of more than 5,000 households. The survey provides detailed information on socioeconomic characteristics of German households and their financial portfolios. Most importantly, the GSOEP data provide two novel measures of risk aversion: one captures the general risk aversion of individuals; the second reflects the propensity to take risk in investment decisions. Both measures are based on respondents' self-declared attitudes toward risk.

The level of portfolio diversification is measured two ways. The first measure is the number of distinct asset types held in the portfolio. Despite its simplicity, this measure is useful when analyzing the decisions of individuals who follow a "naive" diversification strategy based on the principle "don't put all your eggs in one basket." This type of strategy is engaged in fairly frequently by nonprofessional investors (Benartzi and Thaler, 2001). Our second measure of diversification is designed to capture more sophisticated strategies: in addition to the number of assets, it also takes into account their risk content and how they are combined in a portfolio.

The results are surprising, especially regarding the principle of naive diversification. This principle is based on the idea that "naive" investors include as many different assets as possible in their portfolios in the hope that doing so will reduce the return

variance and, thus, the portfolio risk. Accordingly, the more risk averse the investor, the more distinct types of assets are expected to be held in his or her portfolio. Our results are in completely the opposite direction. Furthermore, even if households follow a more sophisticated diversification strategy, that is, they account for the riskiness of the individual assets they include in the portfolio, our results contradict the predictions of classical portfolio theory. We find that propensity to diversify *decreases* when risk aversion rises.

The remainder of the paper is organized as follows. In the next section, we review the existing empirical literature on determinants of diversification of household financial portfolios. The third section describes the data, provides descriptive statistics, and details the two measures of portfolio diversification employed. The fourth section presents the measures of risk aversion. The fifth and the sixth sections describe the empirical strategy and the main results. Section 7 concludes. Ancillary information related to the research is relegated to the Appendix.

2 Previous evidence on determinants of household portfolio diversification

Academic research into the determinants of portfolio diversification is not new and can be traced back to the mean-variance analysis of Markowitz (1952), who showed how investors would select assets if they cared only about the mean and variance of portfolio returns. In this situation, Markowitz theorized that risk aversion would play a major role in determining investment decisions. The prediction with respect of portfolio diversification is that investors with high risk aversion will hold more diversified portfolios in order to minimize the risk associated with variance of returns.

Empirical research into the issue begins with studies by Friend and Blume (1975) and Morin and Suarez (1983) who, in line with predictions of classical portfolio theory, hypothesize that risk aversion is positively related to the level of diversification. Gomes and Michaelides (2005), too, argue that more risk-averse people will have more diversified portfolios. Their explanation of this relationship, however, differs from classical

mean-variance argumentation. The researchers show that risk-prone households accumulate very little wealth and, correspondingly, most of them do not hold stocks. In contrast, more risk-averse investors achieve higher wealth levels and, therefore, have a stronger incentive to pay the market entry costs and acquire more assets. However, King and Leape (1998) find that risk-averse individuals are more likely to limit their portfolios to safe assets, such as saving accounts and government bonds. Correspondingly, they are less likely to diversify into risky assets. In contrast, Campbell et al. (2003) argue that demand for stocks is a hump-shaped function of risk tolerance. Demand is strongly positive at intermediate levels of risk tolerance, but negative for extremely risk-averse and extremely risk-loving investors. The authors explain this idea by noting that stocks can be used to hedge against the fluctuations in their own future returns. This hedging feature should be attractive for investors with intermediate levels of risk aversion, forming the middle of the demand "hump." On either side of this hump are the very conservative investors, who tend to avoid any risk, and the extremely risk-tolerant investors, who have little interest in hedging intertemporally.

Despite the role of risk aversion, it is not the sole determinant of investment behavior. There is a wide agreement in the empirical literature that the socioeconomic and demographic characteristics of investors also have a significant influence on portfolio decisions. In particular, Uhler and Cragg (1971) find that differences in income, age, and education explain a great deal of the variation in the number of different financial assets held by U.S. households; evidence from a wide variety of other countries supports this finding.[2] Therefore, one definitely needs to control for the socioeconomic profile of households when analyzing their portfolio decisions.

One note of caution is in order here. Accurately testing the relationship between risk aversion and portfolio diversification is not easy, chiefly due to problems with measuring risk aversion. In the majority of empirical studies, risk aversion is measured either

[2]See, e.g., Campbell (2006), Bertaut and Starr-McCluer (2000) and King and Leape (1998) on the US; Henry, Odonnat and Ricart (1992) on France; Hochguertel, Alessie and Van Soest (1997) and Alessie, Hochguertel and Van Soest (2000) on Netherlands; Guiso and Jappelli (2000) on Italy; Banks and Smith (2000) and Burton (2001) on the UK; Himmelreicher (1998) and Börsch-Supan and Eymann (2000) on Germany.

experimentally in hypothetical lotteries or is inferred from information about individual behavior in different socioeconomic contexts (e.g., Guiso and Pistaferri (2002), Hartog and Jonker (2000)). However, there is a growing body of empirical research showing that subjective measures of risk aversion, i.e., risk attitude as stated by individuals participating in surveys, is a powerful predictor of decisions regarding portfolio choice (Kapteyn and Teppa (2002) and Fellner and Maciejovsky (2007)). Following this literature, we use self-declared attitudes toward risk taking as a measure of risk aversion in our study.

3 Evidence on household portfolios from the GSOEP

3.1 Ownership of financial assets

To analyze the determinants of household portfolio diversification we employ data from the German Socioeconomic Panel (GSOEP). The GSOEP is longitudinal survey of German households that has been conducted annually since 1984. The structure of the surveyed sample conforms with the distribution of the main socioeconomic characteristics in the target population, making the sample representative for German society. For our analysis we select households that participated in three subsequent waves of the survey in the years 2004 through 2006.[3] Thus, our data set presents a balanced panel, with the number of observation units N = 5,163 and time periods T = 3. The unit of observation is a household.[4]

GSOEP gathers information on whether a household owns any of the following six types of financial assets: saving accounts, home ownership savings contracts, life insurance policies, fixed-interest securities (including saving bonds issued by banks, mortgage-backed bonds, and government bonds), stocks held directly or through mutual funds, and ownership or shares of nonlisted firms.[5]

[3]Only these waves were considered, since the earlier ones do not provide information on individual risk preferences.

[4]For all socioeconomic characteristics that cannot be observed at the household level, e.g., age, sex, etc., reported figures relate to the characteristics of the household head.

[5]The survey provides no information on wealth amounts allocated to distinct financial assets. Only participation is reported in the relevant time period.

Table 1 documents the financial asset ownership of our sample. It reports the fraction of households holding each of the six possible asset types in a particular year. It can be seen that saving accounts are the most frequently held financial asset: more than 70 percent of households report owning this type of asset. Life insurance, at 50 percent frequency, is in second place, followed by home ownership saving contracts at about 40 percent. Stocks add up to about 30 percent and rank fourth, while fixed-interest securities, with roughly 16 percent, rank fifth. Ownership or share holding of nonlisted firms appears to be the least popular investment type, standing at less than 5 percent. The figures do not change significantly during the three years, although a slight decline in the ownership of saving accounts and life insurance is observable.

Table 1: Ownership rates of different assets types in the sample

Asset items in the GSOEP Survey	2004	2005	2006
Saving accounts	74.24	73.76	71.39
Home ownership saving contracts	42.03	42.30	41.58
Life insurance policies	53.42	52.78	51.48
Fixed-interest securities	15.94	16.11	15.30
(e.g., saving bonds and mortgage-backed bonds)			
Stocks held directly or through mutual funds	29.89	29.23	28.65
Ownership/share of a nonlisted firm	4.78	4.47	4.61

3.2 Measures of diversification

Despite the fact that analysis of portfolio diversification has a long history, there is no common approach to measuring degree of diversification in household portfolios. Across the empirical literature one can find diverse approaches, mostly depending on the data in hand. Blume and Friend (1975) use the total number of securities constituting a portfolio as a measure of diversification. Goetzmann, Lingfeng and Rouwenhorst (2005) correct the total number of financial instruments in a portfolio for the correlation among returns on these instruments in order to account for a passive diversification. These measures are close to what financial theory suggests as being appropriate. However, both methods require knowledge of what share of the wealth is allocated to each individual asset,

detailed information that households very rarely provide.

In general, surveys report only rough indicators of resource allocation across assets, a tendency reflective of actual practice, as most households tend to build fairly simple portfolios. For example, Campbell (2006) shows that, generally, household financial portfolios in the United States are poorly diversified. Liquid assets (e.g., cash, demand funds) play the dominant role for the poor and less-liquid savings (e.g., savings accounts, life insurance contracts) dominate the portfolios of middle-class households. Risky assets have some importance for the middle class, but account for the largest portfolio share in wealthier households. Carroll (1995) documents a similar pattern of portfolio composition among European households. Moreover, as shown by Benartzi and Thaler (2001), it is not rare for nonprofessional investors to follow some naive or heuristic diversification strategy, e.g., *1/n strategy*, according to which, investors allocate their wealth evenly among n available assets.

Taking into account the specific nature of household portfolios and the fact that some investors make decisions based on naive notions of diversification, we construct two alternative measures of portfolio diversification: "naive diversification" and "sophisticated diversification."

3.2.1 Naive diversification

Naive diversification takes into account only the number of distinct asset types held in portfolio.[6] As discussed above, the GSOEP data allow identification of six distinct classes of assets.[7]

Table 2 documents change in investment behavior during the three years from 2004 to 2006. During this period, the largest fraction of households allocated their wealth among three assets. The two-asset portfolio is the next most common, followed by the one-asset portfolio. More diversified portfolios appear less frequently in the sample. Less than

[6]The term "naive diversification" is often used to reflect the fact that an equal amount of wealth is attached to all assets available (DeMiguel, Garlappi and Uppal, 2007). We refer only to the number of assets due to the data constraints of the GSOEP.

[7]The expression "**asset type**" is used to emphasize that the data do not provide information on what securities are exactly held and in what quantity they occur in the portfolio.

one-fifth of the respondents allocate their wealth among four assets. Portfolios comprised of five assets are held by less than 5 percent of the households, and portfolios consisting of all six assets are held by less than 1 percent of the respondents. Remarkably, a rather large share of respondents has *no* investments.

Table 2: Distribution of households by the number of asset types in the portfolio

Number of assets	2004	2005	2006
0	13.21	13.98	14.93
1	20.32	19.97	21.23
2	23.18	22.97	22.29
3	25.02	24.52	23.92
4	13.40	14.20	13.25
5	4.24	3.76	3.82
6	0.62	0.60	0.56
Total	100.00	100.00	100.00

3.2.2 Sophisticated diversification

Our second measure of diversification is constructed to capture more sophisticated investment patterns. It accounts for not only the number of assets, but also for their degree of risk and combination in a portfolio. The measure is constructed as follows.

The six financial assets available in the survey data are grouped into three categories according to their riskiness: safe, relatively risky, and risky. Because we do not know the share of wealth allocated to each individual asset, defining riskiness according to the mean-variance approach is not applicable. Instead, we use a simpler, but feasible, categorization drawing upon Blume and Friend (1975) and Börsch-Supan and Eymann (2000). Saving accounts and home ownership saving contracts are categorized as *safe assets*; life insurance policies and fixed interest securities (saving bonds, mortgage bonds, etc.) comprise *relatively risky assets*; and stocks held directly or through mutual funds and shares of nonlisted firms are regarded as *risky assets*.[8]

[8]This approach was also applied by Alessie et al. (2000), Banks and Smith (2000), Bertaut and Starr-McCluer (2000), Guiso and Jappelli (2000).

This categorization is justified as follows. Saving accounts are clearly safe because their returns do not exhibit any variation and are guaranteed by the financial institution. The returns on fixed-interest assets are also stable; however, the real payoff depends on the duration and on the issuer's rating. Holders of life insurance policies do not bear the risk of losing the entire investment, but the real return upon termination is uncertain and can be significantly lower than the expected return. Therefore, fixed-interest assets and life insurance are both regarded as relatively risky assets. Shares of listed and nonlisted firms or ownership of a firm are the riskiest, since share prices and dividends are volatile and uncertain, and the future value of an own business is also subject to great uncertainty.

This classification rule gives rise to three types of diversification. A portfolio that consists of assets from only one category, i.e., either safe, relatively risky, or risky, has the least degree of diversification and is referred to as *undiversified*. Undiversified portfolios can be low, medium, or high risk. A portfolio that includes assets from at least two different categories is referred to as *quite diversified* and, again, three subcategories are defined according to the degree of risk. The portfolio that includes safe and relatively risky assets is denoted as low risk, the portfolio with safe and risky assets is referred to as medium risk, and the one containing relatively risky and risky assets is a "high risk" portfolio. A *fully diversified* portfolio is one that includes assets from all three categories.

Table 3 documents how households hold portfolios under our "sophisticated" diversification scheme. The figures in the lower part of the table indicate that households have a strong tendency toward safety. Around 80 percent of those households with *undiversified* portfolios invest in *safe* assets. A similar picture emerges within *quite diversified* portfolios. Over period studies, more than 80 percent of households prefer *safe* and *relatively risky* assets, whereas the share who hold a combination of *safe* and *risky* assets stays below 15 percent. The percentage of households that mix assets from the *relatively risky* and *risky* categories never reaches 6 percent.

Table 3: Distribution of households according to strategies of "sophisticated diversification".

This table shows the shares of households owning particular types of portfolios. " + " denotes that at least one asset of particular type is owned, "-" indicates that no assets of particular category are owned. The upper part of the table presents the distribution of households among distinct portfolio types. Adding up the first three rows yields the fraction of households with undiversified portfolios. Next three rows show the fraction of households with at least two categories of assets. The last row presents the fraction of households with fully diversified portfolios.

The lover part of the table shows the distribution of households within two categories "undiversified portfolios" and "quite diversified portfolios". E.g. "80.08" in the first row indicates that 80.08 % of the non-diversified portfolios are of low risk. These portfolios contain only clearly safe assets. The other numbers in this table are to be read accordingly.

Portfolio type	Asset types owned			2004	2005	2006
	safe	relatively risky	risky			
1. Undiversified/ low risk	+	-	-	24,10	23,73	24,99
2. Undiversified/moderate risk	-	+	-	3,84	3,76	4,40
3. Undiversified/ high risk	-	-	+	0,80	0,96	1,02
Undiversified total				*28.74*	*28.45*	*30.41*
4. Quite diversified/ low risk	+	+	-	35,07	36,12	34,06
5. Quite divers./moderate risk	+	-	+	5,96	6,00	5,84
6. Quite diversified/ high risk	-	+	+	2,24	1,99	2,46
Quite diversified total				*43.27*	*44.11*	*42.36*
7. Fully diversified portfolios	+	+	+	*27,99*	*27,44*	*27,23*
1. Undiversified/ low risk	+	-	-	80.08	79.73	78.65
2. Undiversified/moderate risk	-	+	-	16.01	16.39	17.34
3. Undiversified/ high risk	-	-	+	3.91	3.88	4.01
Undiversified total				*100.00*	*100.00*	*100.00*
4. Quite diversified/ low risk	+	+	-	80.71	81.64	80.43
5. Quite divers./moderate risk	+	-	+	14.16	13.74	13.89
6. Quite diversified/ high risk	-	+	+	5.13	4.62	5.68
Quite diversified total				*100.00*	*100.00*	*100.00*

4 Measures of risk aversion

The GSOEP data provide unique measures of individual subjective attitudes toward risk taking. In the 2004 wave, respondents were asked about their attitudes toward risk in general as well as in some specific contexts: driving, sports, career, health, trusting others, and investing money. The question on general risk tolerance was asked again in the 2006 wave. Respondents rated their willingness to take risks on a 11-point scale, with 0 indicating complete unwillingness and 10 indicating a very high willingness. The predictive power of the measures was tested in a laboratory experiment: all questions proved to provide valid measures of risk attitudes.[9]

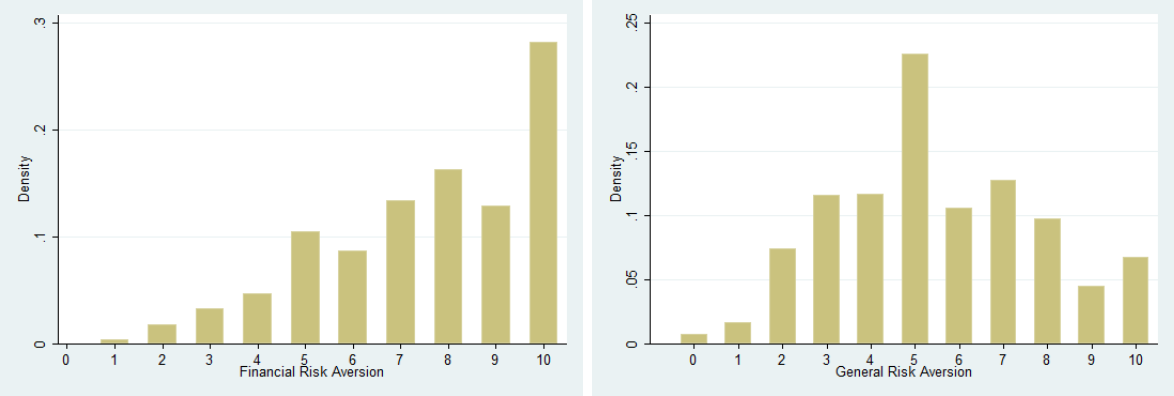
For the present study, two risk measures are of particular interest: the measure of general risk tolerance and the measure of willingness to take risk in making investment decisions. The later measure is more appropriate with respect to the research question at hand. However, by employing both measures, we can check the coherence of the effects of individual risk attitudes on the variable(s) of interest.

Two adjustments were made to the original measures so as to make them better suited to our analysis. First, we transformed both measures from being indicators of risk tolerance into indicators of risk aversion, which was accomplished by simply reversing the scale so that "0" now denotes the lowest risk aversion and "10" the highest risk aversion. The two new discrete variables that emerge are FRA, financial risk aversion, and RA, general risk aversion. Figure 1 presents the level of risk aversion distribution of respondents in year 2004. Clearly, FRA and RA are distinct from each other. Apparently, people perceive financial risk in a quite different way than they do general risk.

Since we have only one year of data for the measure of financial risk aversion, and two years of data for the measure of general risk aversion, a further adjustment is necessary to make the measures useable in the panel-data context. We treat FRA and RA as time-invariant variables and assume that risk attitudes remain stable over our three-

[9]For discussion of the experiment, see Dohmen, Falk, Huffman, Sunde, Schupp and Wagner (2006).

Figure 1: Distribution the measures of risk aversion*



* 0 – lowest risk aversion; 10 – highest risk aversion

year period, which is not an unreasonable assumption.[10]

5 Regression analysis

5.1 The model

Our main hypothesis is that risk aversion has a significant positive effect on the level of diversification in household investment portfolios. To test the hypothesis, we regress each of the two diversification measures on a set of explanatory variables. The explanatory variables include a measure of risk aversion and a range of socioeconomic characteristics, including net household income, number of adult and underage members, and the employment status, gender, age, and education of the household head. Year dummies are also included in the regression equation in order to control for time-specific effects. Table 4 in the Appendix summarizes the descriptive statistics of the explanatory variables used in the regression analysis.

Both diversification measures are categorical variables with J mutually exclusive and exhaustive alternatives. Because of the specifics of the dependent variable, we fit the

[10]Barsky, Kimball, Juster and Shapiro (1997) provide evidence on stability of risk preferences over time.

data to a multinomial logistic regression model drawing upon Uhler and Cragg (1971) and estimate it with maximum likelihood.[11] For a case of J mutually exclusive outcomes, the probability of observing a particular outcome, $P(Y_j)$, is:

$$P(Y_j) = \frac{exp(X'\beta_j)}{\sum_{n=1}^{J} exp(X'\beta_n)}, \quad (1)$$

$$n = 0, 1, 2, ..., J; \quad j = 0, 2, ..., J; \quad j \neq n.$$

5.2 The impact of risk aversion on "naive" diversification

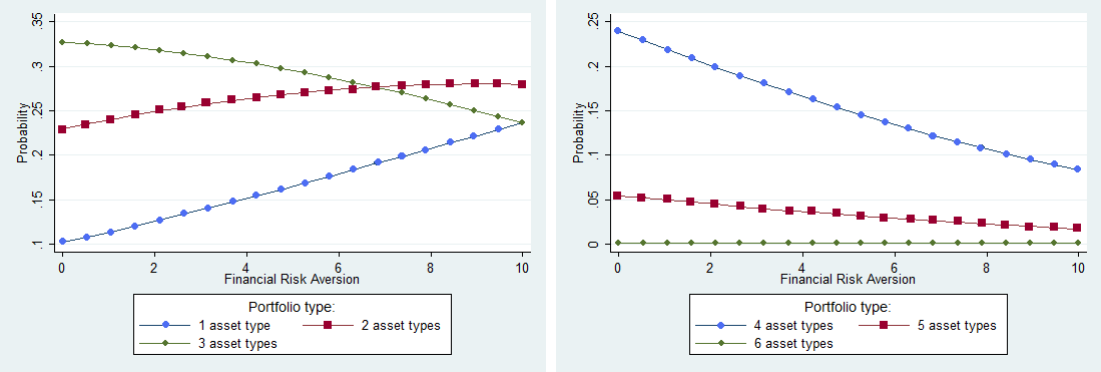
The marginal effects of the explanatory variables on the propensity to diversify following naive rules are documented in Table 5 in the Appendix. The results with respect to our main variable of interest, *FRA*, show that level of self-declared risk aversion in financial matters has a strong effect on level of portfolio diversification, as was expected. All coefficients, except the one for the two-assets portfolio, are statistically significant, most of them highly so. However, we cannot confirm our hypothesis about a positive relationship between risk aversion and level of diversification.

Figure 2 visually demonstrates the influence of risk attitude on the number of assets held in a portfolio. The positive effect of *FRA* on the probability of having a single-asset portfolio indicates that risk-averse individuals tend to invest their wealth in extremely simple portfolios, presumably consisting entirely of assets in the safe class. The probability of allocating wealth among three or more assets decreases as risk aversion increases. The message is clear: the level of risk aversion is negatively related to the number of assets in the portfolio.

As mentioned previously, the GSOEP provides us with an alternative measure of risk aversion based on self-declared willingness to take risk in general, which allows us to test whether propensity to take financial risk has the same effect on portfolio

[11] In case of naive diversification, the dependent variable takes seven successive numbers from 0 to 6, according to the number of asset classes held in a portfolio. Therefore we also tried to fit the data to an ordered logit model. However, the result of a Brant test showed that the parallel regression assumption is violated. Other specification tests indicated that multinomial logit model is appropriate to the data employed here.

Figure 2: Effect of financial risk aversion on the probability of holding particular number of assets*



* 0 – lowest risk aversion; 10 – highest risk aversion

decisions as propensity to take risks not necessarily associated with loss of wealth. We run an additional regression substituting our FRA variable for the measure of general risk aversion, RA. All other explanatory variables remain the same. The results are interesting in two respects. First, the estimated coefficients of RA predict the same direction of relationship between risk aversion and diversification as was the case for "financial risk aversion." However, most of the coefficients are statistically not significant, indicating that "general risk aversion" has little impact on the propensity to diversify naively.

With respect to the socioeconomic control variables, our results are in agreement with the findings of other empirical studies. The effects of factors such as age, income, and education have the expected signs. To check the robustness of these results, we estimate a model without risk-aversion variables, i.e., explanatory variables include only basic socioeconomic characteristics. The coefficients' estimates in this specification do not change significantly and the direction of effects stays the same. The magnitude of some variables' coefficient increases slightly, which indicates that there might be correlation between individual risk attitudes and socioeconomic characteristics.[12]

[12]In fact, Hartog, Ferrer-i Carbonell and Jonker (2002) provide evidence that level of individual risk aversion may change with income, gender, and employment status.

In sum, our findings are rather surprising, in that they do not support the naive diversification principle at all. This principle suggests that investors include as many types of assets as possible in their portfolios, hoping that this will reduce the variance of portfolio returns and, thus, portfolio risk. Accordingly, the more risk averse the investor, the more types of assets he or she is expected to hold in a portfolio. However, our regression analysis comes to the completely opposite conclusion. Perhaps our unexpected findings are due, in part, to the possibility that households do *not*, in fact, diversify naively, but instead follow more sophisticated rules when putting together their investment portfolios. The next section explores this hypothesis in more detail.

5.3 The impact of risk aversion on "sophisticated" diversification

In this section we investigate whether the impact of individual risk aversion on portfolio structure can be better explained by assuming that households follow more sophisticated diversification strategies rather than the simple rule of investing in as many assets as possible. For this purpose, we proceed in the same way as with naive diversification, and by drawing on Table 3, define a new dependent variable *Diversification/Risk* that indicates distinct combinations of diversification type (undiversified, quite diversified, fully diversified) and risk content (low, moderate, and high risk). This results in eight possible outcomes: *undiversified/low, undiversified/moderate, undiversified/high, quite diversified/low, quite diversified/moderate, quite diversified/high*, and *fully diversified* plus one more outcome entitled "no investments". As in the previous subsection, we fit the data to a multinomial logistic model and use the same set of explanatory variables.[13] The estimated marginal effects are reported in Table 6 in the Appendix.

Figure 3 illustrates how the probability of holding a particular portfolio type changes with rising risk aversion. First, we assess the effects on the likelihood of undiversified

[13]We estimated the same model including the measure of general risk aversion, RA, instead of financial risk aversion. As before, the effect of RA has the same sign, although its statistical significance is weak. The estimates of the socioeconomic variables do not change significantly. Given the robust results, we concentrate on the risk propensity variables.

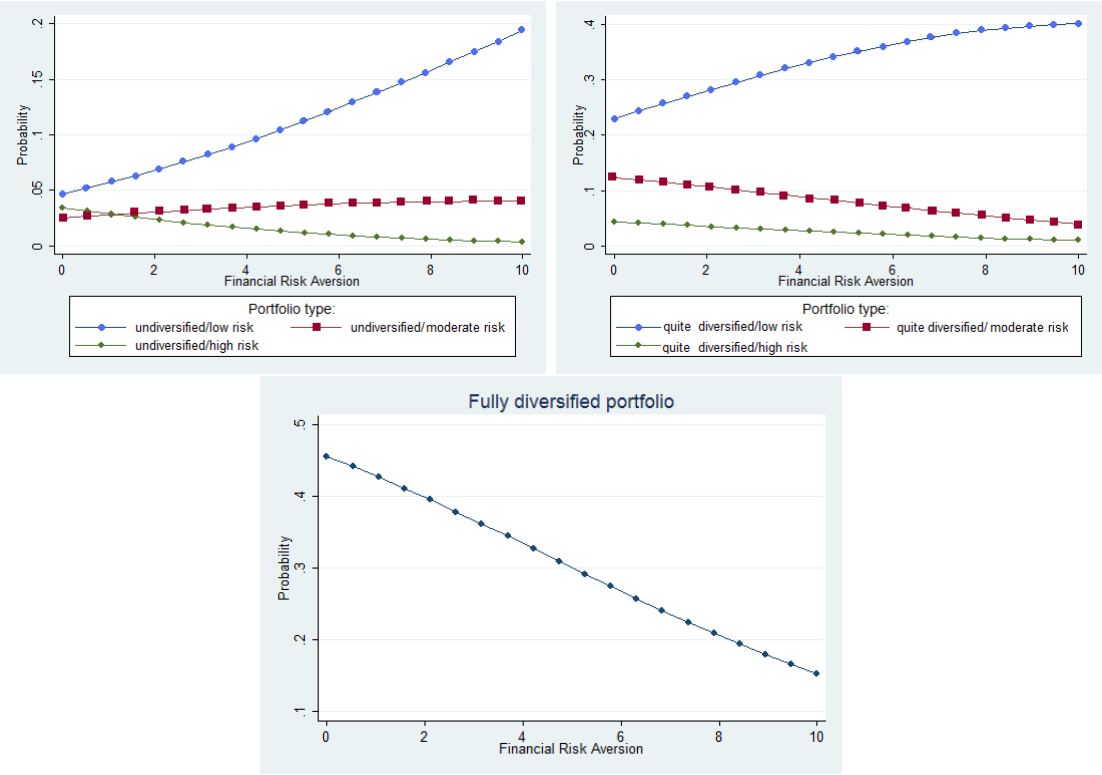
and quite diversified portfolios with low risk. The positive effect of risk aversion on the probability that individuals hold such portfolios is plausible. If risk aversion increases, individuals are more likely to invest in safe assets. However, for individuals with equal levels of risk aversion, the estimated probability of quite diversified portfolios is higher than the probability of undiversified portfolios. Thus, we register a positive relationship between risk aversion and level of diversification.

An opposite relationship emerges when we look at the probabilities for portfolios with high risk. Here, the likelihood is negatively related to the level of risk aversion. Furthermore, individuals with the same risk preferences would invest in quite diversified portfolios rather than in undiversified portfolios, which is what we would expect based on the utility theory and from Markowitz's diversification principle.

However, with respect to portfolios with moderate risk, the relationship is less clear. The probability of having an undiversified portfolio appears to rise with the level of risk aversion, but the effect is not statistically significant. In contrast, the effect of risk aversion on the quite diversified portfolio is statistically significant and obviously negative, suggesting a negative relationship between risk aversion and diversification.

Finally, the effect of risk aversion on the probability of holding a fully diversified portfolio is not easy to explain. To the extent that the returns of the clearly safe assets, on the one hand, and the risky assets, on the other, are negatively correlated, the findings clearly contradict the hypothesis that individuals with higher risk aversion would rather invest in portfolios where the variance of returns is low due to diversification. Even if the risky asset class in these portfolios is thought of as a type of surrogate for the market portfolio, as in the CAPM, a negative relationship is not expected. If the CAPM does, indeed hold, the likelihood of observing this portfolio type should be unaffected by the propensity to take risks, a conclusion that may be the result of limitations of the data set. According to the CAPM, the number of components in the aggregate household portfolio would not change with varying risk attitudes, only their shares in the aggregate value of the portfolio would vary. However, our data set provides information only on number of components in a portfolio, not their share of the total value.

Figure 3: Effect of financial risk aversion on the probability of holding particular number of assets*



* 0 – lowest risk aversion; 10 – highest risk aversion

6 Safety and liquidity first

The previous sections have revealed an empirical mismatch between manifested individual risk aversion and the theorized principle of naive diversification. How can such a puzzling result be explained? The early work of Uhler and Cragg (1971) suggests an explanation:

> Financial assets produce a variety of services to their holders which are indicated by such characteristics as yield, riskiness, marketability, acceptance as a medium of exchange, ownership rights and so on. If markets were perfect, one would expect all households with positive asset holdings to diversify in

> order to obtain an optimal mix of these services. The nature of the mix would depend on the utility function defined over the services.[14]

Accordingly, the selection of assets is driven by many motives, of which minimizing variation in returns is only one. For any particular household, another motive might be stronger. Keynes (1936) suggested that precautionary and transactions motives have a particularly strong effect on household activity. Rational households would first invest in highly liquid or safe assets, such as cash and saving deposits. Only after basic needs are satisfied, would a household consider investing in other, more speculative types of assets, such as stocks or bonds. Thus, it is reasonable to assume that if a household has only one asset, it will be a safe one.[15] Such reasoning implies that a household will invest in a higher number of assets, including risky ones, only after precautionary and transaction needs are satisfied. As a result, a negative relationship between diversification and risk aversion would emerge.

To test this hypothesis, we estimate an additional multinomial logit model where the dependent variable represents the number of risky assets held in a portfolio, taking on values ranging from 0 to 2. The explanatory variables include the same main socioeconomic characteristics of households as employed in the previous regressions, and a metric variable $N_{Safe \quad assets}$ that represents the number of safe assets held in a portfolio. The estimated marginal effects are presented in Table 7 of the Appendix. As expected, there is a positive relationship between the number of safe assets and the ownership of risky financial instruments. Ceteris paribus, ownership of a unit increment in the number of safe assets reduces the probability that a household refrains from investing in any risky asset by almost 6 percent and the likelihood of owning one risky asset increases by 5 percent when one additional safe asset is included into portfolio. The probability of holding two risky assets is also positively associated with a unit increment in safe assets. Thus, we can conclude that the propensity to diversify is highly dependent on whether safety and liquidity needs have been satisfied.

[14] Uhler and Cragg (1971), p.342.

[15] This assumption is supported by the sample descriptive statistics reported in Table 3.

7 Conclusions

This paper explores the link between self-declared risk aversion and level of portfolio diversification. We use a large sample of German households derived from the German Socioeconomic Panel. The data allow controlling for the main demographic characteristics of household members, such as age, gender, and number of children, as well as provide detailed information on socioeconomic status, including education, occupation, self-employment, income, and ownership of financial assets.

We find that self-declared risk aversion and actual behavior in diversifying investments do not always match as expected. Higher risk aversion does not necessarily lead to greater diversification, as is expected from portfolio theory, even when we control for the level of portfolio risk. A further interesting finding with regard to risk attitudes is that, as expected, individual willingness to take financial risk has a better predictive power for household financial behavior than does general risk tolerance. Our findings have implications for the consulting requirements imposed on the financial services industry (EC (2006)). The industry is required to provide advice based on the individual's self-assessment of risk attitude but our findings imply that self-declaration may be an insufficient indicator of true risk preference.

The present research has several limitations that should be kept in mind when interpreting the findings. First, households are considered to depend entirely on labor income as their source of financial wealth. Second, we do not take into account household debts or nonfinancial wealth. Third, the analysis is built on the number and type of assets owned, not value share of asset type. Further, the present research exclusively analyzed the effects of micro-factors, ignoring a range of macro-factors, such as fiscal and social policies, that would, no doubt, have some effect on household portfolios. All these issues present a challenging task for future research.

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8 Appendix

Table 4: Summary statistics[a]

Variable	Description	Mean	Std. Dev.
FRA	Risk aversion in financial matters, assessed on a scale from 0 (none) to 10 (very high)	7.57	2.24
Income	Net annual household income, in Euro[c]	30446.65	18065.28
Own Apartment	= 1 if dwelling is owned, 0 otherwise	1.91	0.98
Age	Age in years	50.72	15.83
Sex	= 1 if female, 0 if male	0.42	0.49
Education	= 1 if higher education[b], 0 otherwise	0.29	0.45
Employment	= 1 if employed, 0 otherwise	0.58	0.49
Self-Employed	= 1 if self-employed, 0 otherwise	0.06	0.24
Retirement	= 1 if retired, 0 otherwise	0.01	0.09
Adults	Number of adult household members age 18 and older	1.93	0.77
$N_{children}$	Number of children under 18	0.51	0.89
Total number of households in the panel, N = 5163			

[a] In this table, for all socioeconomic characteristics that cannot be observed at the household level, e.g., age, sex, etc., reported figures relate to the characteristics of the household head. [b] Higher education is defined according to ISCED-1997-Classification: it begins at the age of 17 or 18, lasts about three, four, or more years, and leads to a university or postgraduate university degree or the equivalent. [c] Income is calculated as real income of individuals adjusted for inflation. Consumer Price Index (CPI) is used as a measure of inflation.

Table 5: The effects of the financial risk aversion on "naive" diversification

The table reports marginal effects of independent variables after estimation of multinomial logit model with maximum likelihood. Marginal effects are calculated at the mean values for continuous variables and at the value of 0 for the binary dummy variables and count variables. Dummy variables are marked with "(d)".
The dependent variable is a categorical variable that takes seven successive values from 0 to 6, according to the number of asset classes held in a portfolio. Variable *FRA* indicates financial risk aversion and takes on values from 0 (lowest risk aversion) to 10 (highest risk aversion). *Income20* through *Income80* are dummy variables indicating to which income group the household belongs: Income20 = the lowest 20-percentile, Income40 = 40-percentile – 20-percentile, etc. Income100 – the upper 20-percentile is the base category.
Probability of outcome is the predicted probability of holding particular number of asset types.

Outcome:	$N_{assets}=0$	$N_{assets}=1$	$N_{assets}=2$	$N_{assets}=3$	$N_{assets}=4$	$N_{assets}=5$	$N_{assets}=6$
				Effects of financial risk aversion			
FRA	0.0119***	0.0144***	0.0020	-0.0120***	-0.0132***	-0.0030***	0.0000
	(0.0014)	(0.0017)	(0.0019)	(0.0018)	(0.0011)	(0.0005)	(0.0001)
				Effects of socioeconomic variables			
Income20 (d)	0.2872***	0.1774***	-0.0628***	-0.2357***	-0.1308***	-0.0332***	-0.0021***
	(0.0239)	(0.0213)	(0.0155)	(0.0097)	(0.0054)	(0.0026)	(0.0004)
Income40 (d)	0.1321***	0.1571***	0.0031	-0.1489***	-0.1119***	-0.0294***	-0.0020***
	(0.0182)	(0.0190)	(0.0157)	(0.0108)	(0.0053)	(0.0026)	(0.0005)
Income60 (d)	0.0657***	0.1029***	0.0263	-0.0952***	-0.0773***	-0.0209***	-0.0014***
	(0.0153)	(0.0173)	(0.0150)	(0.0111)	(0.0054)	(0.0021)	(0.0004)
Income80 (d)	0.0413**	0.0525**	-0.0029	-0.0303**	-0.0426***	-0.0169***	-0.0010***
	(0.0146)	(0.0166)	(0.0143)	(0.0117)	(0.0056)	(0.0020)	(0.0003)
Own Apartment	-0.0418***	-0.0416***	-0.0111**	0.0468***	0.0363***	0.0108***	0.0006**
	(0.0029)	(0.0038)	(0.0043)	(0.0042)	(0.0028)	(0.0012)	(0.0002)
Age <25 (d)	-0.0560**	-0.1754***	-0.1509***	-0.0291	0.1467	0.2667	-0.0019***
	(0.0174)	(0.0093)	(0.0346)	(0.0611)	(0.0795)	(0.1451)	(0.0005)
Age 25-35 (d)	-0.0257*	-0.1943***	-0.1132***	0.0053	0.2064***	0.1212*	0.0003
	(0.0124)	(0.0087)	(0.0209)	(0.0293)	(0.0416)	(0.0582)	(0.0010)
Age 36-45 (d)	0.0309*	-0.1983***	-0.0968***	0.0361	0.1380***	0.0908*	-0.0006
	(0.0152)	(0.0104)	(0.0203)	(0.0265)	(0.0316)	(0.0428)	(0.0007)
Age 46-55 (d)	0.0429**	-0.1611***	-0.0851***	-0.0021	0.1237***	0.0822	-0.0004
	(0.0162)	(0.0103)	(0.0204)	(0.0251)	(0.0319)	(0.0428)	(0.0008)
Age 56-65 (d)	0.0053	-0.1490***	-0.0701***	-0.0044	0.1208***	0.0986*	-0.0012*
	(0.0136)	(0.0098)	(0.0209)	(0.0254)	(0.0324)	(0.0493)	(0.0005)
Age 66-75 (d)	-0.0197	-0.0993***	-0.0045	-0.0182	0.0877**	0.0554	-0.0013*
	(0.0109)	(0.0105)	(0.0215)	(0.0228)	(0.0296)	(0.0356)	(0.0005)
Sex (d)	-0.0051	-0.0045	-0.0223**	0.0101	0.0148**	0.0066**	0.0003
	(0.0055)	(0.0075)	(0.0085)	(0.0084)	(0.0055)	(0.0023)	(0.0003)
Education (d)	-0.0433***	-0.0466***	-0.0014	0.0379***	0.0420***	0.0109***	0.0005
	(0.0060)	(0.0079)	(0.0090)	(0.0087)	(0.0060)	(0.0026)	(0.0003)
Employment (d)	-0.0784***	-0.0258**	0.0154	0.0637***	0.0213**	0.0029	0.0009
	(0.0073)	(0.0099)	(0.0111)	(0.0106)	(0.0070)	(0.0029)	(0.0005)
Self-Employed (d)	0.0818***	0.0285	-0.0216	-0.0760***	-0.0211**	0.0044	0.0040**
	(0.0184)	(0.0187)	(0.0170)	(0.0138)	(0.0082)	(0.0037)	(0.0014)
Retired (d)	-0.0551*	-0.0371	-0.0347	0.1099*	0.0085	0.0101	-0.0017***
	(0.0224)	(0.0352)	(0.0422)	(0.0472)	(0.0305)	(0.0141)	(0.0004)
Adults	0.0125**	0.0037	-0.0033	-0.0083	-0.0033	-0.0013	0.0001
	(0.0045)	(0.0060)	(0.0064)	(0.0061)	(0.0038)	(0.0015)	(0.0002)
$N_{children}$	0.0291***	0.0135*	-0.0039	-0.0270***	-0.0108***	-0.0009	-0.0000
	(0.0034)	(0.0056)	(0.0056)	(0.0051)	(0.0031)	(0.0011)	(0.0001)
Probability of outcome	0.1161	0.2011	0.2785	0.2673	0.1119	0.0237	0.0014

Probability(χ^2)	0.000
Log-Likelihood	-23471.24
Pseudo-R^2	0.1147
N_{obs}	15489

$^{*}p<0.05,^{**}p<0.01,^{***}p<0.001$

Table 6: The effects of financial risk aversion on "sophisticated" diversification

The table reports marginal effects of independent variables after estimation of multinomial logit model with maximum likelihood. Marginal effects are calculated at the mean values for continuous variables and at the value of 0 for the binary dummy variables and count variables. Dummy variables are marked with "(d)".
The dependent variable is a categorical variable that takes eight different values indicating particular portfolio type as defined in Section 3.2.2. Variable *FRA* indicates financial risk aversion and takes on values from 0 (lowest risk aversion) to 10 (highest risk aversion). *Income20* through *Income80* are dummy-variables indicating to which income group the household belongs: Income20 = the lowest 20-percentile, Income40 = 40-percentile – 20-percentile, etc. Income100 – the upper 20-percentile is the base category. *Probability of outcome* is the predicted probability of holding particular portfolio type.

Outcome:	No investments	undiversified portfolio			quite diversified portfolio			fully diversified portfolio
risk		low	medium	high	low	medium	high	
				Effects of financial risk aversion				
FRA	0.0137***	0.0172***	0.0007	-0.0017***	0.0109***	-0.0081***	-0.0028***	-0.0300***
	(0.0015)	(0.0016)	(0.0008)	(0.0003)	(0.0021)	(0.0008)	(0.0004)	(0.0017)
				Effects of socioeconomic variables				
Income20 (d)	0.3075***	0.1850***	0.0146	-0.0038*	-0.1765***	-0.0401***	-0.0196***	-0.2670***
	(0.0251)	(0.0229)	(0.0081)	(0.0017)	(0.0161)	(0.0051)	(0.0019)	(0.0074)
Income40 (d)	0.1463***	0.1762***	0.0102	-0.0012	-0.0804***	-0.0131*	-0.0161***	-0.2220***
	(0.0196)	(0.0210)	(0.0073)	(0.0020)	(0.0168)	(0.0063)	(0.0018)	(0.0074)
Income60 (d)	0.0762***	0.1133***	0.0126	0.0011	-0.0179	-0.0127*	-0.0133***	-0.1593***
	(0.0166)	(0.0186)	(0.0072)	(0.0022)	(0.0164)	(0.0061)	(0.0018)	(0.0079)
Income80 (d)	0.0458**	0.0540**	0.0071	0.0008	0.0090	-0.0010	-0.0107***	-0.1049***
	(0.0156)	(0.0172)	(0.0068)	(0.0021)	(0.0158)	(0.0065)	(0.0018)	(0.0084)
Own Apartment	-0.0437***	-0.0255***	-0.0151***	0.0016*	0.0197***	0.0098***	0.0003	0.0530***
	(0.0031)	(0.0034)	(0.0019)	(0.0006)	(0.0048)	(0.0022)	(0.0010)	(0.0040)
Age <25 (d)	-0.0307	-0.1267***	-0.0121	0.0237	-0.1140*	-0.0177	0.0316	0.2459***
	(0.0196)	(0.0071)	(0.0133)	(0.0171)	(0.0444)	(0.0159)	(0.0261)	(0.0608)
Age 25-35 (d)	-0.0096	-0.1470***	0.0001	0.0021	-0.0110	-0.0098	-0.0002	0.1755***
	(0.0132)	(0.0072)	(0.0104)	(0.0036)	(0.0263)	(0.0094)	(0.0058)	(0.0303)
Age 36-45 (d)	0.0442**	-0.1633***	0.0118	0.0005	0.0193	-0.0195*	0.0024	0.1045***
	(0.0157)	(0.0088)	(0.0120)	(0.0031)	(0.0253)	(0.0086)	(0.0060)	(0.0267)
Age 46-55 (d)	0.0566***	-0.1367***	0.0353*	0.0008	0.0066	-0.0336***	0.0033	0.0677**
	(0.0163)	(0.0079)	(0.0155)	(0.0031)	(0.0250)	(0.0071)	(0.0063)	(0.0261)
Age 56-65 (d)	0.0186	-0.1181***	0.0379*	-0.0042*	0.0208	-0.0145	0.0047	0.0548*
	(0.0137)	(0.0071)	(0.0160)	(0.0020)	(0.0242)	(0.0080)	(0.0063)	(0.0251)
Age 66-75 (d)	-0.0128	-0.0730***	0.0209	-0.0003	0.0153	0.0145	-0.0037	0.0391
	(0.0116)	(0.0077)	(0.0137)	(0.0027)	(0.0238)	(0.0104)	(0.0047)	(0.0248)
Sex (d)	-0.0077	-0.0049	0.0026	-0.0046***	-0.0195*	0.0070	-0.0021	0.0291***
	(0.0060)	(0.0067)	(0.0037)	(0.0014)	(0.0094)	(0.0045)	(0.0021)	(0.0080)
Education (d)	-0.0478***	-0.0430***	-0.0079*	0.0034*	-0.0567***	0.0281***	0.0149***	0.1090***
	(0.0064)	(0.0071)	(0.0037)	(0.0016)	(0.0097)	(0.0051)	(0.0027)	(0.0087)
Employment (d)	-0.0827***	-0.0256**	0.0010	-0.0016	0.0762***	0.0041	-0.0003	0.0290**
	(0.0079)	(0.0090)	(0.0047)	(0.0018)	(0.0119)	(0.0059)	(0.0027)	(0.0102)
Self-Employed (d)	0.0822***	-0.0239	0.0326**	0.0018	-0.1321***	0.0160	0.0134**	0.0101
	(0.0193)	(0.0161)	(0.0102)	(0.0026)	(0.0167)	(0.0095)	(0.0046)	(0.0148)
Retired (d)	-0.0578*	-0.0466	-0.0038	0.0190	0.0706	0.0010	-0.0054	0.0232
	(0.0248)	(0.0274)	(0.0180)	(0.0157)	(0.0505)	(0.0207)	(0.0074)	(0.0454)
Adults	0.0151**	0.0065	0.0045	-0.0030*	0.0263***	-0.0113**	-0.0052***	-0.0329***
	(0.0049)	(0.0055)	(0.0026)	(0.0012)	(0.0068)	(0.0035)	(0.0015)	(0.0058)
$N_{children}$	0.0333***	0.0087	0.0082***	-0.0030**	-0.0001	-0.0180***	-0.0063***	-0.0229***
	(0.0037)	(0.0055)	(0.0021)	(0.0010)	(0.0059)	(0.0035)	(0.0015)	(0.0046)
Probability	0.1256	0.1504	0.0395	0.0067	0.3851	0.0579	0.0157	0.2193
Probability(χ^2)	0.000							
Log-Likelihood	-21522.59							
Pseudo-R^2	0.1340							
N_{obs}	14700							

$^{*}p < 0.05, ^{**}p < 0.01, ^{***}p < 0.001$

Table 7: The effects of the number of safe assets on the number of risky assets held in a portfolio

The table reports marginal effects of independent variables after estimation of multinomial logit model with maximum likelihood. Marginal effects are calculated at the mean values for continuous variables and at the value of 0 for the binary dummy variables and count variables. Dummy variables are marked with "(d)".
The dependent variable is a categorical variable that takes four successive values from 0 to 3, according to the number risky assets classes held in a portfolio. Variable *FRA* indicates financial risk aversion and takes on values from 0 (lowest risk aversion) to 10 (highest risk aversion). *Income20* through *Income80* are dummy variables indicating to which income group the household belongs: Income20 = the lowest 20-percentile, Income40 = 40-percentile – 20-percentile etc. Income100 – the upper 20-percentile is the base category.
Probability of outcome is the predicted probability of holding particular number of risky assets.

Outcome:	no risky assets	one risky asset	two risky assets
Sex (d)	-0.0358**	0.0287*	0.0071**
	(0.0137)	(0.0134)	(0.0022)
Education (d)	-0.1327***	0.1248***	0.0079***
	(0.0134)	(0.0132)	(0.0021)
$N_{children}$	0.0436***	-0.0432***	-0.0004
	(0.0077)	(0.0076)	(0.0008)
Employment (d)	0.0280	-0.0246	-0.0033
	(0.0169)	(0.0167)	(0.0028)
Self-Employed (d)	-0.0891**	0.0188	0.0703***
	(0.0294)	(0.0266)	(0.0137)
log(Income)	-0.2357***	0.2172***	0.0185***
	(0.0148)	(0.0146)	(0.0023)
Age	0.0030***	-0.0028***	-0.0002**
	(0.0006)	(0.0006)	(0.0001)
FRA	-0.0529***	0.0513***	0.0017***
	(0.0029)	(0.0028)	(0.0004)
$N_{Safe\ \ assets}$	-0.0552***	0.0498***	0.0054***
	(0.0073)	(0.0072)	(0.0010)
Probability of outcome	0.6642	0.3252	0.0106
Probability(χ^2)	0.000		
Log-Likelihood	-4676.41		
Pseudo-R^2	0.1695		
N_{obs}	7355		

$^{*}p < 0.05, ^{**}p < 0.01, ^{***}p < 0.001$