Analysis of deviance in household financial portfolio choice: evidence from Spain

Callado Muñoz, Francisco Jose and González Chapela, Jorge and Utrero González, Natalia

Centro Universitario de la Defensa de Zaragoza

22 July 2014

Analysis of deviance in household financial portfolio choice: Evidence from Spain

Callado-Muñoz, F.J.[a], González Chapela, J.[b] and Utrero-González, N.[c]

[a] Centro Universitario de la Defensa de Zaragoza, Academia General Militar. Ctra. de Huesca s/n, 50090 Zaragoza, Spain. fcallado@unizar.es. Telf. +34 976739804. Corresponding author.
[b] Centro Universitario de la Defensa de Zaragoza, Academia General Militar, Ctra. de Huesca s/n, 50090 Zaragoza, Spain. jorgegc@unizar.es. Telf. +34976739834.
[c] Centro Universitario de la Defensa de Zaragoza, Academia General Militar. Ctra. de Huesca s/n, 50090 Zaragoza, Spain. n.utrero@unizar.es. Telf. +34 976739877.

Abstract
We analyze empirically the household financial portfolio allocation decision using a variance decomposition technique that takes into account the constrained, non-normal nature of household portfolio allocation observations. We apply the technique to a relatively wide collection of financial assets. Results show that the main factors underlying household financial portfolio choice in Spain are age and net wealth. Among others, there is also evidence of sizeable risk aversion, education, and income effects, but very modest effects are associated to family size and having accounts in stand-alone Internet banks. Implications for policy are also derived.

Keywords: Household portfolio; analysis of deviance; Spanish Survey of Household Finances.

JEL Codes: C52, D10, D14, G11

1. INTRODUCTION

Starting with the seminal paper on portfolio choice by Markowitz (1952), the household portfolio allocation problem has received increased attention both theoretically and empirically (Campbell (2006)). Yet, very few theoretical models have been able to adequately explain the cross-sectional heterogeneity observed in empirical studies. In particular, household portfolios are found to vary significantly by age, wealth and education, see Guiso et al (2003) for an analysis of US, France, Italy, Netherlands, Sweden and United Kingdom. Taxes and housing are also shown to affect portfolio decisions, King and Leape (1998), Poterba and Samwick (2003) and Cocco (2005) and Yao and Zhang (2005) respectively. The development of microdata on Spanish households has allowed the analysis of portfolio allocation in Spain as well, see López Gómez (2006) and Mora and Escardibul (2008) for a general picture, Mayordomo (2007) and Fernández-Fernández (2008) and Rodríguez-Moreno et al. (2008) for the interaction between housing decisions and portfolio allocation or Domínguez Barrero and López Laborda (2010) for tax effects.

Previous empirical papers share two main shortcomings. First, they do not take into account the constrained, non-normal nature of asset portfolio observations, which is troublesome for estimation and variance decomposition purposes. For example, the multivariate Tobit model (Poterba and Samwick (2003)) with unrestricted covariance matrix requires one equation to be deleted from the system before estimation (Pudney (1989)), but the multivariate Tobit estimator is not invariant to the equation being deleted (see, e.g. Dong et al. (2004)). In addition, to investigate the main features behind the allocation of wealth, one would perform a multivariate analysis of (co)variance on household investment decisions. But since these decisions typically take the form of vector arrays of relative asset shares in which the wealth is divided, the error sum of squares and cross products matrix is singular, which precludes performing an ordinary analysis. Second, most of them, classify assets distinguishing only between two broad categories: riskless and risky assets. The risky alternative refers mainly to stockholding whereas the rest of financial investments are very often considered riskless assets.

In this paper, we attempt to overcome those weaknesses. We use an appropriate methodology to analyze portfolio allocation decisions taking into account that the components of the multivariate dependent variable (shares invested in each asset) are non-negative, may take on certain values with positive probability, and add up to a constant (in this case 1). First, we jointly estimate how different household characteristics affect the investment decisions in the different types of assets following the procedure of Mullahy and Robert (2010) developed for time demand equations that share similar characteristics to wealth allocation. Second, we provide a quantitative ranking of the determinants of household portfolio allocation with a new special technique designed for constrained, non-normal data (González Chapela (2013)). Then, we apply it to a relatively wide variety of assets including the main investment decision determinants of previous papers in the literature in order to obtain richer conclusions. The technique allows us to correctly estimate the complete system of wealth allocation equations and to identify the explanatory variables that differentiate the asset portfolio observations the most. The importance of this exercise may be illustrated with two examples. First, suppose that the quantity of wealth reveals as more important than the amount of income for explaining cross-sectional differences in household portfolio allocation. Then, a government interested in modifying some aspect of that allocation had better change the distribution of wealth rather than alter the distribution of income. The second example is related to the Markets in Financial Instruments Directive of the European Union (MiFiD). It requires financial advisors to identify customer investment preferences and to customize their advice accordingly. Typically, the identification takes place by way of self-disclosure individual's preferences and also by checking her financial, educational and professional status.

Understanding the degree of consistence between self-declared investment preferences and personal and financial characteristics would make the development of adequate financial planning services easier.

In addition, the joint estimation of a system of relative asset shares offers another advantage: When some explanatory variable changes, it is possible to know where the variation in (the proportion of) wealth invested in some assets comes from the other assets. In other words, not only are we able to characterize the determinants of the investments, say the traditional risky asset in previous literature (stockholding), but also to identify the relative movements in the shares of the other financial assets of the household portfolio caused by changes in those same determinants.

We start off by reviewing the literature on household allocation to show the relevance of different factors affecting the portfolio allocation. We then present the data and our statistical strategy. Section 5 presents the results. We conclude in Section 6.

2. PREVIOUS LITERATURE

The literature on portfolio theory analyses how agents make investments. Results show that age, wealth and education are important factors explaining equity holdings of households. Risk aversion of household is also considered to be a relevant factor in explaining portfolio composition and not including it would likely bias results (see Guiso et al. (2002) for a review).

However, empirical results do not clearly follow theoretical predictions. For example, wealth is expected to negatively affect risky asset share whereas evidence suggests a positive or even constant relationship (Campbell (2006), Guiso et al. (2002)). The share of risky assets is found to be low at young ages and either increasing or hump-shaped over the life cycle (Ameriks and Zeldes (2004), Poterba and Samwick (2001)) contrary to what theoretical models claim. Literature has tried to extend standard models to be able to explain these divergences. Among the additional variables considered, labor income risk, health risks and some sort of measure for credit or liquidity constraints have been included in empirical studies. The general result found is that the existence of labor or health risks affects negatively the proportion invested in equity shares (Guiso et al. (1996), Fratantoni (1998)). Furthermore, those households having some borrowing constraints end up investing less in risky assets (see Guiso et al. (1996) and Yamishita (2003) among others).

Gender has been shown to be a key issue within the area of investment behavior. There is an increasing body of literature that documents evidence of (decision-maker) gender affecting investment decision-making (Jianakoplos and Bernasek (1998), Fehr-Duda et al. (2006), Croson and Gneezy (2009)). Barber and Odean (2001) specifically document that over-confidence affects male trading and investment behavior. Correspondingly, they show that marriage changes some of male perceptions and decisions with respect to investment. Accordingly, Bertocchi et al. (2011) show that single women have a lower propensity to invest in risky assets than married females and males.

Real state and business ownership has also been included in the analysis (Flavin and Yamashita (2002), Cocco (2005), Yao and Zhan (2005) and Jin (2011)). This is based on the evidence that housing and private business have associated price and income risks respectively. Further, they might be substitutes for stockholding, since investing in owner-occupied housing as well as private business holdings reduces the percentage of investment in stockholdings (Cocco (2005), Jin (2011) and Heaton and Lucas (2000)). Portfolio final composition will depend on the effect of real state and private business and empirical results indicate a negative impact of these assets in the share of stocks.

However, restricting the analysis to the share of stocks in the household portfolio leaves investment in other risky assets out of the picture. It assumes that the share of just one risky asset can characterize investment behavior when there might be other assets with different risk characteristics in place. In other words, within this framework, a household holding a 30% of its wealth in stocks and 10% in fixed rate assets (that are not riskless) would be considered to have the same portfolio composition and risk as a household with the same share of equity but zero investment in fixed rate assets. In line with this argument, some recent papers introduce other assets but they restrict themselves to stockholdings and mutual funds (Campbell (2006), Calvet et.al. (2006) and Wermers (2011)) or stocks, private business and real state (Jin (2011)). In this paper we use a comprehensive set of risky and non-risky assets available for households. This simultaneous analysis of the different categories of risky and non-risky assets in the household portfolio, we propose, is an alternative to the traditional analysis. It allows taking into account asset differences and distinguishing the differing effects of the determinants of each of the household's portfolio assets with an adequate methodology.

3. DATA

The data for this study are taken from the Spanish Survey of Household Finances (EFF), a useful source of information about assets, debts, income, and other characteristics of Spanish households and their members. Important features of the EFF are the oversampling of wealthy households and the imputation of "No Answer" or "Don't Know" replies for all the variables in the survey.[1] The EFF has been conducted by the Banco de España every three years since 2002. We use data from the 2008 wave, the latest available wave at the time this study is conducted. Five imputed values are provided in the EFF2008 for each missing value. Barceló

[1] Since the distribution of wealth in the population is heavily skewed, and some types of assets are held by only a small fraction of the population, a standard random sample would not contain enough observations for the analysis of wealth. Also, due to the sensitivity of the issue of household finances, item non-response is an inherent characteristic of wealth surveys.

(2006) offers a detailed description of imputation in the EFF, whereas more information about the EFF2008 can be found in Bover (2011).

The total number of completed interviews collected in the EFF2008 is 6,197. 64 percent of these households participate since 2002 or 2005, whereas the remaining 36 percent was incorporated so as to preserve cross-sectional representativeness and overall sample size. We discarded the 565 households whose reference person[2] has never worked (the economic sector of the reference person will be included among the explanatory variables), and the 200 surviving households who report zero financial wealth. This leaves us with 5,432 households.

The EFF2008 collects information on the amount invested by the household in nine different types of financial assets: Accounts and deposits usable for payments, accounts and deposits not usable for payments, listed shares, unlisted shares and other holdings in companies, mutual funds, fixed-income securities, life insurances and pension schemes, portfolios under management, and a catch-all category for other financial assets.

From the previous literature on investment choice, we have selected a total of 14 characteristics whose influence on households' financial portfolio composition is to be assessed. These are: gender, education level, age, and health status of the reference person; whether the reference person is married, self-employed, and works in the financial sector; income, net wealth, degree of risk aversion, and number of members of the household;[3] and

---

[2] We use the figure of reference person as a way of organizing the data consistently. The reference person is the person (or one of the persons) responsible for accommodation. Usually, he/she is the member more involved in handling the economic issues of the household.

[3] Household income is calculated as the sum of labour and non-labour incomes for all household members in 2007, but it is expressed in euros of the first quarter of 2009. Net wealth is defined as all assets minus the outstanding debt.

whether the household owns its home, is liquidity constrained, and holds some account in stand-alone internet banks.

The degree of risk aversion is taken from a direct answer to a question on the risk the household is willing to take when making financial decisions. Similarly, a household is considered to be liquidity constrained if answering to a direct question it declares not to have asked for a loan, or if it has asked and the loan has been denied, in the last two years. Each of the 14 characteristics will be represented by a set of dummy variables whose elements are taken from Banco de España reports on the EFF2008 (e.g., see Banco de España, 2010). Table 1 lists those dummy variables and presents sample descriptive statistics of all variables used in this study.

We do not consider the impact of taxes on portfolio composition because, due to the differential tax treatment of assets. Further, the marginal tax rate is endogenous to the choice of portfolio (King and Leape (1998)), and, to be able to decompose the total variation in the dependent variable into explained and unexplained variation, the explanatory variables are to be uncorrelated with the disturbance.

4. STATISTICAL STRATEGY

4.1 Multivariate Fractional Logit Estimates

Although the amount of household financial wealth has been classified into a set of nine mutually exclusive and exhaustive assets, suppose, for generality's sake, that the set is made up of M assets. The relative share of financial wealth invested in asset m, $m=1,\dots,M$, is denoted y_m, whereas $\mathbf{x} \equiv (1, x_2, \dots, x_K)$ represents a $1 \times K$ random vector of explanatory variables. For systems of equations in which the components of the multivariate dependent variable are non-negative, may take on certain values with positive probability, and add up to

1, Mullahy and Robert (2010) developed an attractive specification as well as a simple quasi-likelihood estimator that extends Papke and Wooldridge's (1996) fractional regression model to a multivariate context. Let the population regression of y_m on $\mathbf{x}$ be of the multinomial logit form:

$$E\left(y_m \middle| \mathbf{x}\right) = \frac{\exp\left(\mathbf{x}\boldsymbol{\beta}_m\right)}{\sum_{l=1}^{M} \exp\left(\mathbf{x}\boldsymbol{\beta}_l\right)}, \quad m = 1, \ldots, M, \tag{1}$$

where each $\boldsymbol{\beta}_m$ is a $K \times 1$ vector of unknown parameters. This nonlinear specification presents several attractive properties: It ensures that predicted relative asset shares ($\hat{y}_m$) lie between 0 and 1, that $\sum_{m=1}^{M} \hat{y}_m = 1$, and that the partial effect of x_k on $E\left(y_m \middle| \mathbf{x}\right)$ is not constant but dependent on $\mathbf{x}$. An additional feature is that equation (1) is well defined even if every y_m takes on 0 or 1 with positive probability. The normalization $\boldsymbol{\beta}_1 = \mathbf{0}$ is generally imposed for identification purposes.

Mullahy and Robert (2010) advocate a particular quasi-likelihood method to estimate the parameters of (1). The multinomial logit log-likelihood function

$$l\left(\mathbf{b}\right) \equiv \sum_{m=1}^{M} y_m \left(\mathbf{x}\mathbf{b}_m - \ln\left(\sum_{l=1}^{M} \exp\left(\mathbf{x}\mathbf{b}_l\right)\right)\right), \tag{2}$$

where $\mathbf{b} \equiv \left(\mathbf{0}', \mathbf{b}_2', \ldots, \mathbf{b}_M'\right)'$ is a generic element of the parameter space, is an objective function associated with the linear exponential family (LEF) of probability distributions. Given a sample of N independent observations $\left\{\left(\mathbf{y}_i, \mathbf{x}_i\right) : i = 1, \ldots, N\right\}$, where

$\mathbf{y}_i \equiv \left(y_{i1}, \ldots, y_{iM}\right)'$, the quasi-maximum likelihood estimator (QMLE) of $\boldsymbol{\beta} \equiv \left(\mathbf{0}', \boldsymbol{\beta}_2', \ldots, \boldsymbol{\beta}_M'\right)'$, $\hat{\boldsymbol{\beta}}$, obtained from the maximization problem

$$\max_{\mathbf{b}} \sum_{i=1}^{N} l_i\left(\mathbf{b}\right) \tag{3}$$

is consistent for $\boldsymbol{\beta}$ and asymptotically normal provided that equation (1) holds.[4] In other words, although the conditional probability distribution of $\mathbf{y}$ cannot be multinomial, if its conditional mean is correctly specified, the fact that the assumed probability distribution is linear exponential makes $\hat{\boldsymbol{\beta}}$ to have satisfying econometric properties regardless of the true conditional distribution of $\mathbf{y}$.

The average partial effect (APE) of the *k*th explanatory variable on the *m*th conditional mean is estimated as

$$\widehat{APE}_{mk} = \frac{1}{N}\sum_{i=1}^{N}\frac{\Delta\hat{E}\left(y_{im}|\mathbf{x}_i\right)}{\Delta x_{ik}}, \tag{4}$$

where

$$\frac{\Delta\hat{E}\left(y_{im}|\mathbf{x}_i\right)}{\Delta x_{ik}} = \frac{\exp\left(\mathbf{x}_{i,-k}\hat{\boldsymbol{\beta}}_{m,-k}+\hat{\beta}_{mk}\right)}{\sum_{l=1}^{M}\exp\left(\mathbf{x}_{i,-k}\hat{\boldsymbol{\beta}}_{l,-k}+\hat{\beta}_{lk}\right)} - \frac{\exp\left(\mathbf{x}_{i,-k}\hat{\boldsymbol{\beta}}_{m,-k}\right)}{\sum_{l=1}^{M}\exp\left(\mathbf{x}_{i,-k}\hat{\boldsymbol{\beta}}_{l,-k}\right)} \tag{5}$$

and $\mathbf{x}_{i,-k}$ and $\hat{\boldsymbol{\beta}}_{m,-k}$ represent the vectors $\mathbf{x}_i$ and $\hat{\boldsymbol{\beta}}_m$ with the *k*th component excluded.[5] Note that $\sum_{m=1}^{M}\widehat{APE}_{mk}=0$ since $\sum_{m=1}^{M}\hat{E}\left(y_m|\mathbf{x}\right)=1$. When a characteristic of the household or of the reference person is represented by more than one dummy variable, the $\widehat{APE}$ is calculated with respect to the excluded category. Standard errors of $\widehat{APE}$s are calculated using the delta method.

[4] A good exposition of the properties of QML estimators is provided in Gourieroux et al. (1984).

[5] In the case where x_k is continuous, $\widehat{APE}_{mk} = \frac{1}{N}\sum_{i=1}^{N}\frac{\partial\hat{E}\left(y_{im}|\mathbf{x}_i\right)}{\partial x_{ik}}$, with $\frac{\partial\hat{E}\left(y_{im}|\mathbf{x}_i\right)}{\partial x_{ik}} = \hat{E}\left(y_{im}|\mathbf{x}_i\right)\left(-\sum_{l=1}^{M}\hat{E}\left(y_{il}|\mathbf{x}_i\right)\hat{\beta}_{lk}\right)$.

4.2 Variance Decomposition and Goodness of Fit

The literature on generalized linear models has extended the analysis of variance to certain nonlinear contexts based on the concept of deviance. Let $f_{\mathbf{y}_i}$ and $f_{\mathbf{p}}$ denote two LEF probability distributions associated to the random vector $\mathbf{y}$. $f_{\mathbf{y}_i}$ is centered at a realization of $\mathbf{y}$, whereas $f_{\mathbf{p}}$ is centered at $E\left[\mathbf{y}|\mathbf{x}\right]=\mathbf{p}$. The estimated deviance between the observations $\mathbf{Y}=\left(\mathbf{y}_1,\ldots,\mathbf{y}_N\right)$ and fitted values $\hat{\mathbf{P}}=\left(\hat{\mathbf{p}}_1,\ldots,\hat{\mathbf{p}}_N\right)$ is

$$K\left(\mathbf{Y},\hat{\mathbf{P}}\right)\equiv 2\sum_{i=1}^{N}\left(\ln f_{\mathbf{y}_i}\left(\mathbf{y}_i\right)-\ln f_{\hat{\mathbf{p}}_i}\left(\mathbf{y}_i\right)\right) \tag{6}$$

(e.g., see McCullagh and Nelder, 1989). The difference $K\left(\mathbf{Y},\hat{\mathbf{P}}_{\mathbf{0}}\right)-K\left(\mathbf{Y},\hat{\mathbf{P}}\right)$, where the sub-index $\mathbf{0}$ refers to the null model, measures the reduction in deviance achieved by the inclusion of explanatory variables.

In practice, however, the data-generating process for the household financial portfolio, $f_{\mathbf{p}}$, is unknown. But the deviance can still be calculated if certain features of the data are assumed. Suppose $\mathbf{y}$ has conditional mean $\mathbf{p}$ with mth element as given in (1). Assume also that the conditional variance of $\mathbf{y}$ is given by

$$V\left(\mathbf{y}|\mathbf{x}\right)=\sigma^2\mathbf{V}, \tag{7}$$

where σ^2 denotes a dispersion parameter, $\mathbf{V}$ represents a matrix with mlth element $p_m\left(\delta_{ml}-p_l\right)$, and δ_{ml} is an indicator variable equal to 1 if $m=l$ and equal to 0 otherwise. Then, McCullagh and Nelder (1989, Ch. 9) showed that the deviance between observations and fitted values can be computed as

$$-2Q\left(\hat{\mathbf{P}};\mathbf{Y}\right), \tag{8}$$

where

$$Q\left(\hat{\mathbf{P}};\mathbf{Y}\right)=\sum_{i=1}^{N}\left(\sum_{m=1}^{M} y_{im}\left(\mathbf{x}_i\hat{\boldsymbol{\beta}}_m-\ln\left(\sum_{l=1}^{M}\exp\left(\mathbf{x}_i\hat{\boldsymbol{\beta}}_k\right)\right)\right)-\sum_{m=1}^{M} y_{im}\ln y_{im}\right) \tag{9}$$

is the estimated quasi-likelihood. The reduction in deviance achieved by the inclusion of explanatory variables is $-2\left(Q\left(\hat{\mathbf{P}}_{\mathbf{0}};\mathbf{Y}\right)-Q\left(\hat{\mathbf{P}};\mathbf{Y}\right)\right)$. The attractive properties of (1) as a regression model for relative asset shares suggest, in turn, that the multinomial covariance structure (7) could be a reasonable model for $V\left(\mathbf{y}|\mathbf{x}\right)$. However, (7) presents a restriction in the fact that all elements outside its main diagonal are negative. As the structure of the conditional covariance matrix is partly reflected in the structure of the unconditional one, we have tried to increase the adequacy of the model to data by aggregating investments that are positively correlated. This was the case of the amount invested in both types of shares and mutual funds, whose resulting asset category is named simply *shares*. After this change, all pairwise unconditional sample correlations between relative shares of the surviving seven types of assets are negative.

The commonly reported goodness-of-fit statistic in the standard linear regression model, R^2, is troublesome when applied to nonlinear contexts, as it can lie outside the $[0,1]$ interval and decrease as explanatory variables are added. Hence, alternative R^2-type statistics, generally called pseudo-R^2s, have been constructed for particular nonlinear models. González Chapela (2013) proposed a pseudo-R^2 for multinomial regression models calculated using quasi-maximum likelihood statistics which, among other satisfying properties, lies between 0 and 1 and is non-decreasing as explanatory variables are added to the model. That pseudo-R^2, denoted R_Q^2, can be calculated as

$$R_Q^2=\frac{Q\left(\hat{\mathbf{P}}_{\mathbf{0}};\hat{\mathbf{P}}\right)}{Q\left(\hat{\mathbf{P}}_{\mathbf{0}};\mathbf{Y}\right)}, \tag{10}$$

where $Q\left(\hat{\mathbf{P}}_{\mathbf{0}};\hat{\mathbf{P}}\right)$ is (up to the factor -2) the estimated deviance between the null and fitted models. R_Q^2 can be interpreted as the fraction of total deviance explained by the fitted model.

It turns out that the increase in deviance when an explanatory variable is removed from the model provides a convenient basis for testing exclusion restrictions. The quasi-likelihood ratio (QLR) test statistic,

$$QLR = \frac{-2\left(\sum_{i=1}^{N} \ln f_{\hat{\mathbf{p}}_r}\left(\mathbf{y}_i\right) - \sum_{i=1}^{N} \ln f_{\hat{\mathbf{p}}_u}\left(\mathbf{y}_i\right)\right)}{\hat{\sigma}_u^2}, \tag{11}$$

is derived from that increase. In this expression, the subscripts r and u indicate, respectively, the restricted and unrestricted models, whereas $\hat{\sigma}_u^2$ is calculated as

$$\hat{\sigma}^2 = \left((M-1)(N-K)\right)^{-1} \sum_{im} \left(y_{im} - \hat{p}_{im}\right)^2 \Big/ \hat{p}_{im}\left(1-\hat{p}_{im}\right) \tag{12}$$

using results from unrestricted estimation (see Wooldridge, 2002, p. 370). QLR has a χ^2 limiting distribution under the restricted model, with degrees of freedom (QLR(df)) given by the number of restrictions being tested. Since each explanatory term can have associated non-zero coefficients in $M-1$ relative share equations, QLR(df) will be proportional to $M-1$. For example, if we are testing the inclusion in $\mathbf{x}$ of a certain characteristic represented by 2 (say) dummy variables, QLR(df)=$2(M-1)$.

4.3 Combining Regression Estimates and Test Statistics

To make inferences from the five imputed datasets provided by the EFF2008, one must, first, analyze each of the five datasets by complete-data methods, and then combine the results. We now provide the rules used to combine the results.

Let S be a generic scalar estimand (e.g. an average partial effect or a deviance between observations and predicted values), and let $\hat{S}^{(t)}$ and $U^{(t)}$ denote, respectively, the point and variance estimates of S obtained from the t_{th} set of imputed data, $t = 1,\ldots,5$. Following Rubin (1987, Ch. 3), the combined point estimate for S is the average of the five point estimates,

$$\bar{S} = \frac{1}{5}\sum_{t=1}^{5}\hat{S}^{(t)} . \tag{13}$$

The variance estimate associated with $\bar{S}$ has two components. The within imputation sampling variance is the average of the five variance estimates,

$$\bar{U} = \frac{1}{5}\sum_{t=1}^{5}U^{(t)} . \tag{14}$$

The between imputations variance, which reflects variability due to imputation uncertainty, is the variance of the point estimates,

$$B = \frac{1}{4}\sum_{t=1}^{5}\left(\hat{S}^{(t)} - \bar{S}\right)^2 . \tag{15}$$

The total variance for $\bar{S}$ is given by

$$T = \bar{U} + (6/5)B , \tag{16}$$

so that $\sqrt{T}$ is the combined standard error of $\bar{S}$.

Schafer (1997, Ch. 4) provides rules for combining likelihood-ratio (LR) test statistics. Since in the context of generalized linear models the QLR statistic has the same chi-square distribution under the null and the same non-central chi-square distribution under local alternatives than the LR criterion (Cameron and Trivedi, 2005, p. 244), the method in Schafer is followed to combine QLR statistics. Let

$$QLR^{(t)} = QLR\left(\hat{\boldsymbol{\beta}}_r^{(t)}, \hat{\boldsymbol{\beta}}_u^{(t)} \middle| \mathbf{Y}^{(t)}, \mathbf{X}^{(t)}\right) \tag{17}$$

be the QLR statistic obtained from the *t*th imputed dataset, where $\hat{\boldsymbol{\beta}}_r^{(t)}$ and $\hat{\boldsymbol{\beta}}_u^{(t)}$ are the maximizers of (2) under the restricted and unrestricted models, respectively, and $\mathbf{X} = \left(\mathbf{x}_1', \ldots, \mathbf{x}_N'\right)$. Let also

$$\overline{QLR} = \frac{1}{5}\sum_{t=1}^{5} QLR^{(t)} \tag{18}$$

be the average of these QLR statistics, and

$$\overline{\boldsymbol{\beta}}_r = \frac{1}{5}\sum_{t=1}^{5} \hat{\boldsymbol{\beta}}_r^{(t)}, \tag{19a}$$

$$\overline{\boldsymbol{\beta}}_u = \frac{1}{5}\sum_{t=1}^{5} \hat{\boldsymbol{\beta}}_u^{(t)} \tag{19b}$$

the averages of the estimates of $\boldsymbol{\beta}$ across imputations. Lastly, let

$$\widetilde{QLR} = \frac{1}{5}\sum_{t=1}^{5} QLR\left(\overline{\boldsymbol{\beta}}_r, \overline{\boldsymbol{\beta}}_u \middle| \mathbf{Y}^{(t)}, \mathbf{X}^{(t)}\right) \tag{20}$$

denote the average of the QLR statistics evaluated at $\overline{\boldsymbol{\beta}}_r$ and $\overline{\boldsymbol{\beta}}_u$, rather than at the imputation-specific parameter estimates. The combined QLR test statistic is given by

$$QLR_c = \frac{\widetilde{QLR}}{QLR\left(df\right)(1+r)}, \tag{21}$$

where

$$r = \frac{6}{4QLR\left(df\right)}\left(\overline{QLR} - \widetilde{QLR}\right). \tag{22}$$

QLR_c is referred to an $F_{QLR(df),w}$ distribution, with denominator degrees of freedom calculated as

$$w = 4\left(1 + \left(QLR\left(df\right) - 1\right)\left(1 + (1 - (2QLR(df))^{-1})r^{-1}\right)^2\right). \tag{23}$$

5. RESULTS

Table 2 presents the multivariate fractional logit $\widehat{APE}$s. Each row of this table lists the $\widehat{APE}$s of a certain explanatory term on each of the relative asset shares (or, equivalently, on the probability of holding each of the available assets). As explained at the end of subsection 4.1, the row sum of $\widehat{APE}$s amounts to zero. The $\widehat{APE}$s of all the explanatory terms on the relative share of a certain asset (or, equivalently, on the probability of holding that asset) are shown per column. Robust standard errors are presented in parentheses below the corresponding $\widehat{APE}$s.

Column 1 presents the results for the more liquid and lowest return asset: accounts and deposits usable for payments (liquid asset from now on). Higher income, higher wealth, better health and less risk averse households have a lower proportion of their net wealth devoted to this asset. Age has also a negative effect but it is non-linear: younger and older invest more than middle aged. Education, both general and related to the financial sector, implies a lower share of this liquid asset in the portfolio. There are only three characteristics with a positive effect: female, home ownership and being liquidity constrained. Women prefer more liquid assets and owning your home usually means having a mortgage and this might reduce liquidity to invest in other assets.

Money away from the most liquid asset can be distributed among various assets with different risk profiles or invested in insurance and pension funds. We will look first to risky investment assets. The less risky alternative is accounts and deposits not usable for payments (column 2). Part of the net wealth diverted from the liquid asset goes to this low risk investment in the case of aged, higher income and higher net wealth households. The opposite is true for homeowners and liquidity constrained households: the higher proportion of the liquid asset contrasts with the lower investment in accounts and deposits not usable for payments. As in the case of the liquid asset, the most educated households invest less in this low risk alternative. Business owners distract funds from this asset to invest in other risky alternatives (column 6).

Out of accounts and deposits not usable for payments wealth can be invested in shares, fixed income, portfolios under management and other assets. The following step in terms of risk would be fixed income securities (column 3). Older, higher wealth and less risk averse households choose to invest part of the money distracted from the liquid asset in this alternative. This effect is much smaller than the one of the previous asset. Households with a married couple invest less whereas home owners prefer this asset to the rest of risky choices.

Shares is the only risky asset where educated people invest more (column 4). Aged and higher wealth households also invest part of the wealth taken from the liquid asset in shares. This effect is much greater than the one for fixed income. The same applies to risk aversion, individuals invest more than ten times in shares the amount invested in fixed income. Households that work in the financial sector place all the money diverted from the liquid asset in shares. Finally, liquid asset investments of liquidity constrained households and female come from the lower stake invested in shares.

Age does not show a clear relationship with respect to investments in portfolios under management (column 5) and the effect is very small. Lowest risk averse, poor health and liquidity constrained households invest less in this asset.

Most educated and aged greater than 55 invest less in the other assets category (column 6). Self employed invest the money from accounts and deposits not usable for payments in this type of assets.

We look now at precautionary savings (column 7). Most educated households invest part of the money distracted from the two more liquid assets in insurance and pension funds. Investment increases with age till retirement where funds are directed to the other alternatives previously analyzed. Households with higher income invest more than half of the money detracted from the liquid asset in pension and insurance schemes. Households with married couples and better health status have a higher investment in this asset.

Table 3 presents the results of a partial analysis of deviance of households' financial portfolio composition. (For table layout simplicity, possible overlaps among the explanatory characteristics are ignored.) The partial deviance is calculated as the deviance explained by all 14 explanatory characteristics minus the deviance in the sub-model in which the characteristic of interest is removed. Also listed in Table 3 are the values, degrees of freedom, and associated p-values of the QLR_c for testing the statistical significance of each explanatory characteristic and of the overall model.

The total deviance in the sample amounts to 10,921. When all 14 explanatory characteristics are included in $\mathbf{x}$, the model is able to explain 2,162 units of this deviance, implying an R_Q^2 of size 0.198. Clearly, the model provides a good fit for these data. Age and net wealth are the major contributors to deviance in the allocation of financial wealth: Their partial deviances represent, respectively, 2.6 and 2.5 percent of the total deviance. There is also evidence of sizeable risk aversion, education, self-employment, income, liquidity constraints, and health status effects: The p-value for testing the exclusion of each of them is well below standard significance levels. Therefore, each of these characteristics significantly contributes to the predictive ability of the model even if all other 13 characteristics are included in $\mathbf{x}$. On the other hand, very modest effects are associated to gender of the reference person and having some account in stand-alone Internet banks, which, considered individually, do not serve as significant predictors of the allocation of financial wealth. Family size is not significant either.

This analysis helps us understand decisions associated to household finance with a methodology that suits the characteristics of the decision households have to make and help to qualify previous evidence on household determinants of portfolio allocation.

5.1 Political implications

We now try to derive political implications related to three different questions found in the financial literature: what are the determinants of the demand for assets? What characterizes the extent of savings for retirement? And what are the determinants of sound financial planning counseling?

As said above, asset demand is mainly characterized by age and net wealth of households, being risk aversion and education the next relevant features. This finding has important implications for developing policies aimed at encouraging the participation of households in financial markets. Age looses importance as a policy tool since it is difficult to influence and it affects evenly investments in nearly all risky assets. Actions design to modify wealth redistribution could increase the proportion of households that invest in listed financial assets. More effort devoted to education and financial literacy could also improve participation in shares through a better understanding and attitude towards risk.

The ageing of the population has serious implications for the sustainability of public pension systems, as it is the case in Spain. The promotion of savings for retirement in this scenario seems to become a serious policy concern in the near future. As presented above, income and education would be the main determinants of investing in this private pension schemes. Devoting public funds to increasing the level of education would mean higher investments in pension plans. In the case of income there would be also some room for public intervention. The low income households do not invest in private plans for their retirement. Should Policy makers want to increase the attractiveness of these investments, focused informative campaigns, improved tax deductions or subsidies could help increasing household wealth invested in private pension plans.

Mifid directive regulates investor protection and adequate financial counseling. Financial institutions should classify customers and assess the advisability of financial instruments according to client's characteristics. Educated people tend to significantly invest a higher proportion of their wealth in shares both listed and non listed. Low educated households would probably need additional advice if they were to invest in this kind of assets. Although positive, investments in fixed income for people above 44 are very modest whereas they do not significantly invest below this age. The under 44 households would have to be correctly informed about the risks of these instruments, especially in the case of implicit derivative and perpetual issuances. On the contrary, a greater proportion of wealth is devoted to shares across the age distribution what reduces the need of supplementary advice. Income is only related to accounts non usable for payments, with very low risk, and pension and insurance schemes. It should not be one of the main variables to include in the investor analysis. Finally, only households with net wealth greater than the average significantly invest in shares and fixed income. Careful assistance should be provided to people in the lower levels of the wealth distribution in both investments. Households that declare to be willing to take higher risks end up investing a significant proportion of their wealth in shares and less in fixed income. This self-declared risk aversion seems to be a good proxy for the portfolio desired actual risk.

6. CONCLUSIONS

The household portfolio allocation problem has received increased attention both theoretically and empirically. This paper adds to this literature first, by using an appropriate methodology to take into account the boundability of portfolio allocation choices. This technique allows the jointly estimation of how different household characteristics affect the investment decisions in the different types of assets. Second, by analyzing decisions over a wider asset classification, that enables to obtain richer conclusions.

It has been shown which determinants previously studied in the empirical and theoretical literature on stockholding, affect decisions on seven different assets that compound the household portfolio. These findings enhance our understanding of the interaction among distinct investment options and provide the possibility of knowing where the wealth invested in some asset comes out. Therefore, we are able to identify the relative changes in each financial asset of the household portfolio due to the same determinants.

Another important contribution from this investigation is the assessment of the relevance of each of the determinants to explain the variance of the household portfolio allocation problem. The paper provides a partial analysis of deviance adapted to the boundability of data. Results show that the main factors explaining the variability of the financial allocation of wealth are age and net wealth. Their partial deviances represent, respectively, 2.6 and 2.4 percent of the total deviance. There is also evidence of sizeable risk aversion, education, self-employment, income, liquidity constraints, and health status effects. On the other hand, very modest effects are associated to gender and having some account in stand-alone Internet banks and even less to family size, which, considered individually, do not serve as significant predictors of the allocation of financial wealth.

An implication of these findings is that both age and net wealth, and probably risk aversion and education, should be taken into account when looking at household portfolio composition decisions. This information can be used to develop targeted interventions aimed at promoting participation of households in the financial markets, for example by investing in stocks, or at encouraging precautionary investments, such as life insurance or pension funds. Another important practical implication is the better understanding of the personal and financial characteristics that would make the development of adequate financial planning services easier.

ACKNOWLEDGEMENTS

We started writing this paper during our stay at the University of Girona, whose hospitality we gratefully appreciate. We wish to thank conference participants at the XIV Iberian-Italian Congress of Financial and Actuarial Mathematics, the XXI Finance Forum and the 6th International Conference on Mathematical and Statistical Methods for Actuarial Sciences and Finance for helpful comments. Financial support from the Spanish Ministry of Education (ECO2011-29751/ECON), (ECO2010-16353) and (ECO2010-21393) is gratefully acknowledged.

REFERENCES

Ameriks, J., & Zeldes, S. (2004). How do household portfolio shares vary with age? Working paper, Columbia Business School, September.

Banco de España. (2010). Encuesta financiera de las familias (EFF) 2008: Métodos, resultados y cambios desde 2005. *Boletín Económico*, Banco de España.

Barceló, C. (2006). *Imputation of the 2005 wave of the Spanish survey of household finances (EFF).* Occasional Paper No. 0603, Banco de España.

Barber, B. M. and Odean, T. (2001). Boys will be boys: gender, overconfidence, and common stock investment, *The Quarterly Journal of Economics*,116, 261–92.

Bertocchi, G., Brunetti, M. and Torricelli, C. (2011). Marriage and other risky assets: A portfolio approach, *Journal of Banking and Finance*, 35(11), 2902-2915.

Bover, O. (2011). *The Spanish survey of household finances (EFF): description and methods of the 2008 wave*. Occasional Paper No. 1103, Banco de España.

Calvet, L.E., Campbell J.Y. and Sodini, P. (2006). Down or Out: Assessing the Welfare Costs of Household Investment Mistakes, *Journal of Political Economy*, vol. 115(5), 707-747.

Cameron, C. A., and Trivedi P.K.. (2005). *Microeconometrics: Methods and applications*. Cambridge University Press, New York.

Campbell, J. Y. (2006). Household finance. *Journal of Finance*, 61(4): 1553-1604.

Cardak, B. A. & Wilkins, R., (2009). The determinants of household risky asset holdings: Australian evidence on background risk and other factors, *Journal of Banking & Finance,* Elsevier, vol. 33(5), pages 850-860, May.

Cocco, J. (2005). Portfolio choice in the presence of housing. *Review of Financial Studies*, 18(2): 524-567.

Croson, R. and Gneezy, U. (2009). Gender differences in preferences, *Journal of Economic Literature*, 47, 448–74

Domínguez Barrero, F. and J. López Laborda. (2010). Taxation and portfolio structure of Spanish households. *Instituto de Estudios Fiscales*, 14/10.

Dong, D., B.W. Gould, and H.M. Kaiser. 2004. Food demand in Mexico: An application of the Amemiya-Tobin approach to the estimation of a censored food system. *American Journal of Agricultural Economics* 86(4):1094-1107.

Fehr-Duda, H., DeGennaro, M. and Schubert, R. (2006). Gender, financial risk, and probability weights, *Theory and Decision*, 60, 283–313.

Fernández Fernández, J. D. (2008). Elección de cartera de los hogares españoles: el papel de la vivienda y los costes de participación. *Tesina Cemfi, nº0803*.

Flavin, M. and T. Yamashita. (2002). Owner-Occupied Housing and the Composition of the Household Portfolio, *American Economic Review* 92(1), 345-62.

Fratantoni, M.C. (1998). Homeownership and investment in risky assets. *Journal of Urban Economics* 44, 27-42.

González Chapela, J. (2013). Things that make us different: Analysis of deviance with time-use data. *Journal of Applied Statistics* 40(7):1572-1585.

Gourieroux, C., Monfort A., and Trognon, A. (1984). Pseudo Maximum Likelihood methods: theory. *Econometrica* 52(3): 681-700.

Guiso, L., Haliassos, M. and Jappelli, T. (2002) Introduction, in *Household Portfolio*, eds. Guiso, L., M. Haliassos, and T. Jappelli, 1-24, Cambridge: The MIT Press.

Guiso, L., Haliassos, M. and Jappelli, T. (2003). Equity culture. Theory and cross-country evidence. *Economic Policy*, 18(36): 123-170.

Guiso, L., Jappelli, T. and Terlizzese, D. (1996). Income risk, borrowing constraints and portfolio choice. *American Economic Review* 86(1), 158-172

Jianakoplos, N. A. and Bernasek, A. (1998). Are women more risk averse?, *Economic Inquiry*, 36, 620–30

Jin F. (2011). Revisiting the Composition Puzzles of the Household Portfolio: New Evidence. *Review of Financial Economics*, 20 (2), 63-73.

Heaton, J. and Lucas, D. (2000). Portfolio Choice and Asset Prices: the Importance of Entrepreneurial Risk, *Journal of Finance* 59, 137-63.

King A.M. and J. Leape. (1998). Wealth and portfolio composition: theory and evidence. *Journal of Public Economics*, 69:155-193.

López Gómez, P. (2006). Composición de carteras de las familias españolas. *Tesina Cemfi nº 0606*.

Markowitz, H. (1952). Portfolio selection. *Journal of Finance*, 7(1): 77-91.

Mayordomo, S. (2007). ¿Afectan las restricciones financieras al régimen de tenencia de vivienda?. Tesin*a Cemfi, nº0704*.

McCullagh, P. and Nelder, J.A. (1989). *Generalized Linear Models*. Second edition. Boca Raton (Florida), Chapman & Hall/CRC.

Mora, T. and Escardibul, J. O. (2008). Los efectos de la edad y la educación en la aversión al riesgo. Un análisis sobre las inversiones financieras en España. *Revista Asturiana de Economía*, 41: 67-83.

Mullahy, J. and Robert, S.A.. (2010). No time to lose: Time constraints and physical activity in the production of health. *Review of Economics of the Household* 4:409-432.

Papke, L.E. and Wooldridge J.M. (1996). Econometric methods for fractional response variables with an application to 401 (K) plan participation rates. *Journal of Applied Econometrics* 11(6): 619-632.

Poterba, J. M. & Samwick, A. A. (2001). *Household portfolio allocation over the life cycle*, in Aging Issues in the United States and Japan, Eds. Ogura, S. Tachibanaki, T. and Wise, D.A., University of Chicago Press.

Poterba, J. M. and A.A. Samwick. (2003). Taxation and household portfolio composition; US evidence from the 1980 and 1990s. *Journal of Public Economics*, 87: 5-38.

Pudney, S. 1989. *Modelling individual choice. The econometrics of corners, kinks and holes*. Basil Blackwell, Oxford.

Rodriguez Moreno, M., Mayordomo, S. and Peña, J.I., Portfolio Choice with Indivisible and Illiquid Housing Assets: The Case of Spain (2011). Available at SSRN: http://ssrn.com/abstract=1799560 or http://dx.doi.org/10.2139/ssrn.1799560

Rubin, Donald B. (1987). *Multiple imputation for nonresponse in surveys*. John Wiley & Sons.

Schafer, J. L. (1997). *Analysis of incomplete multivariate data*. Chapman & Hall, London.

Wermers, R. (2011) Performance measurement of mutual funds, hedge funds, and institutional accounts. *Annual Review of Financial Economics*, 3, 537-574.

Wooldridge, J. M. (2002). *Econometric analysis of cross section and panel data*. Cambridge and London, The MIT Press.

Yamishita, T. (2003). Owner occupied housing and investment in stocks: an empirical test. *Journal of Urban Economics* 53, 220-237.

Yao, R. and Zhang, H. H. (2005). Optimal consumption and portfolio choices with risky housing and borrowing constraints. *Review of Financial Studies*, 18: 197-239.

Table 1. Sample descriptive statistics, the Spanish Survey of Household Finances 2008

Variable (€1,000)	Mean	SD	Min	Max	25th pctl	50th pctl	75th pctl	% = 0
Financial assets	220.6	1300	.001	35,150	3.4	19.0	90.6	0
(1)	18.9	91.9	0	4000	1.4	4.1	12.0	3.0
(2)	34.2	172.9	0	7000	0	0	10.0	67.4
(3)	3.8	42.3	0	1400	0	0	0	96.7
(4)	136.1	1,201	0	35,000	0	0	6.7	69.0
(5)	2.3	40.2	0	1430	0	0	0	98.8
(6)	9.5	134.1	0	8845	0	0	0	91.5
(7)	15.8	98.3	0	9448	0	0	5.0	67.3

Variable (%)	Mean	*Variable (%)*	Mean
Female	38.9	Net wealth pctl < 25	14.6
Less than a high school diploma	58.6	Net wealth pctl 25-50	16.5
Exactly high school	10.9	Net wealth pctl 50-75	21.0
More than a high school diploma	30.4	Net wealth pctl 75-90	16.8
Age < 35	6.2	Net wealth pctl > 90	31.2
Age 35-44	14.9	Married	67.5
Age 45-54	20.3	Not willing to take financial risk	77.7
Age 55-64	21.3	Fairly risk inclined	19.0
Age 65-74	21.2	Quite risk inclined	2.7
Age 75+	16.0	Pretty risk inclined	0.6
Income pctl < 20	14.0	Owner	87.3
Income pctl 20-40	17.1	Self-employed	13.9
Income pctl 40-60	17.2	Very good health	19.1
Income pctl 60-80	18.6	Good health	54.4
Income pctl 80-90	11.3	Acceptable health	20.2
Income pctl > 90	21.7	Poor health	5.5
Family size = 1	17.9	Very poor health	0.9
Family size = 2	36.7	Liquidity constrained	12.4
Family size = 3	21.8	Works in financial sector	4.6
Family size = 4	17.3	Account stand-alone internet bank	1.0
Family size = 5+	6.3		

Notes: Data are of 5432 households from the EFF2008. Financial assets are made up of (1) accounts and deposits usable for payments, (2) accounts and deposits not usable for payments, (3) fixed-income securities, (4) shares, (5) portfolios under management, (6) other financial assets, and (7) life insurances and pension schemes. Asset values are expressed in euros of the first quarter of 2009. Variables in the lower panel refer to the reference person except income, family size, net wealth, risk aversion, liquidity constraints, and accounts in stand-alone internet banks, which refer to the household.

Table 2. Multivariate fractional logit estimates on the probability of holding each type of asset: Average partial effects

	Dependent variables: see the table notes.						
Independent variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Female	.0222	-.0069	-.0004	-.0236	-.0000	.0043	.0043
	(.0113)*	(.0097)	(.0026)	(.0077)*	(.0018)	(.0046)	(.0072)
Exactly high school	-.0301	-.0309	.0028	.0388	-.0031	.0023	.0203
	(.0173)	(.0147)*	(.0043)	(.0117)*	(.0024)	(.0073)	(.0113)
More than a high school diploma	-.0418	-.0436	.0014	.0756	-.0022	-.0089	.0195
	(.0131)*	(.0108)*	(.0027)	(.0092)*	(.0018)	(.0049)	(.0083)*
Age 35-44	-.0833	-.0188	.0021	.0479	.0045	-.0094	.0570
	(.0265)*	(.0236)	(.0025)	(.0188)*	(.0019)*	(.0134)	(.0163)*
Age 45-54	-.1139	-.0197	.0056	.0331	.0028	-.0208	.1130
	(.0265)*	(.0232)	(.0027)*	(.0176)	(.0012)*	(.0136)	(.0167)*
Age 55-64	-.1286	-.0102	.0082	.0440	.0064	-.0277	.1078
	(.0274)*	(.0235)	(.0027)*	(.0173)*	(.0018)*	(.0140)*	(.0169)*
Age 65-74	-.0824	.0477	.0137	.0870	.0047	-.0336	-.0371
	(.0283)*	(.0252)	(.0037)*	(.0190)*	(.0014)*	(.0141)*	(.0147)*
Age 75+	-.0500	.0542	.0122	.0944	.0082	-.0440	-.0750
	(.0295)	(.0263)*	(.0041)*	(.0201)*	(.0029)*	(.0135)*	(.0141)*
Income pctl 20-40	-.0335	.0201	-.0038	-.0008	-.0069	.0008	.0240
	(.0243)	(.0169)	(.0081)	(.0181)	(.0044)	(.0094)	(.0160)
Income pctl 40-60	-.0601	.0380	-.0099	.0024	-.0076	-.0056	.0427
	(.0231)*	(.0170)*	(.0072)	(.0176)	(.0042)	(.0094)	(.0148)*
Income pctl 60-80	-.0942	.0528	-.0095	-.0005	-.0045	-.0033	.0593
	(.0244)*	(.0179)*	(.0072)	(.0173)	(.0052)	(.0096)	(.0156)*
Income pctl 80-90	-.1009	.0502	-.0082	.0092	-.0090	-.0041	.0629
	(.0268)*	(.0209)*	(.0078)	(.0186)	(.0048)	(.0103)	(.0160)*
Income pctl > 90	-.1456	.0581	-.0081	.0367	-.0070	.0010	.0650
	(.0276)*	(.0214)*	(.0079)	(.0193)	(.0050)	(.0108)	(.0167)*
Family size = 2	.0117	.0029	.0031	.0095	-.0014	-.0011	-.0247
	(.0190)	(.0160)	(.0038)	(.0143)	(.0034)	(.0073)	(.0147)
Family size = 3	.0170	.0068	.0015	-.0162	-.0028	.0066	-.0130
	(.0218)	(.0182)	(.0040)	(.0152)	(.0034)	(.0082)	(.0155)
Family size = 4	.0282	.0150	.0022	-.0417	.0007	.0058	-.0101
	(.0245)	(.0208)	(.0054)	(.0162)*	(.0050)	(.0096)	(.0167)
Family size = 5+	.0277	-.0018	.0042	-.0114	.0025	.0017	-.0228
	(.0288)	(.0247)	(.0082)	(.0198)	(.0069)	(.0104)	(.0185)
Net wealth pctl 25-50	-.0798	.0606	.0015	.0140	-.0049	.0047	.0039
	(.0258)*	(.0173)*	(.0026)	(.0116)	(.0056)	(.0093)	(.0177)
Net wealth pctl 50-75	-.1519	.0980	.0096	.0373	-.0014	-.0005	.0090
	(.0266)*	(.0178)*	(.0032)*	(.0112)*	(.0060)	(.0086)	(.0187)
Net wealth pctl 75-90	-.2531	.1236	.0095	.1085	-.0033	-.0002	.0151
	(.0270)*	(.0186)*	(.0037)*	(.0132)*	(.0055)	(.0098)	(.0178)
Net wealth pctl > 90	-.3719	.1341	.0144	.1906	.0042	.0149	.0137
	(.0280)*	(.0201)*	(.0035)*	(.0154)*	(.0064)	(.0110)	(.0185)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Married	.0062	-.0242	-.0102	-.0135	-.0029	.0063	.0383
	(.0154)	(.0140)	(.0047)*	(.0113)	(.0031)	(.0057)	(.0092)*
Fairly risk inclined	-.0981	.0030	.0072	.0744	.0018	.0028	.0090
	(.0135)*	(.0113)	(.0035)*	(.0089)*	(.0021)	(.0050)	(.0081)
Quite risk inclined	-.1247	-.0064	.0072	.1102	-.0050	.0150	.0037
	(.0303)*	(.0248)	(.0076)	(.0223)*	(.0010)*	(.0135)	(.0184)
Pretty risk inclined	-.2082	.0212	.0338	.0490	-.0051	.0970	.0122
	(.0638)*	(.0556)	(.0233)	(.0480)	(.0010)*	(.0531)	(.0397)
Owner	.0508	-.0504	.0059	-.0177	.0039	-.0113	.0188
	(.0219)*	(.0227)*	(.0027)*	(.0183)	(.0029)	(.0097)	(.0141)
Self-employed	.0148	-.0441	.0018	-.0077	-.0001	.0378	-.0026
	(.0156)	(.0117)*	(.0034)	(.0091)	(.0022)	(.0079)*	(.0089)
Good health	-.0466	.0238	.0041	.0008	.0022	.0063	.0094
	(.0136)*	(.0112)*	(.0025)	(.0091)	(.0020)	(.0046)	(.0081)
Acceptable health	-.0460	.0461	.0013	-.0106	.0014	.0114	-.0036
	(.0172)*	(.0148)*	(.0030)	(.0116)	(.0025)	(.0073)	(.0110)
Poor health	.0133	.0357	.0099	-.0531	-.0038	.0101	-.0120
	(.0279)	(.0228)	(.0067)	(.0169)*	(.0017)*	(.0133)	(.0203)
Very poor health	.0959	-.0171	-.0078	-.0051	-.0040	.0220	-.0838
	(.0646)	(.0444)	(.0019)*	(.0428)	(.0017)*	(.0447)	(.0266)*
Liquidity constrained	.1238	-.0720	-.0025	-.0425	-.0057	.0105	-.0116
	(.0183)*	(.0140)*	(.0047)	(.0141)*	(.0010)*	(.0081)	(.0123)
Works in financial sector	-.0592	-.0186	-.0012	.0567	.0059	-.0030	.0193
	(.0250)*	(.0194)	(.0040)	(.0145)*	(.0059)	(.0099)	(.0147)
Account in stand-alone internet bank	-.0397	.0687	.0197	-.0255	.0212	.0004	-.0448
	(.0441)	(.0407)	(.0137)	(.0231)	(.0151)	(.0190)	(.0167)*

Notes: Data are of 5432 households from the EFF2008. Robust standard errors calculated with the delta method appear in parentheses. Dependent variables are relative shares of financial assets invested in (1) accounts and deposits usable for payments, (2) accounts and deposits not usable for payments, (3) fixed-income securities, (4) shares, (5) portfolios under management, (6) other financial assets, and (7) life insurances and pension schemes,. Independent variables refer to the reference person except income, family size, net wealth, risk aversion, liquidity constraints, and accounts in stand-alone internet banks, which refer to the household. Unreported categories: less than a high school diploma, younger than 35, income percentile < 20, one-person household, wealth percentile < 25, not willing to take financial risk, very good health. *: Significant at 5 percent.

Table 3. Analysis of deviance in the allocation of financial assets

Source	Partial deviance	df	QLR_c	$QLR(df)$	w	Prob > QLR_c
Model	2161.6	34	14.3	204	311,793	.000
Female	7.6	1	1.7	6	19,838	.109
Education	63.2	2	7.2	12	30,047	.000
Age	283.6	5	13.1	30	157,268	.000
Income	50.3	5	2.1	30	11,405	.000
Family size	19.5	4	1.1	24	195,855	.314
Net wealth	278.2	4	14.5	24	6889	.000
Married	16.6	1	3.8	6	30,806	.001
Risk aversion	90.7	3	6.9	18	46,539	.000
Owner	10.7	1	2.4	6	8307	.026
Self-employed	28.5	1	6.6	6	33,463	.000
Health status	34.5	4	2.0	24	130,069	.003
Liquidity constrained	46.1	1	10.5	6	12,369	.000
Works in financial sector	13.3	1	3.0	6	10,705	.006
Account in stand-alone internet bank	7.5	1	1.7	6	49,751	.109
Residual	8759.4	5397				
Total deviance	10,921	5431				
R_Q^2	.198					

Notes: Data are of 5432 households from the EFF2008. Dependent variables are relative shares of financial assets invested in: accounts and deposits usable for payments, accounts and deposits not usable for payments, fixed-income securities, shares, portfolios under management, other financial assets, and life insurances and pension schemes. Independent variables (listed in the *Source* column) refer to the reference person except income, family size, net wealth, risk aversion, liquidity constraints, and accounts in stand-alone internet banks, which refer to the household. QLR_c: combined quasi-likelihood ratio test statistic. The QLR statistic from the *t*th imputed dataset is calculated as $partial\ deviance/\hat{\sigma}^2$. $\hat{\sigma}^2$ is computed using results from the model with all independent variables included, and its multiple-imputation point estimate equals 0.703.