ARC Centre of Excellence in Population Ageing Research

Working Paper 2011/20

Financial competence, risk presentation and retirement portfolio preferences

Hazel Bateman, Christine Eckert, John Geweke,
Jordan Louviere, Stephen Satchell and Susan Thorp*

Financial competence, risk presentation and retirement portfolio preferences

Hazel Bateman, Christine Eckert, John Geweke,
Jordan Louviere, Stephen Satchell and Susan Thorp[1]

Financial regulators are weighing up the effectiveness of different templates for communicating investment risk to retirement savers since welfare depends on comprehension of risk information. We compare nine standard risk presentations using a discrete choice experiment where subjects choose between three retirement accounts. Switching between graphical or textual presentations, or between formats that emphasize benchmarks rather than return ranges or values at risk, affects predicted choices more than large changes in underlying risk. Innumerate individuals are more susceptible to presentation, and those with weak basic financial literacy are insensitive to increasing risk levels, regardless of presentation. Presentation effects are moderated but not eliminated as financial literacy improves.

Keywords: discrete choice, risk preference, disclosure, financial literacy
JEL Classification: G23; G28; D14

[1]Bateman: Centre for Pensions and Superannuation, University of New South Wales, Sydney NSW 2052 Australia; Eckert: Centre for the Study of Choice, University of Technology Sydney, PO Box 123, Broadway NSW 2007 Australia. Geweke: Centre for the Study of Choice, University of Technology Sydney, PO Box 123, Broadway NSW 2007 Australia. Louviere: Centre for the Study of Choice, University of Technology Sydney, PO Box 123, Broadway NSW 2007 Australia. Satchell: Trinity College, University of Cambridge, University of Sydney, Trinity College, Cambridge, CB2 1TQ, U.K. Thorp: Centre for the Study of Choice, University of Technology Sydney, PO Box 123, Broadway NSW 2007 Australia, email: susan.thorp@uts.edu.au; T: +61 2 95147784; F: +61 2 95147722

1

As retirement schemes shift from defined benefit to defined contribution, many ordinary members are being compelled to choose investment portfolios for their accumulations. These choices depend both on personal financial competence and the menu of information offered by plan providers, advisers or financial institutions. Portfolio choices hinge on an appreciation of investment risk and have far reaching implications for the adequacy and security of retirement incomes.

Financial regulators want to ensure effective communication between providers and clients through intelligible, standardized documentation.[2] But with growing evidence that many people lack even basic financial skills (Lusardi and Mitchell 2009),[3] focus is shifting from mandating minimum disclosures towards ensuring comparability, relevance, and comprehensibility to ordinary consumers. Investment risk is key, and the financial services industry already uses many different formats to explain it in marketing and disclosure documents. So far regulators have not set standards for risk communication, but they are now weighing up the merits of alternative templates.[4]

Existing research shows that investment menu design (Benartzi and Thaler 2001; Madrian and Shea 2001; Huberman and Jiang 2006; Brown et al. 2007; Beshears et al. 2009; Agnew and Szykman 2005), specific presentations of return and risk (Benartzi and Thaler 1999; Rubaltelli et al. 2005; Anagol and Gamble 2010), home bias and name familiarity (Weber et al. 2005) and fram-

---

[2]The US Department of Labor is proposing a simplified disclosure format based on historical returns (Hung et al. 2010), Australian regulators have mandated a short-form disclosure document for pension funds (Minister for Financial Services, 2010) and the UK Financial Services Authority is working to make insurance and pension disclosures easier to understand (Andrews 2009). German banks are required to inform investors about past assets performance (Weber et al. 2005). Cross-country co-ordination of simplified disclosures is being initiated by multilateral organizations such as the European Commission and the OECD (European Commission 2009a,b; Organisation for Economic Cooperation and Development 2008).

[3]See http://www.dartmouth.edu/~alusardi/fcw.html. for a summary of comparable financial literacy survey results for Italy, New Zealand the United Kingdon and the United States.

[4]In Australia, proposals for suitable descriptions of investment risk for retirement savings accounts include range graphs around an average return (Super System Review 2010); an estimate of the expected frequency of negative returns over a 20 year time period (APRA 2010); and a 'risk meter' (Minister for Financial Services 2010).

ing (Brown et al. 2008; Agnew et al. 2008; Saez 2009) all influence investment decisions independently of underlying portfolio risk and return. Moreover, poor financial literacy makes people more susceptible to presentation effects (Agnew et al. 2008; Hastings et al. 2010). Recent studies of investment risk formats analyze dynamic and static illustrations of risk, including the combination of text and graphs (Vlaev et al. 2009), portfolio return distribution builders (Goldstein et al. 2008) and 'experience sampling', where decision makers receive feedback about outcomes (Haisley et al. 2010). While distribution builders and 'experience sampling' are important additions to the financial advice tool kit, their role in retirement planning is usually restricted to professional advisers or proprietary interfaces, putting them out of reach of most ordinary retirement fund members.

While these and other studies demonstrate the importance of design and framing of risk information, no existing research evaluates and compares the most common commercial presentations. Here we show the extent of variation in retirement account investment choices caused by changing from one standard format of risk presentation to another. We investigate the types of presentations that are included in retail prospectuses or disclosure statements, testing nine stylized versions of 'mass-market' risk presentations in a discrete choice experiment (DCE) on 1200 retirement account holders. Because of the large differences in risk information actually conveyed in extant disclosures, and given the range of formats being debated by regulators, we do not confine our study only to strict framing variations. In other words, the risk presentations analyzed here include re-statements of objectively equivalent information but also some partially-overlapping information sets. Like Weber et al. (2005), we aim to understand the way lay investors react to risk presentations to help inform policy choices but we expand current research by implementing a within and between subjects design over a larger set of risk presentations.

Policy makers are rightly concerned with the effects of risk presentation, since plan members in the accumulation phase whose account choices are distorted by unclear risk information may be much worse off at the point of retirement. Under standard assumptions on risk preferences and distributions

of returns, the certainty-equivalent wealth reduction of mistakes may exceed 70% for extremely risk averse members, may be as high as 30% for relative risk aversion between 0.5 and 3, or may be as little as 5%. Further, subjects' susceptibility to large losses varies with demographics and financial literacy.

Conditioning on subjective stockmarket expectations and individual demographics, we assess risk perception and presentation sensitivity at different levels of financial competence. We identify risk presentations that tilt choices towards, or away from, high return/high risk accounts, and profile the groups of people most likely to choose safe or risky allocations. All formats are not equal and even minimal framing changes have significant effects on allocations. We find a marked contrast between graphical and textual presentations of investment risk and between formats that emphasize event frequencies rather than return ranges or values at risk. Respondents with poor financial competence tend to be more susceptible to presentation changes and those with weak basic financial literacy are also less sensitive to changes in the underlying risk profile of investments. Further, expectations about post-crisis stock market recovery play as large a role in predicting allocations as the risk information presented in the survey.

The next section explains the context and design of the discrete choice experiment, including the survey structure and alternative risk presentations. The following sections set out the underlying model for investment choice and estimation results. The final section discusses conclusions and implications for policy.

1 Background

The experiment is built around an investment decision for mandatory retirement savings where we ask each subject to allocate their current retirement accumulation and future contributions among a safe, risky and 50:50 account in 12 settings. All subjects (apart from the very few who have only ever been defined benefit (DB) fund members) would have made a similar decision in the past via their participation in the Australian retirement savings system. Con-

sequently these hypothetical choices fall within the range of normal experience rather than unfamiliar scenarios that may be difficult to imagine.[5] Employers of all Australian workers who satisfy minimal conditions are required by law to contribute at least 9% of employees' earnings to individual retirement savings ('superannuation') accounts that have many features in common with U.S. 401(k) plans. Most contributions are preserved in privately-managed, defined contribution (DC) funds until a prescribed age. On joining a new DC fund, members (employees) are offered investment menus with upwards of 10 options, differing by underlying asset mix, and usually including cash, fixed interest, local and overseas stocks, real estate and alternative asset classes such as private equity and infrastructure. These investment menus are set out in 'product disclosure statements' that may run to several hundred pages.[6] Ordinary workers typically confront investment choices each time they change jobs, and are also able make ongoing changes after joining a fund, usually at zero or low cost. In reality, most members do not reallocate frequently and the majority of accounts are held in 'balanced' portfolios with 60-70% allocations to growth assets (Australian Prudential Regulation Authority, 2011).

---

[5]The ability of experimental subjects to imagine accurately a hypothetical decision outside their experience was raised by Kahneman and Tversky (1979) and critically investigated by many researchers including Holt and Laury (2002) and Anderson and Mellor (2009). However Louviere, Hensher and Swait (2002) compare studies using stated preference data against revealed preference data and find a high level of empirical consistency. Barsky, et al. (1997) show that hypothetically elicited risk tolerance predict risky behaviors. Dohman et al. (2011) confirm the power of a very general (unincentivized) survey question on willingness to bear risk for predicting both the outcomes of an incentivized lottery experiment, and risky behaviors in other contexts (such as driving, sport, health and career).

[6]Two leading superannuation providers in Australia offer the following information: the AMP product disclosure statement is 81 pages accompanied by 150 pages of investment 'Fact Sheets'. Similarly Australian Super supplies a 24 page and a 40 page investment choice guide plus many other pages of 'Fact Sheets'. (https://www.amp.com.au/wps/amp/au/FileProxy?vigurl=/vgn-ext-templating/fileMetadataInterface?ids=87785329484b8210VgnVCM1000001903400aRCRD) (https://www.amp.com.au/wps/amp/au/FileProxy?vigurl=%2Fvgn-ext-templating%2FfileMetadataInterface%3Fids%3Ddf07bba9fdc4c210VgnVCM1000001903400aRCRD). (http://www.australiansuper.com/tools-and-resources/~/media/files/Guides /10249_PDSIndustryChoice_0711.ashx) (http://www.australiansuper.com/tools-and-resources/~ /media/BC63AA71E8D44C27B431658E3C937750.ashx) (http://www.australiansuper.com/tools-and-resources/forms-and-publications.aspx#choice-of-fund)

1.1 Survey structure

The experiment was conducted via the internet over two weeks in May 2010. We sampled 1220 adults from the PureProfile online web panel of over 600,000 Australians and randomly assigned them to four treatments. PureProfile filtered the sample to ensure that all respondents currently held retirement savings (superannuation) accounts, that genders were equally represented and that the age distribution did not deviate far from population proportions. Of the 1220 respondents, 1199 (around 300 respondents per treatment) fully completed the survey over the internet, and were paid a flat rate of $3AUD ($3USD). The demographic characteristics of the survey sample is consistent with the general Australian population on most measures, with some over-sampling of the employed and more educated, partly a consequence of selecting superannuation account holders (Table 1).

Respondents completed a four-part questionnaire:

- Introductory questions about subjects' retirement savings, including the name of their superannuation fund (pension plan provider) and the aggregate amount in their accounts;
- 14 questions to measure financial competence as well as questions to elicit self-assessed knowledge of finance, access to financial education, use of financial advice and expectations of repeated stock market crises;
- A hypothetical asset allocation task for retirement savings; and
- Demographics.[7]

1.2 Financial literacy, education and advice

The survey assessed three dimensions of financial competence: numeracy, basic financial literacy and sophisticated financial literacy (Table 2). Higher financial capability is linked to retirement preparedness (Lusardi and Mitchell 2009; van Rooij et al. 2009) increased stock market participation (Yoong 2010; van Rooij et al. 2007), higher private retirement saving (Bucher-Koenen 2010) and greater portfolio diversification (Guiso and Jappelli 2008).

---

[7]We provide access to the entire survey at http://survey.confirmit.com/wix/p1250911674.aspx

Numeracy is associated with general cognition, and poor numeracy has been shown to predict aspects of financial inefficiency such as low savings, mortgage defaults and mistakes using credit cards (Banks and Oldfield 2007; Gerardi et al. 2010; Agarwal and Mazumder 2011). Numeracy questions test concepts such as fractions, percentages, division, multiplication and simple probability.

For other components of financial literacy, we follow the American Life Panel (ALP), the Health and Retirement Survey (HRS) and the Dutch Household Survey (DHS), dividing questions into 'basic financial literacy' covering compound interest, inflation, time value of money and money illusion, and 'sophisticated financial literacy' relating more closely to the asset allocation decisions frequently required for retirement saving, and covering knowledge of the differences between bonds and stocks and the impact of risk and diversification. For some questions we adapted the wording to Australian terminology and practices.

Respondents also gave a self-assessment of their understanding of finance on a scale of 1 (very low) to 7 (very high), reported current (and prior) access to financial education at school and in the workplace, and indicated if they had recently paid for financial advice. Further questions assessed respondents' expectations of the prospect of another stock market crash within five years of the survey.[8]

---

[8]The questions were worded as follows: On a scale of 1 to 7, where 1 means very low and 7 means very high, how would you assess your understanding of finance?; How much of your financial education was devoted to financial education, such as commerce, business studies, finance or economics? (Responses: A lot; Some; A little; Hardly at all.); Did any of the firms you have worked for (including your current employer) offer financial education programs, for example retirement seminars? (Responses: Yes; No; Not applicable.); Have you paid for professional financial advice about your superannuation over the past twelve months? (Responses: Yes; No.); In the global financial crisis that began in late 2007 Australian shares lost about half their value before they began to recover. Since then, they have recovered about half the value they lost and are worth about 75% of what they were at the market's high in September 2007. How likely is it that Australian share prices will suffer another similar sized loss in the next 5 years? (Answers: Nearly impossible (Chance of this happening is 1 in 100 or less); Very unlikely (Chance of this happening is higher than 1 in 100 but less than 1 in 10); Unlikely (Chances of this happening are between 1 in 10 and 1 in 2); Toss-up (Chance is about 1 in 2); Likely (Chance is greater than 1 in 2); Don't know; Refuse to answer.).

Self-assessed financial competence was high, (particularly for males) with more than 80% of respondents reporting at least an average understanding of finance. Views on the likelihood of another stock market crash in the near future were diffuse, and around 20% of respondents could not assign a probability to the prospect. The distribution of self-reported retirement savings account balances closely matched Australian Bureau of Statistics survey data (ABS 2008), showing fairly modest accumulations, with 70% at $80,000 or less. Table 1 reports responses to key introductory survey questions.

Most respondents answered numeracy questions correctly, although 17% scored at least one incorrect response (Table 2). Results for the financial literacy questions were more variable, with only 36.5% of respondents correctly answering all basic financial literacy questions. Similarly, subjects had trouble with the sophisticated financial literacy questions, although disaggregated data not reported here showed higher scores for older respondents with large superannuation accounts. Only 35.5% of respondents correctly answered all sophisticated financial literacy questions.

To simplify econometric modelling of account choices, we constructed numeracy and financial literacy indices, along the lines of Lusardi and Mitchell (2009) and van Rooij et al. (2009). We began by assigning a value of one to correct answers and zero to incorrect (which included 'incorrect', 'do not know' and 'refuse to answer') and then conducted an exploratory principle components analysis of the correlation matrix of the 14 recoded responses. Next we retained the (three) factors with eigenvalues larger than one and applied a varimax rotation to obtain factor loadings that closely aligned with the original classification of the questions as numeracy, basic and sophisticated financial literacy. With the exception of question nine, the factor analysis preserved the original groupings. We then split the 14 instruments, into six numeracy questions, four basic literacy questions and four sophisticated literacy and conducted another principal component analysis. The result was three indices which could be used to describe the numeracy and financial literacy of each respondent in the modelling discussed below.

1.3 Allocation task

The discrete choice task reflects the fact that retirement portfolio decisions involve a substantial fraction of lifetime wealth, where risk preferences shape choices. We asked subjects to choose an investment option for their entire current mandatory retirement accumulation and all future contributions under a (hypothetical) simplification of retirement savings arrangements by the Government. Such regulatory simplifications have been enacted in the recent past and made a plausible context for the survey (Super System Review 2010).

The instructions for the experiment are reproduced in Appendix 1 and present a simplified retirement savings scheme in which the only investment options are a 100% bank account ('bank') with a guaranteed real rate of return, 50% bank account and 50% growth assets ('50:50') and 100% growth assets ('growth') comprised of risky financial assets such as 'shares and property'. The experiment instructions did not specify the exact composition of the growth account for two reasons: first, growth options in Australian superannuation investment menus often include a wide range of conventional and alternative asset classes and respondents may be distracted by descriptions of relatively unfamiliar alternative assets such as private equity and infrastructure; secondly, as far as possible, we wanted to deflect attention away from current conditions in a particular financial market and encourage respondents to focus on the information given in the choice sets. Although we anchored the experimental settings of risk and returns in historical data, we did not say they were past rates of return or risk levels to avoid, as far as possible, confounding the experimental information with personal views on the predictability of returns or parameter uncertainty.

We asked respondents to select which option he or she would be most likely to choose, and which option he or she would be least likely to choose, in a series of settings in which average real returns remain the same but levels of risk and presentation of risk vary. There are 36 settings in total in the experiment, of which each respondent sees 12. Each setting presents the annual returns net of inflation (2% for the bank account, 3.25% for the 50:50 account, and 4.5% for the growth account) together with a presentation of risk for the 50:50 and

9

growth accounts. (Figure 1 shows an example choice set.) The 12 settings are the product of four risk levels (common to all respondents) and three of the nine risk presentations, which we now describe.

1.4 Risk presentations

Presentations: We utilized modified versions of standard risk formats, drawn from retail financial documents in Australia and the United States, as well as from related studies (Vlaev et al. 2009). Table 3 sets out the nine formats. Presentations 1, 2, and 9 give returns ranges expressed as annual percentages with the probability of falling outside or within the range expressed as a frequency ('1 in 10', '9 in 10') via text (P1 and P2) and as a graph (P9). Graphical presentation of returns ranges were proposed as a preferred risk disclosure format in the recent public review of the Australian retirement system (Super System Review 2010, Chapter 4, p. 118) and ranges of returns for investment asset classes appear in typical retirement fund prospectuses, such as AustralianSuper, one of the largest general membership retirement funds in Australia.[9] Similarly, The Vanguard Group (US) use a risk description in mutual fund disclosures where the minimum and maximum quarterly returns over a ten year period are reported via text, the implicit frequency of these events being around 1 in 20.[10] Following Vlaev et al. (2009), to test sensitivity to range information, we break it down into right and left tail quantiles in presentations 4 and 5. The left tail quantile corresponds to Value at Risk measures more commonly used in institutional risk management and banking regulation (Jorion 2007) and but which appears in some pension fund documentation.[11]

Presentations 5 and 6 convey risk as the average number of years in 20 that

---

[9]AustralianSuper: Investment Choice Guide, presents 'range of returns' for asset classes (average returns 1990-2010), page 6, http://www.australiansuper.com/tools-and-resources/~/media/BC63AA71E8D44C27B431658E3C937750.ashx

[10]For example, see https://personal.vanguard.com/us/LiteratureRequest? FW_Activity=ViewOnlineActivity&litID=2210057045&FW_Event=start&view_mode =web&usage_cat2=&viewLitID=2210057045&formName= Balanced+Index+Fund+Summary+Prospectus&vendorID=SP02&cbdForceDomain=true

[11]For example, see the Annual Report of the Ontario Teachers' Pension Plan: http://docs.otpp.com/AnnRepFinancials2009.pdf at page 89.

returns will be positive or negative. The negative frame of this presentation was recommended as good practice for investment risk descriptions by the Australian prudential regulator and is a risk format often chosen by large superannuation providers.[12] The positive frame of this format has also been used by retirement funds.[13] We also introduce presentations 7 and 8, which benchmark against the bank account, the risk-free rate.

Framing effects occur where changing the statement of an objectively equivalent scenario tilts preferences in different directions (Tversky and Kahneman 1981). Numerous studies have demonstrated the sensitivity of preferences to lottery outcomes framed as gains or losses but investigation of framing effects have widened to include many additional modes of presentation and different contexts, including retirement savings choices returns.[14] The presentations utilized here are not always objectively equivalent scenarios: presentations 1 through 4 and presentation 9 convey risk through the cumulative distribution function of annual returns whereas presentations 5 through 8 convey risk through the frequency of returns exceeding or falling below simple reference points or benchmarks. Presentations 3 and 4 inform respondents about either the left or right tail of the returns distribution, whereas presentations 1, 2 and 9 give information about both tails. We include these information differences in the experiment because financial service providers and regulators do not confine themselves to presentations that are strict reframings of equivalent content when comparing disclosure formats.

Some subsets of the nine presentations do convey equivalent information

---

[12]AustralianSuper: Investment Choice Guide, presents 'expected frequency of negative annual return... approximately x years in every 20', page 13, http://www.australiansuper.com/tools-and-resources/~/media/
BC63AA71E8D44C27B431658E3C937750.ashx

[13]AGESTSuper presented investment risk in the format 'positive returns expected in x years out of 25 years'. This can be found in the AGESTSuper PDS of January 2010 (pp34-37): http://www.agest.com.au/storage/documents/ AGEST_Product_Disclosure_Statement.pdf. However, since August 2010 they have used 'negative returns expected in x out of 20 years' - see PDS August 2010 version (pp34-37)
http://www.agest.com.au/storage/documents/ AGEST_Product_Disclosure_Statement.pdf.pdf

[14]Levin et al. (1998) gives a survey and typology of framing studies. See Maule and Villejoubert (2007) for a more recent review.

and allow conventional framing tests. Presentation 1 emphasizes the likelihood of returns *within* the range, presentation 2 emphasizes the complementary likelihood of returns *outside* the range, and presentation 9 shows the range in a graph. These three create a test of sensitivity to wording that emphasize the center or the tails of the returns distribution (P1 versus P2) and also of changing from text to graphs (P1 and P2 versus P9). Similarly, presentations 5 and 6 (7 and 8) convey equivalent information on gains or losses around a benchmark.

We arranged the nine investment risk presentations into four groups (denoted 'presentation groups'), each made up of three risk presentations with the visual range graph (P9) common to each group. For one group of respondents, A, the presentations are 1, 2 and 9; for group B, 3, 4 and 9; C, 5, 6 and 9; and for group D, 7, 8 and 9.

Investment risk levels: The standard deviation of returns to the growth asset enters the choice sets at four levels ranging from 12% to 28% p.a. Every subject made choices across all four risk levels in each of three of the nine presentations. Table 4 reports the simulated values that entered the risk presentations.[15] Bateman et al. (2010) gives a description of the theoretical model and underlying returns densities used to calibrate the choice sets.

The experimental design provided nearly 14400 rankings of the three accounts: around 1200 per format for P1-P8, and nearly 4800 for P9. In the econometric analysis below, we concentrate on explaining 'most preferred' choices using investment risk, risk presentation, financial competence and demographics. This allows us to estimate presentation effects on stated preferences for retirement investments in a general framework.[16]

---

[15]By holding the expected return constant and allowing the risk of the 50:50 and growth accounts to vary, we created mean-preserving spreads of the returns distributions.

[16]Even though respondents ranked all three retirement accounts in each choice set, a full multinomial logit analysis of all six possible rankings with the complex model outlined in the next section is unlikely to result in reliable estimation. For an analysis of the complete preference rankings, see Bateman et al. (2010).

2   Model

We assume individuals maximize a general linear random utility function in choosing their most preferred retirement savings (superannuation) accounts. We estimate a conditional mixed logit, as described in Revelt and Train (1998), where the mixing is due to random individual error components (random intercepts) rather than random coefficients on attributes. The alternative-specific intercept varies with investment risk presentation, and observed and unobserved respondent characteristics. Predicted choices also depend on taste for investment risk adjusted by interactions between the variable risk level and each respondent's financial competence factor scores.

We write the nth individual's random utility (U_{nktj}) from investment option (alternative) j ($j = 1, .., 3$), for risk presentation k ($k = 1, ..., 9$), at risk level t ($t = 1, ..., 4$) as

$$U_{njkt} = \alpha'_j z_n + \gamma'_{jk} l_n + \beta'_j x_{jt} + \eta_{njkt} \qquad (1)$$

where α_j is a (1×13) vector of alternative-specific coefficients on a constant and observed respondent characteristics including age and age squared, reported retirement savings (superannuation) accumulation, six indicator variables for equity market expectations, numeracy and financial literacy factor scores (z_n); γ_{jk} is a (1×4) vector of presentation and alternative-specific coefficients on a constant and the interactions between the presentation risk indicator and three numeracy and financial literacy scores of individual n (l_n); β_j is a (1×4) vector of alternative-specific coefficients on the risk level of investment alternative j and interactions between the risk of alternative j and three numeracy and financial literacy scores for individual n, (x_{njt}); and η_{njkt} is a random error comprised of two components such that $\eta_{njkt} = \mu_{nj} + \varepsilon_{njkt}$. The first error component is assumed normally distributed and captures unobserved heterogeneity among individual respondents that may create serial correlation in the errors. These alternative-specific random effects $\boldsymbol{\mu}_n = (\mu_{n1}, \mu_{n2})'$ are multivariate normally distributed $\boldsymbol{\mu}_n \tilde{} N(0, \boldsymbol{\Omega})$, with $\boldsymbol{\Omega} = diag(\omega_1^2, \omega_2^2)$. (The error component of the third alternative is $\mu_{n3} = -(\mu_{n1} + \mu_{n2})$.) In other words, the random effects, μ_{nj}, are draws from a scaled standard normal distribution,

where the unit standard deviation is scaled by the alternative-specific parameter ω_j. The second error component ε_{njkt} is assumed *iid* extreme value with zero mean and variance $\pi^2/6$ and is independent of μ_{nj}.

Given the assumption regarding the error term ε_{njkt}, the choice probability for alternative j can be expressed as

$$
\begin{aligned}
P_{njkt}(\mu_n) &= \Pr(U_{njkt} > U_{nikt}|\mu_n, \ \forall j \neq i) \\
&= \frac{e^{\alpha_j'z_n+\gamma_{jk}'l_n+\beta_j'x_{jt}+\mu_{nj}}}{\sum_i e^{\alpha_i'z_n+\gamma_{ik}'l_n+\beta_i'x_{it}+\mu_{ni}}},
\end{aligned}
$$

and the unconditional choice probability is given by the integral over all possible values of μ_n

$$
P_{njkt} = \int_\mu \frac{e^{\alpha_j'z_n+\gamma_{jk}'l_n+\beta_j'x_{jt}+\mu_{nj}}}{\sum_i e^{\alpha_i'z_n+\gamma_{ik}'l_n+\beta_i'x_{it}+\mu_{ni}}} f(\mu)\, d\mu.
$$

We augment standard maximum likelihood methods for the conditional logit component with Gauss-Hermite quadrature for the (normal) integral over the random effects. Estimation of the parameters of this probability is implemented in Latent GOLD software (Magidson and Vermunt 2005). We restricted the set of covariates to those found to be relevant after pre-testing more general models.

3   Estimated choice probabilities

Estimated odds ratios from the maximum likelihood estimation of the model in equation (1) and standard errors are reported in Table 5. The ratios show the change in the odds of choosing one account over another when the relevant covariate increases by one. For example, the odds ratio 1.023 in the second cell of column one indicates that when age rises by one, the probability of choosing the 50:50 account over the bank account increases by 2.3%, holding other things equal. For risk, and interactions between risk and financial competence index scores, the table reports the change in odds caused by an 8% p.a. increase in growth asset volatility, which implies at 4% p.a. increase in 50:50 account

volatility.

The odds ratios show that increasing age, retirement wealth, and stock market optimism all have positive and statistically significant effects on the riskiness of account choices. Increasing age leads to a stronger preference for the 50:50 account at the expense of both bank and growth accounts. Retirement account balances affect choice probabilities only at very high levels (towards $1 million or more) where preferences for the growth account increase sharply. A greater amount of choice variation is due to optimistic or pessimistic views on the stock market. Respondents who rated the probability of another large stock market crash in the next five years as 'nearly impossible' or 'very unlikely' have a higher than 50% probability of selecting the growth account compared with about 25% for those who thought the chance of another crash was as likely as not ('a toss-up'). More pessimistic or uncertain respondents (who chose 'don't know') exhibited much more conservatism.

The changes in choice probabilities due to these covariates can be large compared with the impact of changes in investment risk itself. For example, the impact on the odds of selecting the growth over the 50:50 account is much greater when a respondent thinks another stock market crash is 'very unlikely' than if growth account risk falls by 8 percentage points. Results indicate that people mix the risk information offered in the survey, and by implication, in commercial prospectuses, with their own priors and uncertainty.

Improvements in basic and sophisticated financial literacy increase the odds of choosing the growth account over the 50:50 account, whereas improvements in numeracy reduce those odds. Increasing risk levels significantly reduce the odds of choosing the 50:50 and growth accounts over the bank account, indicating that the average respondent is risk averse. Further, coefficients on indicators for risk presentations and their interactions with financial competence scores are significant. A precise interpretation of the marginal effects depends on the levels of all covariates so we turn now to consider these effects on the choice probabilities of the median respondent.

3.1 Investment risk

The benchmark (median) respondent is 35-44 years of age and has a retirement savings account balance of $20-39.9K, considers the prospect of another large stock market crash within the next five years to be as likely as not (a 'toss-up') and has numeracy and basic and sophisticated financial literacy scores above the (zero) mean at 0.466, 0.227 and 0.272, respectively. Along with all other respondents, this individual evaluated the graphical risk presentation (P9). If the underlying risk level of the growth account is set at 20% p.a., a respondent with this median profile chooses the bank account with a 1.9% probability, the 50:50 account with a 76.9% probability and the growth account with a probability of 21.2% (Table 6, last row, third column) showing a preference for the middle choice among three of increasing risk, consistent with Benartzi and Thaler (2002).

Moving along the last row of Table 6, holding risk presentation fixed but allowing the risk level to increase, we see that the probability of choosing the growth account declines by 9 percentage points (standard error of 3%) as volatility rises by 16 percentage points, while the bank account gains 1 percentage point and the 50:50 account, 8 percentage points. This pattern of risk aversion holds for all presentations. The largest change in choice probability due to increasing volatility is estimated for P4, when the chance of left tail returns are reported. In this case, the probability of the median respondent choosing the bank account increases from 48% to 65% for a 16 percentage point increase in risk. Overall, however, the effect of increasing returns volatility on stated preferences is modest.

3.2 Presentation effects

To give some context to presentation and framing effects described here, we can compare account choices using a certainty equivalent wealth measure. Differences in preferences, work history and background wealth make measuring individual welfare losses due to misperception of risk very difficult. As a rough guide to the potential impact of choosing the 'wrong' account, Table 7 shows

certainty equivalent wealth reductions at retirement for a representative plan member with CRRA preferences who chooses the wrong account. Take a worker who earns a constant real wage close to the current median (around $50,000 p.a.) for a 30 year working life and who contributes a fixed $4500 p.a. (9%) to a retirement savings account that is invested in either the growth, 50:50 or bank accounts. (When investing in the growth account, this strategy results in accumulations of around $290,000, in the 50:50 account of close to $230,000 and over $190,000 in the bank account). Assuming that returns are net of fees and taxes and allowing growth account risk to take one of four values from 12% to 28% p.a., we simulate the expected utility of 10,000 retirement wealth values for relative risk aversion levels from 0 to 8 then compare the certainty equivalent wealth levels at retirement.

Welfare comparisons for retirement depend on mortality, future investment and spending patterns, so to simplify here, we assume that members purchases a lifetime annuity with their accumulation.[17] On this basis, the cost of mistakes range from as little as 3% to as much as 74%. At the lowest risk level, a plan member with risk aversion at or below unity would be 30% worse off if they chose the bank account instead of the risky account. The opposite extreme is a very risk averse member who mistakenly chooses the risky account at the highest risk level and is 74% worse off in utility terms. For members with relative risk aversion in the more conventional range of 0.5-3, losses range from 3%-44%. If presentation and framing distort choices, mild to moderate losses for plan members are likely.

Compared with the effect of higher risk, the changes in account choices due to switching risk presentation are dramatic: we see much greater variation down the columns than along the rows of the Table 6. Switching from text to graphs for example, has a large impact. Visual displays of risk are popular in documentation and may help understanding of numerical risks by effective depiction of proportions, by evoking automatic mathematical operations and

---

[17]Mean-tested public pension payments may supplement annuity income when wealth outcomes are low, effectively raising certainty equivalent wealth. The comparisons in Table 7 do not account for public pension payments.

facilitating better comparisons (Lipkus 2007). Here, the range graph (P9) is associated with the least probability of choosing the bank account and highest probability of 50:50 and growth account choice probabilities. Under P1, for instance, the growth account choice probability declines by 6 percentage points as risk rises from 12% to 28%, but keeping risk constant and reframing from text to graph (switching from P1 to P9) causes an increase in growth account probability of nearly twice that amount, 11 percentage points.

The largest switch in choice probabilities within the same treatment group is for Group B, when respondents see the upper (P3) and then the lower (P4) tail values at risk. It appears that this group does not infer that a high probability of losses also implies a high probability of gains when evaluating accounts, and exhibit more caution than recklessness. Their flight-to-safety when presented with the lower tail risk is much larger (57% probability of choosing the bank account and 3% of choosing the growth account) than the switch to growth when seeing the upper tail risk (23% probability of choosing the growth account). For investors with relative risk aversion of one or less, if hearing only about lower tail risk leads to a mistaken choice of the bank account rather than the risky account, welfare losses as high as 30% may follow (Table 7).

The least variation in probabilities is for changes in the range presentations (Group A) where choices are largely constant despite P1 emphasizing the center of the returns distribution and P2 emphasizing the tails. The stability of choices under range presentations confirms results of Vlaev et al. (2009).

Benchmark presentations (P5-P8) induce generally more conservative choices and show more variation than range presentations (P1, P2 and P9). Just changing the benchmark from a zero return to the bank account return creates a 30 percentage point variation in the probabilities of choosing the 50:50 account and close to 20 percentage point variation in probabilities of choosing the bank account. These mistakes are also potentially costly: wrongly choosing 50:50 over bank or vice versa can penalize utility of wealth at retirement by between 5% and 35% (Table 7). Within-group variations for group A, and for the first two presentations in groups C and D, are strict framing effects

18

and we consider these next.

3.3 Framing effects

Beginning with Tversky and Kahneman's (1981, 1986) Asian Disease problem, most framing experiments find that people accept more risk under loss frames and less risk under gain frames (Levin et al.1998). However when we give subjects a choice among three accounts of increasing risk, the impact of loss and gain framing on risk aversion is not monotonic. Here we find that loss versus gain framing causes people to choose the 50:50 account more, and both the bank and growth accounts, less. For example, when shown the gain frame P5 (average number years out of 20 when returns will be positive at 20% risk, Table 6), the median respondent chooses the bank account with 28% probability, and when shown the same information reframed as a loss (P6), this probability falls to 12%, consistent with the standard result. However the growth account probability is higher (14%) for the gain frame than for the loss frame (9%) indicating that the gain frame leads to more risk tolerant behavior. Clearly, if the probability of bank and growth both go up, the probability of choosing the 50:50 account must be much lower under the gain frame (58%) than under the loss frame (79%). (All these effects are large relative to the estimated standard errors.) In other words, rather than uniformly inducing risk aversion, information about frequencies of positive returns shifts choices away from the 50:50 account towards both the safe and risky extremes, whereas emphasizing negative returns does the reverse.

Moreover, when respondents are told the average number of years out of 20 when returns will be above (P7) or below (P8) the bank account, we find the same pattern of choices shifting away from the extremes, but now reversed for gains and losses. Here the median respondent chooses the bank account and the growth account with a significantly higher probability, and the 50:50 account with significantly lower probability, when the frame emphasizes losses (P8). So in one reframing (P5 and P6) 'gains' induce extreme account choices and in the other reframing (P7 and P8), 'losses' do.

At this point we need to distinguish between using 'framing' as the label for internal representation of a choice by the decision maker and 'framing' as the way the problem is formulated by the experimenter (Maule and Villejoubert 2007). It seems likely that either our classification of P5 as a 'gain', or P8 as a 'loss', does not fit the internal representations of the survey respondents but we cannot infer which classification might be wrong. What is clear is that reframing losses as gains does not change risk preferences monotonically, as often concluded in past studies, but shows up as a movement towards the middle from the extremes. Further, these reframings may be important: the 50:50 account is optimal at several risk levels for investors with CRRA parameters of 1-3, and shifting to the extremes can result in losses of 4% - 20% of certainty equivalent wealth.

Finally, presentations 1 and 2 are textual re-framings of the range graph and this reframing is associated with a substantial change in choice probabilities. Switching to the graphs from P1 or P2 raises the probability of the median respondent choosing the growth account by around 10 percentage points (standard errors around 2%), whereas switching emphasis from the center of the distribution ('9 in 10 chance of a return between') in P1 to same information emphasizing the tails ('1 in 10 chance of a return outside') has no significant effect.[18]

3.4 Variations in numeracy

Figures 2, 3 and 4 show an array of graphs that capture the effects of risk level and risk presentation on choice probabilities at varying levels of financial competence, and we turn to those results now. Each graph shows the probabilities of choosing the bank, 50:50 and growth accounts as either numeracy (Figure 2), basic (Figure 3) or sophisticated (Figure 4) financial literacy index scores move from the 1st to the 99th percentile. Standard errors for each choice probability computed using the delta method are summarized in the figure notes.

---

[18]By constrast, some psychological studies show that graphical representations of risk reduction induce a greater willingness to pay to avoid risk than numerical information (see, for example, Schirillo and Stone 2005).

Each row of the figures corresponds to one of the nine risk presentations (P1 to P9) and the four panels along each row corresponds to the risk level for the growth account indicated near the head of the figure (12% to 28%).

Numeracy scores depend on correct answers to questions testing general arithmetic skills with no stronger link to retirement savings decisions than to other financial decisions, but changes in numeracy have some surprising effects on account choices. At very low levels of numeracy, the model predicts high probabilities of choosing the growth or bank accounts that decline in favor of the 50:50 account as numeracy improves. For example, the bottom right panel shows the least numerate have choice probabilities for bank, 50:50 and growth of 7%, 57% and 36%, whereas the most numerate have probabilities of 2%, 81% and 17% (standard errors below 2%). This pattern can be seen for all risk presentations except P3 and P4, suggesting that very innumerate respondents may tend to choose concentrated portfolios in preference to diversification.

Further, changes in choice probabilities due to presentation switches are larger as numeracy declines. For example, moving from P2 to P9 (reframing range information from text to graph) at the highest risk level, changes the choice probabilities for bank, 50:50 and growth by an average of 20 percentage points for the least numerate but by an average of 5 percentage points for the most numerate.

Our results confirm Peters and Levin's (2008) finding that numeracy moderates framing effects, which they attribute to a tendency of innumerate subjects to integrate fewer items of information and to respond more to non-numeric information sources. Additionally, several existing studies show that higher cognitive scores are correlated with lower risk aversion and lower error rates in complex decisions (see, among others, Burks et al. 2009), although Dave et al. (2010) demonstrate that risk aversion measures from innumerate subjects are sensitive to elicitation method. Our results do not connect low numeracy with low risk aversion but point towards a failure to understand diversification, which can be costly to moderately risk averse investors, as we observe in Table 7.

3.5 Variations in basic financial literacy

Unlike innumerate subjects, respondents with poor basic financial literacy prefer the bank and 50:50 accounts over the growth account but as basic financial literacy improves, subjects begin to accept more risk (Figure 3) overall. In terms of the estimated model, the main source of this increasing preference for riskier accounts is shifting intercepts. The positive estimates of alternative-specific constants for basic financial literacy scores, $\alpha_{j,12}$, cause the odds of the risky account choices to rise as the basic scores rise. However, the coefficient on the interaction between basic literacy and risk level, $\beta_{j,3}$, is negative and works to *reduce* the demand for risky accounts as risk and basic literacy rises. In other words, respondents who score well in the key components of basic financial literacy (time value of money, compounding and inflation) are more sensitive to changes in risk than respondents who score poorly.

A close examination along the rows of Figure 3 shows that choice probabilities change more at the right hand side than at the left hand side of each graph. For example, shifting from the first panel to the fourth panel in the bottom row (P9) covers an increase in growth account volatility of 16 percentage points. This large rise in risk causes *no* significant change in choice probabilities by subjects with low basic literacy, whereas for subjects with high basic literacy, the same increase in volatility means a significant *decrease* in choices of growth (from 25% to 15% with standard errors below 2%). In other words, respondents with basic literacy scores two or more standard deviations below the mean become insensitive to rising risk, while at the same time choosing more conservative accounts overall than their more literate peers. Consequently, individuals with poor basic financial literacy are unlikely to switch to higher yielding portfolios even if investment risk declines sharply. Growth and 50:50 account choices are likely to be optimal for moderately risk averse investors at historically average volatilities, and penalties of 4% to 30% could apply for failing to make the risk-return trade off (Table 7).

Presentation effects are reduced by better basic literacy but not removed. For example, moving from P2 to P9 at 28% risk changes the choice probabilities for bank, 50:50 and growth by an average of 17 percentage points for the

lowest basic literacy percentile but by 5 percentage points for the highest percentile. The changes exceed two standard errors at both the lowest and highest percentiles of basic literacy.

3.6 Variations in sophisticated financial literacy

Figure 4 shows the same analysis holding numeracy and basic financial literacy constant at median scores and allowing sophisticated financial literacy to vary. Improvements in sophisticated financial literacy - knowledge of diversification and the risk and return features of financial assets - is associated with a greater probability of choosing growth and 50:50 accounts. However, unlike the previous two measures of financial competence, risk sensitivity and preference for diversification is relatively constant across different sophisticated financial literacy levels.

We continue to observe many large presentation effects even at high levels of sophisticated financial knowledge although some effects are reduced. In particular, reframing from text to graph creates a significant change in choices at the lowest sophisticated literacy quantile, but not for the highest. Moving from P2 to P9 (reframing range information from text to graph) at 28% risk changes the choice probabilities for bank, 50:50 and growth by an average of 12 percentage points for the lowest sophisticated literacy percentile but only by 4 percentage points for the highest percentile. Changes at the highest sophisticated literacy percentile are smaller than two standard errors.

3.7 Profiles of respondents by investment account choice

Finally, we profile the respondent most likely to select the growth or bank accounts. Setting aside the effects of risk presentation, the probability of choosing the growth account is maximized at 94.4% for a respondent of any age but of maximum wealth, who considers the prospect of another stock market crash within the next five years as 'very unlikely', who has relatively

poor numeracy, but high sophisticated and basic financial literacy[19] and who is making choices at the lowest volatility level for the risky asset. This respondent has a 5.5% chance of selecting the 50:50 account and his or her probability of choosing the bank account approaches zero. The respondent most likely to choose the bank account is among the 18-24 years age group, the lowest wealth level, is uncertain about the probability of a future stock market crash, and has relatively high numeracy skills but low basic and sophisticated financial literacy. For this profile, the probability of choosing the bank account is 93.2%, with a 6% probability of choosing the 50:50 account and a 0.9% probability of choosing the growth account.

4 Conclusion

This paper presents evidence that retirement savings portfolio decisions in a discrete choice experiment are sensitive to the format used to describe risk. Sensitivity to format changes is most evident when different information about the returns distribution is conveyed but is still substantial even when equivalent information is re-framed as a visual image or by textual emphasis on losses or gains. If framing or presentation changes, or financial illiteracy, result in mistakes in investment allocation, simulation experiments indicate that welfare losses at retirement can be very large in certainty equivalent terms, so choice of presentation matters. We summarize the main results in the following points:

1. Consistent with expected utility theory, choice probabilities for the risky accounts decrease when investment risk rises: the median subject pays attention to risk information and exhibits risk aversion. But risk responsiveness declines with basic financial literacy, approaching zero for people with very poor scores. Individuals with poor basic financial literacy are

---

[19]We count 87 respondents who score below the median for numeracy but above the median for other financial literacy measures, and 150 respondents who score above median for numeracy and below median for the other financial literacy scores.

unlikely to switch to higher yielding portfolios even if investment risk declines sharply.

2. Choice variation due to risk presentation changes is large compared with underlying investment risk. Switching from a textual range presentation to a graphical range presentation has twice the impact on growth account choices than a 16 percentage points risk reduction. When shown the right and left tail of the returns distribution, most subjects do not infer that a high probability of losses also implies a high probability of gains and they exhibit more caution when shown the lower tail, than recklessness when shown the upper tail. When risk is presented with respect to a benchmark, for example "On average, negative returns occur 7 years in every 20," portfolio choices are more conservative and sensitive to re-framing than when risk is described as the chance of returns falling within a specified range.

3. Reframing benchmark presentations as losses or gains does not change risk preferences monotonically to more risk tolerance or avoidance, as often concluded in past studies, but shows up here as a movement towards the 50:50 account from the safe and risky extremes. Reframing from text to graph encourages riskier account choices, but emphasizing the center or tails of the returns range does not change preferences significantly.

4. Presentation effects are moderated but not completely removed as numeracy, basic and sophisticated financial literacy improves. Moreover innumerate respondents choose concentrated portfolios in preference to diversification. Investment in improved literacy may result in net welfare gains at retirement.

5. Age, retirement accumulation and the probability assigned to the prospect of another stock market crisis in the near future significantly predict account choices. Older ages prefer diversified accounts; very wealthy subjects favor risky accounts and optimistic stock market expectations boost

risky account choice probabilities at least as much as large underlying risk reductions.

We conclude that retirement fund providers and regulators cannot assume that members digest the risk information provided in standard formats independently of template, background knowledge, expectations and skills. Fund members read investment information in a personal context, interpret textual and graphical information differently and integrate provider information with their own pre-existing opinions. For some people, the provided information is difficult to interpret, incomplete, or relatively unimportant, so they are guided by other factors almost entirely. For the majority, the risk information is significant and influential, but large changes in underlying risk do not change choice probabilities as much as changes in the way that risk is communicated.

Our findings indicate that as governments divest themselves of the responsibility to finance and pay public pensions, they need to pay attention to financial product disclosure requirements and the information provision practices of industry. As well, initiatives to improve financial competence are needed to help retirement savers understand the information provided.

APPENDIX 1. Instructions to survey subjects

The Australian Government is concerned about the complexity of superannuation arrangements and is looking for ways of simplifying superannuation investment choices. One possibility is to offer only three investment options for all superannuation accounts. Each investment option has a different expected rate of return (the average rate at which your investment will grow each year), and a different amount of investment risk (year to year UPSIDE and DOWNSIDE variation in the return to your investment).

The options are

Option A: All (100%) of your superannuation account is invested in a guaranteed bank deposit with a fixed rate of interest paid each year.

Option B: Your superannuation account will be divided half and half (50%/50%) between the bank account and growth assets. You can anticipate that savings in this option will grow faster than the bank deposit (Option A), but will grow more slowly and be less risky than only choosing growth assets (Option C).

Option C: All (100%) of your superannuation account is invested in assets like shares and property. On average, you can anticipate that savings in this option will grow at a faster rate than in the bank deposit (Option A) but without a guarantee. There is some risk that your account will grow faster or slower than average if you choose this option.

We are going to show you 12 sets of these options for investing your superannuation. Each set includes 3 investment options like the ones described

27

above. Each investment option has a average rate of return and investment risk. The average rates of return stay the same in each of the twelve sets; only the risk will change. Remember that more risk of high returns also means more risk of low returns.

What we want you to do is simple. There are two questions to ask about each set of options::

1.   If these superannuation options were available for you to invest your money today, which one of the three would you be most likely to choose?

2.   If these superannuation options were available for you to invest your money today, which of the three would you be least likely to choose?

Your choices will inform government and industry about better ways to simplify superannuation arrangements.

APPENDIX 2. Variable definitions for mixed logit choice model

Age – mean centred mid points of response ranges 18-24 years; 25-34 years; 35-44 years; 45-54 years; 55-64 years; 65-74 years; and 75 years and over. Mid point for respondents age 75 and over was set at 79.5.

Retirement savings accumulation – mean centred and divided by 1000 mid points of response ranges to the question 'Which of the following ranges best describes the total amount you currently have in all your superannuation accounts in Australia?'; Ranges where: Under $10,000; $10,000 - $19,999; $20,000 - $39,999; $40,000 - $59,999; $60,000 - $79,999; $80,000 - $99,999; $100,000 - $149,999; $150,000 - $199,999; $200,000 - $299,999; $300,000 - $499,999; $500,000 - $999,999; $1,000,000 - $4,999,999; and $5,000,000 or over. No respondents selected the highest category.

Stockmarket crash 'Nearly impossible' – indicator variable for share market recovery question S1 taking value 1 if response was 'Nearly impossible', 0 otherwise

Stockmarket crash 'Very unlikely' – indicator variable for share market recovery question S1 taking value 1 if response was 'Very unlikely', 0 otherwise

Stockmarket crash 'Unlikely' – indicator variable for share market recovery question S1 taking value 1 if response was 'Unlikely', 0 otherwise

Stockmarket crash 'Toss up' – indicator variable for share market recovery question S1 taking value 1 if response was 'Toss up', 0 otherwise

Stockmarket crash 'Likely' – indicator variable for share market recovery question S1 taking value 1 if response was 'Likely', 0 otherwise

Stockmarket crash 'Don't know/refuse to answer' – indicator variable for share market recovery question S1 taking value 1 if response was 'Don't know' or 'Refuse to answer', 0 otherwise; this category served as base category in the estimation with effects-coding of all equity crash indicator variables.

Numeracy index score – mean centred factor weighted responses to answers on numeracy skills questions; coded 1 for correct and 0 for incorrect/'don't know'/'refuse to answer'.

Basic financial literacy index score – mean centred factor weighted responses to answers on basic financial literacy skills questions; coded 1 for correct and 0 for incorrect/'don't know'/'refuse to answer'.

Sophisticated financial literacy skills index score – mean centred factor weighted responses to answers on sophisticated financial literacy skills questions; coded 1 for correct and 0 for incorrect/'don't know'/'refuse to answer'.

P1 – indicator variable taking value 1 if risk presentation format showed returns between 5 and 95 percentiles.

P2 – indicator variable taking value 1 if risk presentation format showed returns outside 5 and 95 percentiles.

P3 – indicator variable taking value 1 if risk presentation format showed returns above 95 percentile.

P4 – indicator variable taking value 1 if risk presentation format showed returns below 5 percentile.

P5 – indicator variable taking value 1 if risk presentation format showed expected years in 20 with returns above 0.

P6 – indicator variable taking value 1 if risk presentation format showed expected years in 20 with returns below 0.

P7 – indicator variable taking value 1 if risk presentation format showed expected years in 20 with returns above bank.

P8 – indicator variable taking value 1 if risk presentation format showed expected years in 20 with returns below bank.

P9 – indicator variable taking value 1 if risk presentation format showed range graph of 5 and 95 percentiles; this category served as base category in the estimation with effects-coding of all frame indicator variables.

Investment risk – mean-centered risk levels of alternatives.

References

Agarwal, S., & Mazumder, B. (2011). Cognitive abilities and household financial decision making. Paper presented at the 2nd Boulder Conference on Consumer Financial Decision Making, June, 2011, Boulder CO.

Agnew, J.R., & Szykman, L.R. (2005). Asset allocation and information overload: The influence of information display, asset choice and investor experience. *Journal of Behavioral Finance*, 6, 57-90.

Agnew, J.R., Anderson, L.R., Gerlach, J.R., & Szykman, L.R. (2008). Who chooses annuities? An experimental investigation of the role of gender, framing and defaults. *American Economic Review*, 98(2), 418-22.

Anagol, S., & Gamble, K.J. (2010). Presenting investment results asset by asset lowers risk taking. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1640791.

Anderson, L.R., & Mellor, J.M. (2009) Are risk preferences stable? Comparing an exprimental measure with a validated survey-based measure. *Journal of Risk and Uncertainty*, 39, 137-160.

Andrews, P. (2009). Did life and pensions 'disclosure' work as expected?" Occasional Paper Series No. 32, UK Financial Services Authority, London, UK.

Australian Bureau of Statistics (ABS). (2008). Employment arrangements, retirement and superannuation, Australia, ABS 6361.0.

Australian Prudential Regulation Authority (APRA). (2011). Annual Superannuation Bulletin. June 2010 (released 19 January 2011).

Australian Prudential Regulation Authority (APRA).. (2010). Good Practice Guidance - Investment Risk Description. http://www.apra.gov.au/Super/Documents/Ltr-IRD-29-June-2010-FINAL-trustee.pdf .

Banks J., & Oldfield, Z. (2007). Understanding pensions: Cognitive function, numerical ability, and retirement saving. *Fiscal Studies,* 28, 143–170.

Barsky, R.B., Juster, F.T., Kimball, M.S., & Shapiro, M.D. (1997). Preference parameters and behavioral heterogeneity: An experimental approach in the Health and Retirement Study. *Quarterly Journal of Economics,* 112(2), 537-579.

Bateman, H.J., Ebling, C., Geweke, J., Louviere, J.J., Satchell, S.E., & Thorp, S.J. (2010). Economic rationality, risk presentation and retirement portfolio choice. CenSoC Working Paper No. 10-004.

Beshears, J., Choi, J.J., Laibson, D., & Madrian, B.C., (2009). The importance of default options for retirement saving outcomes:Evidence from the United States. in Brown, J.R., Liebman, J., & Wise, D.A., (Eds) *Social Security Policy in a Changing Environment*, (pp.167-195). Chicago: University of Chicago Press.

Benartzi, S., & Thaler R.H. (1999). Risk aversion or myopia? Choices in repeated gambles and retirement investments. *Management Science*, 45(3), 364-81.

Benartzi, S., & Thaler R.H. (2001). Naïve diversification strategies in defined contribution saving plans. *American Economic Review*, 91(1), 79-97.

Benartzi, S., & Thaler R.H. (2002). How much is investor autonomy worth? *Journal of Finance*, 57(4), 1593-1616.

Brown, J.R., Liang, N., & Weisbenner, S.J. (2007). Individual account investment options and portfolio choice: Behavioral lessons from 410(k) plans. *Journal of Public Economics*, 91(10), 1992-2013.

Brown, J.R., Kling, J.R., Mullainathan, S., & Wrobel, M.V. (2008). Why don't people insure late life consumption? A framing explanation of the under-annuitization puzzle. *American Economic Review*, 98(2), 304-309.

Bucher-Koenen, T. (2010). Financial literacy and private old age provision in Germany. University of Mannheim Discussion Paper No. 104.

Burks, S.V., Carpenter, J.P., Goette, L., & Rustichini, A. (2009). Cognitive skills affect economic preferences, strategic behavior, and job attachment. *Proceedings of the National Association of Sciences*, 106(19), 7745-7750.

Dave, C., Eckel, C.C., Johnson, C.A., & Rojas, C. (2010). Eliciting risk preferences: When is simple better? *Journal of Risk and Uncertainty*. 41, 219-243.

Dohmen, T., Falk, A., Huffman, D., Sunde, U., Schupp, J., & Wagner, G.G. (2011). Individual risk attitudes: Measurement, determinants and behavioral consequences. *Journal of the European Economic Association*, 9(3), 522-550.

European Commission. (2009a). UCITS Disclosure Testing Research Report, prepared for the European Commission by IFF Research and YouGov, June 2009.

European Commission. (2009b). Update on Commission work on Packaged Retail Investment Products, December 2009.

Gerardi, K., Goette, L., & Meier, S. (2010). Financial literacy and subprime mortgage delinquency: Evidence from a survey matched to administrative data. Federal Reserve Bank of Atlanta Working Paper Series No 2010-10.

Goldstein, D.G., Johnson, E.J., & Sharpe, W.F. (2008). Choosing outcomes versus choosing products: Consumer-focused retirement investment advice. *Journal of Consumer Research,* 35, 440-456.

Guiso, L., & Jappelli, T. (2008). Financial literacy and portfolio diversification. European University Institute Working Paper, ECO 2008/31.

Haisley, E., Kaufmann, C., & Weber, M. (2010). How much risk can I handle? The role of experience sampling and graphical displays on one's risk appetite. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1616186

Hastings, J., Mitchell, O.S., & Chyn, E. (2010). Fees, framing, and financial literacy in the choice of pension manager. Pension Research Council Working Paper PRC WP2010-09.

Holt, C.A., & Laury, S.K. (2002). Risk aversion and incentive effects. *American Economic Review*, 92(5), 1644-1655.

Huberman, G., & Jiang, W. (2006). Offering versus choice in 401(k) plans: Equity exposure and number of funds. *Journal of Finance*, 56(2), 763-801.

Hung, A., Heinberg, A., & Yoong, J. (2010). Do risk disclosures affect investment choice? RAND Working Paper Series WR- 788.

Jorion, P. (2007). *Value at Risk: The new benchmark for managing financial risk*. 3rd edn. New York:McGraw-Hill.

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica*, 47(2), 263–91.

Levin, I.P., Schneider, S.L., & Gaeth, G.J. (1998). All frames are not created equal: A typology and critical analysis of framing effects. *Organizational Behavior and Human Decision Processes*, 76(2), 149–188.

Lipkus, I.M. (2007). Numeric, verbal, and visual formats of conveying health risks: suggested best practices and future recommendations. *Medical Decision Making,* 27, 696-713.

Louviere, J.J., Hensher, D.A., & Swait, J.D. (2002). *Stated choice methods: Analysis and applications.* Cambridge:Cambridge University Press.

Lusardi, A., & Mitchell, O.S. (2007). Baby boomer retirement security: The roles of planning, financial literacy, and housing wealth. *Journal of Monetary Economics*, 54(1), 205-44.

Lusardi, A., & Mitchell, O.S. (2009). How ordinary consumers make complex economic decisions: Financial literacy and retirement readiness. NBER Working Paper w15350.

Madrian, B.C., & Shea, D. F. (2001). The power of suggestion: Inertia in 401(k) participation and saving behavior. *Quarterly Journal of Economics*, 16(4), 1149-87.

Magidson, J. & Vermunt, J.K. (2005). *Technical guide to Latent Gold Software 4.5.* Statistical Innovations.

Maule, J., & Villejoubert, G. (2007). What lies beneath: Reframing framing effects. *Thinking & Reasoning,* 13 (1), 25-44

Minister for Financial Services. (2010). Explanatory statement, select legislative instrument 2010 (No.135), Corporations Amendment Regulations 2010 (No.5), Canberra. http://www.comlaw.gov.au/Details/F2010L01585/Explanatory%20Statement/Text

Organization for Economic Cooperation and Development (OECD) (2008). Improving financial education and awareness on insurance and private pensions. OECD, Paris.

Peters, E., & Levin, I.P. (2008). Dissecting the risky-choice framing effect: Numeracy as an individual-difference factor in weighting risky and riskless options. *Judgment and Decision Making*, 3(6), 435–448.

Revelt, D., & Train, K. (1998). Mixed logit with repeated choices: Households' choices of appliance efficiency level. *Review of Economics and Statistics*, 80(4), 647-657.

Rubaltelli, E., Rubichi, S., Savadori, L., Tedeschi, M., & Ferretti, R. (2005). Numerical information format and investment decisions: Implications for the disposition effect and status quo bias. *Journal of Behavioral Finance*, 6(1), 19-26.

Saez, E. (2009). Details matter: The impact of presentation and information on the take-up of financial incentives for retirement saving. *American Economic Journal: Economic Policy*, 1(1), 204–228.

Schirillo, J.A., & Stone, E.R. (2005). The greater ability of graphical versus numerical displays to increase risk avoidance involves a common mechanism. *Risk Analysis*, 25(3), 555-566.

Super System Review. (2010). Super System Review Final Report, Part 1, Overview and Recommendations, Commonwealth of Australia. http://www.supersystemreview.gov.au/content/downloads/final_report/part_one/Final_Report_

Tversky, A. & Kahneman, D. (1981). The framing of decisions and the psychology of choice. *Science*, 211(4481), 453-458.

Tversky, A. & Kahneman, D. (1986). Rational choice and the framing of decisions. *Journal of Business*, 2(2), 73-85.

van Rooij, M.C.J., Clemens J.M.K., & Prast, H.M. (2007). Risk-return preferences in the pension domain: Are people able to choose? *Journal of Public Economics*, 91(3-4), 701-722.

van Rooij, M.C.J., Lusardi, A., & Alessie, R. (2009). Financial literacy and retirement planning in the Netherlands. DNB Working Paper No. 231, November, De Nederlandsche Bank.

Vlaev, I., Chater, N. & Stewart, N. (2009). Dimensionality of risk perception: Factors affecting consumer understanding and evaluation of financial risk. *Journal of Behavioral Finance*, 10(3), 158-181.

Weber, E.U., Siebenmorgen, N., & Weber, M. (2005). Communicating asset risk: How name recognition and the format of historic volatility information affect risk perception and investment decisions. *Risk Analysis*, 25(3), 597-609.

Yoong, J. (2010). Financial illiteracy and stock market participation: Evidence from the RAND American Life Panel. Pension Research Council Working Paper, PRC WP2010-29.

TABLE 1- DEMOGRAPHICS [a]

	Survey (%)	Pop'n (%)		Survey (%)	Pop'n (%)
Gender			*Highest non-school qualification*		
Male	49.9	50.1	Postgraduate or equivalent	13.6	6.7
Female	50.1	49.9	Graduate Diploma or Certificate	8.4	3.6
Age (as % of 18-65 years pop'n)			Bachelor Degree or equivalent	30.8	29.3
18-34 years	35.8	37.4	Vocational Diploma or equivalent	20.7	18.0
35-54 years	43.2	43.6	Vocational Certificate or equivalent	26.6	42.4
55-65 years	21.1	18.9	*Annual total household gross income*		
Marital status			Less than $18,200 pa	3.3	4.7
Not partnered	42.9	46.7	$18,200-$72,799 pa	34.3	39.5
Married / de facto	57.1	53.3	$72,800-$129,999 pa	31.6	28.4
Work status			$130,000 pa or more	16.9	14.9
Employed full-time	51.7	40.8	Prefer not to answer	13.9	12.4
Employed part-time	23.5	18.8	*Self-assessed understanding of finance?*		
Unemployed	3.4	3.5	1 (very low)	3.7	n.a.
Not in the labour force	21.3	36.9	2	5.9	n.a.
High School completion			3	10.1	n.a.
Year 12 or equivalent	70.5	46.9	4 (about average)	39.1	n.a.
Year 11 or equivalent	9.1	11.1	5	23.2	n.a.
Year 10 or equivalent	17.1	25.4	6	13.7	n.a.
Year 9 or equivalent	2.1	7.7	7 (very high)	4.3	n.a.
Year 8 or below	1.1	8.0	*Expectation of stock market crash (5 yrs)*		
Did not go to school	0.1	1.0	Nearly impossible (1 in 100 or less)	2.3	n.a.
Knows retirement fund name			Very unlikely (Between 1 in 100 & 1 in 10)	13.0	n.a.
Yes	80.2	n.a.	Unlikely (Between 1 in 10 & 1 in 2)	24.1	n.a.
Amount in superannuation account(s)			Toss-up (About 1 in 2)	24.2	n.a.
Under $20,000	35.9	n.a.	Likely (Chance is greater than 1 in 2)	16.3	n.a.
$20,000 - $79,999	35.0	n.a.	Don't know/ Refuse to answer	19.2	n.a.
$80,000 - $499,999	26.6	n.a.			
$500,000 or over	2.5	n.a.			

Notes: Table shows responses to survey questions compared with Australian census population data where possible. The survey sample of 1220 is taken from the PureProfile web panel of 600,000 Australians and filtered to ensure that respondents were over 18 and current holders of a superannuation account. The entire survey is available at http://survey.confirmit.com/wix/p1250911674.aspx. [a] Source for population statistics: Australian Bureau of Statistics Census of Population and Housing & Household Wealth and Wealth Distribution, Australia, 2005-2006.

TABLE 2: NUMERACY AND FINANCIAL LITERACY RESPONSES

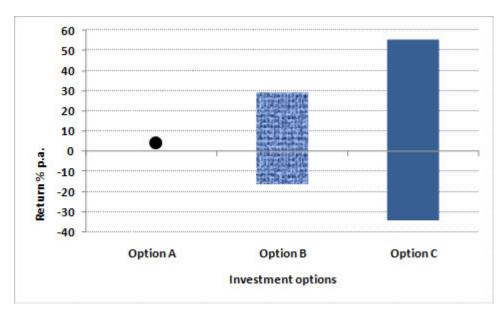|	Correct (%)
Q1: In a sale, a shop is selling all items at half price. Before the sale, a sofa costs $300. How much will it cost in the sale?	96.1
Q2: If the chance of getting a disease is 10 per cent, how many people out of 1,000 would be expected to get the disease?	95.8
Q3: A second hand car dealer is selling a car for $6,000. This is two-thirds of what it cost new. How much did the car cost new?	91.6
Q4: If 5 independent, unrelated people all have the winning numbers in the lottery and the prize is $2 million, how much will each of them get?	92.9
Q5: If there is a 1 in 10 chance of getting a disease, how many people out of 1,000 would be expected to get the disease?	91.1
Q9: Money Illusion. Suppose that in the year 2020, your income has doubled and prices of all goods have doubled too. In 2020, how much will you be able to buy with your income?	86.8
Q6: Numeracy. Suppose you had $100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow?	88.4
Q7: Inflation. Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account?	78.4
Q8: Time value of money. Assume a friend inherits $10,000 today and his sibling inherits $10,000 three years from now. In three years, who is richer because of the inheritance?	55.2
Q10: Compound interest. Suppose you had $100 in a savings account and the interest rate is 20% per year and you never withdraw money or interest payments. After 5 years, how much would you have on this account in total?	72.0
Q11: Risky assets. Is the following statement true or false? Shares are normally riskier than bonds.	64.3
Q12: Long period returns. Considering a long time period (for example 10 or 20 years), which asset normally gives the highest return?	55.2
Q13: Volatility. Normally, which asset displays the highest fluctuations over time?	76.9
Q14: Risk diversification. When an investor spreads his money among different assets, does the risk of losing money?	73.4

Note: Table shows proportion of correct responses in aggregate to numeracy and basic and sophisticated financial literacy questions. a. 'Incorrect' includes 'don't know' and 'refuse to answer'. See notes to Table 1 for survey sample characteristics. Note that the factor analysis reassigns Q9 on money illusion to numeracy rather than basic financial literacy skills.

TABLE 3 - ALTERNATIVE PRESENTATIONS FOR INVESTMENT RISK

P1 : There is a 9 in 10 chance of a return between x% and y%.

P2 : There is a 1 in 10 chance of a return outside x% and y%.

P3 : There is a 1 in 20 chance of a return above y%.

P4 : There is a 1 in 20 chance of a return below x%.

P5 : On average, positive returns occur (20-x) years in every 20.

P6 : On average, negative returns occur x years in every 20.

P7 : On average, returns above the bank account occur (20-x) years in every 20.

P8 : On average, returns below the bank account occur x years in every 20.

P9 : Three options are shown in the chart below.

- Option A: 100% bank account, the rate of return is always exactly x% (black dot)
- Option B: 50% bank account & 50% growth asset, there is a 9 in 10 chance of a rate of return within the light blue box
- Option C: 100% growth asset, there is a 9 in 10 chance of a rate of return within the dark blue box

Notes: Table shows nine alternative formats for investment risk information as inserted into retirement savings choice sets (see Figure 1). Each respondent answered 12 choice sets (3 out of the 9 presentations x 4 risk levels). The nine investment risk presentations were arranged into four presentation groups then randomly assigned to one quarter of the sample of respondents: group A, 1, 2 and 9; group B, 3, 4 and 9; group C, 5, 6 and 9; and group D, 7, 8 and 9. Values of x and y depend on quantities derived from four log normal growth account returns densities with mean equal to 1.045 and standard deviation taking four values from the 0.12 to 0.28. Table 3 reports all x and y values that entered the risk presentations.

TABLE 4 - INVESTMENT RISK LEVELS AND PRESENTATION PARAMETERS

	Net rates of return %, p.a.			Volatility %, p.a.	
Level	Bank	50:50	Growth	50:50	Growth
1	2.0	3.25	4.5	6	12
2	2.0	3.25	4.5	8	16
3	2.0	3.25	4.5	10	20
4	2.0	3.25	4.5	14	28
Presentation	**1-4: (x,y)**			**5-6: x**	**7-8: x**
Portfolio	50:50		growth	50:50	growth	50:50 & growth
Risk level 1	(-6,14)		(-14,25.5)	6	7	9
Risk level 2	(-9,17.5)		(-19.5,32.5)	7	8	9.5
Risk level 3	(-11.5,21)		(-25,40)	8	9	10
Risk level 4	(-16.5,29)		(-34.5,55.5)	9	10	11.5

Notes: Top panel shows net rates of return entered into retirement account choice sets (see Figure 1 for example choice set), and four volatility levels of the distributions of mixed and growth account returns. Lower panel shows numerical values entered into choice sets for presentations 1-8 at four risk levels (Table 2).

TABLE 5: ODDS RATIOS FOR MIXED LOGIT CHOICE MODEL

1199 respondents; 14388 account choices		Retirement savings account			Covariate		Retirement savings account		
Covariate		50:50/bank	Grth/bank	Grth/50:50			50:50/bank	Grth/bank	Grth/50:50
constant	$\alpha_{i,1}$	5.599 (0.157)	1.748 (0.087)	0.312 (0.058)	P1 * basic	$\gamma_{i1,3}$	1.067 (0.102)	0.849 (0.068)	0.795 (0.132)
Age	$\alpha_{i,2}$	1.023 (0.003)	1.017 (0.004)	0.994 (0.005)	P2 * basic	$\gamma_{i2,3}$	1.046 (0.108)	1.007 (0.077)	0.962 (0.156)
Age^2	$\alpha_{i,3}$	1.000 (0.000)	1.000 (0.000)	1.000 (0.000)	P3 * basic	$\gamma_{i3,3}$	1.183 (0.090)	1.021 (0.076)	0.863 (0.117)
Retirement savings accumulation	$\alpha_{i,4}$	1.004 (0.000)	1.004 (0.000)	1.000 (0.000)	P4 * basic	$\gamma_{i4,3}$	0.720 (0.086)	0.382 (0.054)	0.531 (0.117)
Equity crash 'Nearly impossible'	$\alpha_{i,5}$	0.689 (0.136)	1.813 (0.168)	2.631 (0.414)	P5 * basic	$\gamma_{i5,3}$	0.649 (0.068)	0.752 (0.068)	1.159 (0.140)
Equity crash 'Very unlikely'	$\alpha_{i,6}$	2.713 (0.187)	3.969 (0.214)	1.463 (0.192)	P6 * basic	$\gamma_{i6,3}$	0.933 (0.084)	0.990 (0.076)	1.061 (0.134)
Equity crash 'Unlikely'	$\alpha_{i,7}$	1.523 (0.107)	1.307 (0.105)	0.858 (0.138)	P7 * basic	$\gamma_{i7,3}$	1.184 (0.111)	2.719 (0.132)	2.297 (0.230)
Equity crash 'Toss up'	$\alpha_{i,8}$	1.861 (0.142)	0.905 (0.085)	0.486 (0.097)	P8 * basic	$\gamma_{i8,3}$	1.231 (0.111)	1.535 (0.101)	1.247 (0.173)
Equity crash 'Likely'	$\alpha_{i,9}$	0.580 (0.066)	0.427 (0.058)	0.737 (0.126)	P9 * basic	$\gamma_{i9,3}$	1.191 (0.049)	0.965 (0.038)	0.810 (0.060)
Equity crash 'Don't know/refuse to answer'	$\alpha_{i,10}$	0.325 (0.049)	0.275 (0.049)	0.845 (0.125)					
Numeracy index score	$\alpha_{i,11}$	1.073 (0.036)	0.785 (0.030)	0.731 (0.049)	P1 * sophisticated	$\gamma_{i1,4}$	1.340 (0.114)	1.373 (0.088)	1.024 (0.150)
Basic financial literacy index score	$\alpha_{i,12}$	2.242 (0.072)	2.390 (0.070)	1.066 (0.083)	P2 * sophisticated	$\gamma_{i2,4}$	1.177 (0.113)	1.617 (0.097)	1.374 (0.184)
Sophisticated financial literacy index score	$\alpha_{i,13}$	1.451 (0.062)	2.037 (0.072)	1.404 (0.099)	P3 * sophisticated	$\gamma_{i3,4}$	1.486 (0.101)	1.474 (0.098)	0.992 (0.124)
					P4 * sophisticated	$\gamma_{i4,4}$	0.835 (0.091)	0.527 (0.063)	0.631 (0.127)
P1: returns between 5-95 percentile	$\gamma_{i1,1}$	1.752 (0.116)	1.924 (0.095)	1.098 (0.133)	P5 * sophisticated	$\gamma_{i5,4}$	0.639 (0.066)	0.840 (0.066)	1.314 (0.145)
P2: returns outside 5-95 percentile	$\gamma_{i2,1}$	1.077 (0.094)	1.104 (0.073)	1.025 (0.134)	P6 * sophisticated	$\gamma_{i6,4}$	0.880 (0.082)	1.212 (0.079)	1.376 (0.152)
P3: returns above 95 percentile	$\gamma_{i3,1}$	6.801 (0.226)	9.464 (0.235)	1.392 (0.132)	P7 * sophisticated	$\gamma_{i7,4}$	1.160 (0.108)	0.929 (0.080)	0.801 (0.131)

P4: returns below 5 percentile	$\gamma_{i4,1}$	0.085 (0.029)	0.048 (0.017)	0.561 (0.106)	P8 * sophisticated	$\gamma_{i8,4}$	0.771 (0.087)	0.687 (0.068)	0.890 (0.142)
P5: years in 20 above zero	$\gamma_{j5,1}$	0.281 (0.039)	0.410 (0.047)	1.458 (0.132)	P9 * sophisticated	$\gamma_{j9,4}$	1.015 (0.039)	0.893 (0.040)	0.880 (0.059)
P6: years in 20 below zero	$\gamma_{j6,1}$	0.810 (0.068)	0.592 (0.056)	0.730 (0.094)					
P7: years in 20 above bank	$\gamma_{j7,1}$	2.604 (0.140)	1.609 (0.096)	0.618 (0.098)	Risk[a]	$\beta_{j,1}$	0.753 (0.040)	0.965 (0.038)	0.795 (0.035)
P8: years in 20 below bank	$\gamma_{i8,1}$	0.392 (0.054)	0.349 (0.044)	0.890 (0.120)	Risk[a] * numeracy	$\beta_{i,2}$	0.980 (0.039)	0.599 (0.041)	0.983 (0.042)
P9: range graph 5-95 percentile	$\gamma_{j9,1}$	3.937 (0.080)	7.645 (0.095)	1.942 (0.077)	Risk[a] * basic	$\beta_{j,3}$	0.853 (0.046)	0.982 (0.055)	0.898 (0.044)
					Risk[a] * sophisticated	$\beta_{i,4}$	0.991 (0.048)	0.963 (0.045)	0.991 (0.045)
P1 * numeracy	$\gamma_{j1,2}$	1.113 (0.080)	1.047 (0.068)	0.940 (0.120)					
P2 * numeracy	$\gamma_{i2,2}$	1.071 (0.081)	0.781 (0.060)	0.729 (0.109)					
P3 * numeracy	$\gamma_{i3,2}$	1.385 (0.088)	2.158 (0.088)	1.558 (0.149)					
P4 * numeracy	$\gamma_{j4,2}$	0.779 (0.068)	1.190 (0.071)	1.527 (0.157)					
P5 * numeracy	$\gamma_{i5,2}$	0.779 (0.080)	0.842 (0.076)	1.081 (0.151)					
P6 * numeracy	$\gamma_{j6,2}$	0.713 (0.079)	0.698 (0.069)	0.980 (0.143)					
P7 * numeracy	$\gamma_{i7,2}$	1.296 (0.083)	0.821 (0.055)	0.634 (0.093)	Random effect	ω_i	4.695 (0.049)	8.009 (0.058)	
P8 * numeracy	$\gamma_{i8,2}$	0.915 (0.067)	0.722 (0.052)	0.788 (0.100)	Log likelihood (model)			-9166.6	
P9 * numeracy	$\gamma_{j9,2}$	1.181 (0.041)	1.368 (0.039)	1.158 (0.065)					

Notes: Table shows estimated odds ratios for model of retirement savings account choices. Odds ratios show the change in the odds of selecting the 50:50 or growth accounts over the bank account, or the growth account over the 50:50 account, when the relevant covariate rises by one. For example, a ratio of 1.5 indicates a 50% increase in the probability of choosing the numerator account over the denominator account. [a]For risk and risk interactions, we compute the change in odds associated with an 8% p.a. increase in growth asset volatility (a 4% increase in 50:50 volatility). Approximate standard errors, computed using the delta method, are in brackets.

TABLE 6: PREDICTED ACCOUNT CHOICE PROBABILITIES FOR MEDIAN RESPONDENT

							Risk level (Growth account volatility, % p.a.)					
	12%			**16%**			**20%**			**28%**		
Presentation	**Bank**	**50:50**	**Grth**	**Bank**	**50:50**	**Grth**	**Bank**	**50:50**	**Grth**	**Bank**	**50:50**	**Grth**
Group A												
P1 : There is a *9 in 10* chance of a return between x% and y%.	0.03	0.82	0.15	0.03	0.83	0.14	0.04	0.84	0.12	0.06	0.85	0.09
	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)
P2 : There is a *1 in 10* chance of a return outside x% and y%.	0.05	0.81	0.14	0.06	0.82	0.13	0.07	0.82	0.11	0.09	0.82	0.09
	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)
Group B												
P3 : There is a 1 in 20 chance of a return *above* y%.	0.01	0.76	0.23	0.01	0.78	0.21	0.01	0.80	0.19	0.01	0.84	0.15
	(0.00)	(0.03)	(0.03)	(0.00)	(0.02)	(0.03)	(0.00)	(0.02)	(0.02)	(0.00)	(0.02)	(0.02)
P4 : There is a 1 in 20 chance of a return *below* x%.	0.48	0.47	0.05	0.53	0.43	0.04	0.57	0.40	0.03	0.65	0.33	0.02
	(0.05)	(0.04)	(0.01)	(0.05)	(0.04)	(0.01)	(0.05)	(0.04)	0.00	(0.05)	(0.04)	(0.00)
Group C												
P5 : On average, *positive* returns occur (20-x) years in every 20.	0.21	0.61	0.19	0.24	0.60	0.16	0.28	0.58	0.14	0.36	0.54	0.10
	(0.04)	(0.03)	(0.03)	(0.04)	(0.03)	(0.02)	(0.04)	(0.03)	(0.02)	(0.05)	(0.04)	(0.02)
P6 : On average, *negative* returns occur x years in every 20.	0.08	0.80	0.12	0.10	0.80	0.10	0.12	0.79	0.09	0.16	0.77	0.07
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.03)	(0.02)	(0.01)
Group D												
P7 : On average, returns *above* the bank account occur (20-x) years in every 20.	0.02	0.89	0.09	0.02	0.90	0.08	0.03	0.90	0.07	0.04	0.91	0.06
	(0.00)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
P8 : On average, returns *below* the bank account occur x years in every 20.	0.14	0.75	0.11	0.16	0.74	0.10	0.19	0.73	0.08	0.25	0.69	0.06
	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)	(0.01)	(0.03)	(0.03)	(0.01)	(0.04)	(0.03)	(0.01)
All groups												
P9 : Range chart.	0.01	0.73	0.26	0.01	0.75	0.23	0.02	0.77	0.21	0.02	0.81	0.17
	(0.00)	(0.03)	(0.03)	(0.00)	(0.02)	(0.03)	(0.00)	(0.02)	(0.02)	(0.00)	(0.02)	(0.02)

Notes: Table shows estimated choice probabilities for retirement savings account choices for median respondent by risk level and risk presentation. The median respondent is 35-44 years of age and has a retirement savings account balance of $20-39.9K, considers the prospect of another large stock market crash within the next five years to be as likely as not (a 'toss-up') and has numeracy and basic and sophisticated financial literacy scores of 0.466, 0.227 and 0.272, respectively. Approximate standard errors, computed using the delta method, are in brackets.

TABLE 7 – VARIATIONS IN CERTAINTY EQUIVALENT RETIREMENT WEALTH

(percent reduction in optimal wealth)

	CRRA parameter				
	0	0.5	1	3	8
Risk level 1 (12% p.a.)					
Growth	0%	0%	0%	0%	-19%
50:50	-19%	-17%	-14%	-3%	0%
Bank	-35%	-32%	-29%	-16%	-5%
Risk level 2 (16% p.a.)					
Growth	0%	0%	0%	-9%	-38%
50:50	-19%	-15%	-10%	0%	-5%
Bank	-35%	-29%	-24%	-10%	0%
Risk level 3 (20% p.a.)					
Growth	0%	0%	0%	-20%	-55%
50:50	-19%	-12%	-4%	0%	-16%
Bank	-35%	-26%	-18%	-4%	0%
Risk level 4 (28% p.a.)					
Growth	0%	0%	-9%	-44%	-74%
50:50	-20%	-5%	0%	-8%	-35%
Bank	-35%	-18%	-10%	0%	0%

Notes: Table reports percentage reduction in certainty equivalent wealth at retirement due to suboptimal allocation of retirement savings to growth, 50:50 or bank account for CRRA investor. Optimal choices are indicated by 0%. Certainty equivalent wealth is computed as the inverse of expected utility of 10000 simulated values of retirement wealth for a worker contributing $4500 p.a. into an account over a 30 year working life. Agents annuitize wealth at retirement. Growth account returns are computed as 30 draws from a lognormal distribution with mean 1.045 and standard deviation of 0.12, 0.16, 0.20 or 0.28. Bank account returns accumulate at a constant gross return of 1.02 p.a.; 50:50 account returns are the sum of half the growth account return and half of the bank account return.
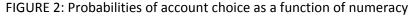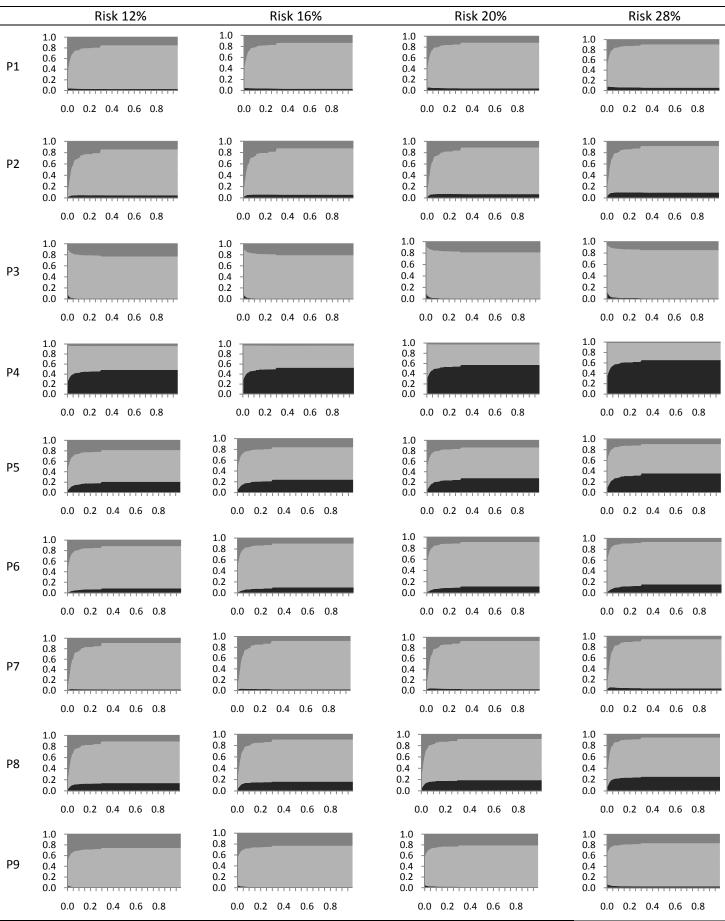
FIGURE 1: EXAMPLE INVESTMENT CHOICE TASK

Features of Options	Option A	Option B	Option C
Option type	100% Bank account	50% Bank account & 50% Growth assets	100% Growth assets
Average annual rate of return (above inflation)	2%	3.25%	4.5%
Level of investment risk	No risk	There is a 1 in 20 chance of a rate of return <u>above</u> 14%	There is a 1 in 20 chance of a rate of return <u>above</u> 25.5%

If these superannuation options above were available for you to invest your money today

1. Which one of the three would you be **most likely** to choose?

☐   Option A

☐   Option B

☐   Option C

2. Which one of the three would you be **least likely** to choose?

☐   Option A
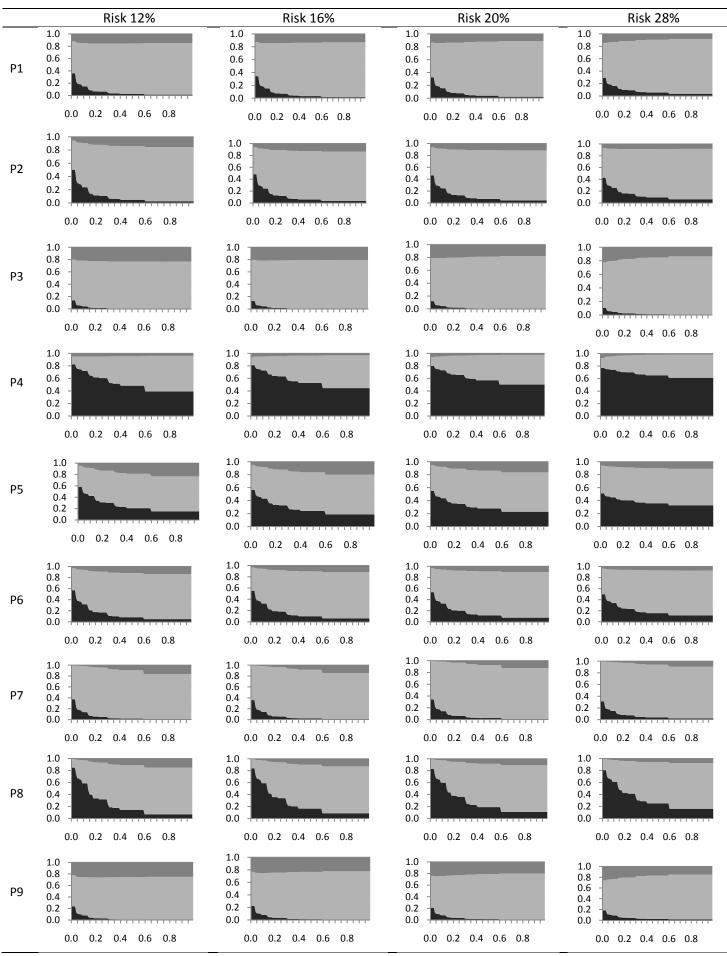
☐   Option B

☐   Option C

Note: Figure shows example investment choice task using presentation 3 at risk level 1. There are 36 such settings in total, of which each of 1199 respondents sees 12. Each of 1199 survey respondents answered 12 such tasks where rates of returns stayed constant and risk level (x4) and risk presentation (x3) varied.

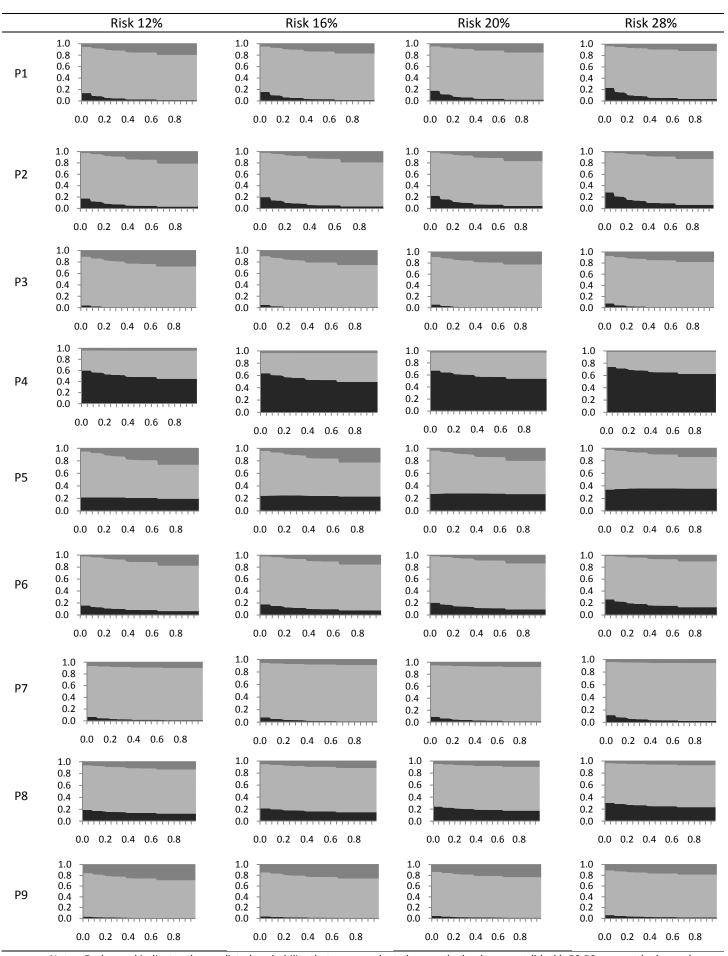FIGURE 2: Probabilities of account choice as a function of numeracy

Notes: Each panel indicates the predicted probability that a respondent chooses the bank account (black), 50:50 account (pale grey) and the growth account (dark grey) as a function of the quantile of the respondent's numeracy score (horizontal axis). The panels in each row correspond to a given risk presentation, indicated at the left end of the row and defined in Table 3. In each row, each of the four panels corresponds to the risk level indicated near the head of the table. All other respondent characteristics are set to median values. 90% of the standard errors fell between .0032 and .0502.

FIGURE 3: Probabilities of account choice as a function of basic financial literary

Notes: Each panel indicates the predicted probability that a respondent chooses the bank account (black), 50:50 account (pale grey) and the growth account (dark grey) as a function of the quantile of the respondent's basic financial literacy score (horizontal axis). The panels in each row correspond to a given risk presentation, indicated at the left end of the row and defined in Table 3. In each row, each of the four panels corresponds to the risk level indicated near the head of the table. All other respondent characteristics are set to median values. 90% of the standard errors fell between .0028 and .0570.

FIGURE 4: Probabilities of account choice as a function of sophisticated financial literacy

Notes: Each panel indicates the predicted probability that a respondent chooses the bank account (black), 50:50 account (pale grey) and the growth account (dark grey) as a function of the quantile of the respondent's sophisticated financial literacy score (horizontal axis). The panels in each row correspond to a given risk presentation, indicated at the left end of the row and defined in Table 3. In each row, each of the four panels corresponds to the risk level indicated near the head of the table. All other respondent characteristics are set to median values. 90% of the standard errors fell between .0034 and .0509.