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## **Financial Literacy among Elderly Australians**

### **Abstract**

Financial illiteracy is widespread amongst the elderly. Financially illiterate people are more likely to experience asset loss and outlive their savings after retirement. This paper measures financial literacy of elderly Australians using Item Responses Theory. Using a Lasso regression, we find that younger, married males with higher income and greater net wealth are more likely to be financially literate. Better financial literacy is also associated with good health, higher educational attainment, better occupation and outright home ownership. Our findings suggest policy makers take action and we make informed and practicable policy recommendations.

## 1. Introduction

In recent decades, with the liberalisation and deregulation of financial markets, there has been a wide array of financial products and services available to consumers. People are faced with both challenges and opportunities. However, the continuous progress of financial liberalisation has become a challenge to society, requiring people to be well-equipped with financial knowledge and financial skills (Lusardi and Mitchell, 2011b).

Within a current Defined Contribution (DC) pension plan, employees are taking more responsibility for their pension accounts (Loretto et al., 2000). Since they have to make financial decisions on their own in a more diversified financial market, they are exposed to more financial risks (Lusardi and Mitchell, 2011a).

Lusardi and Mitchell (2011b) noted that low financial literacy is widespread among developed and developing countries. Even worse, people tend to be overconfident of their financial knowledge and skills (van Rooij et al., 2011b). A low level of financial literacy is more likely to lead to low savings rates (Moore and Mitchell, 1997) and less retirement wealth accumulation (Bernheim et al., 2001). Such people are therefore more likely to experience asset loss (Lusardi and Mitchell, 2007a) and have problems with debt (van Rooij et al., 2011b).

In contrast, those with greater level of financial literacy tend to make efficient and effective financial decisions (Lusardi and Mitchell, 2007b), and thus make better financial plans for their retirement life (Orth, 2006; Lusardi and Mitchell, 2011a).

In Australia, households have also been exposed to more risks in the financial environment because of the increasingly easier access to financial products and services. The ANZ Bank's Survey of Adult Financial Literacy in Australia has reported the widespread presence of financial illiteracy among Australians (Roy Morgan Research, 2003). In another survey, Roy Morgan Research (2003) found that young Australian adults of low socio-economic background are much less likely to make well-informed financial decisions.

This paper analysed data from a 2010 survey, which aimed to understand financial issues within the elderly group in Australia, and focused specifically on people on the verge of retirement and retirees. Three questions in the survey were designed to test the respondents' financial literacy. We will construct a financial literacy index (FLI) based on these literacy

questions.

Although several existing studies have measured financial literacy, the measurement of it amongst the older Australian population has received little attention. The Item Response Theory (IRT) model has been utilised in the current study to construct a financial literacy index (FLI). Compared to commonly used factor analysis (FA), the IRT model makes use of more information when obtaining the unobserved trait index (Gibbons and Hedeker, 1992; Thompson, 2004).

Another contribution of this paper is a consideration of a wider range of socio-demographic factors compared with prior research, such as residence owning type (outright, mortgaged or rented) and self-assessed health. We expect this to bring about new insights of financial literacy across different socio-demographic features and provide an empirical basis for policy makers to make informed financial policies.

The structure of the remainder of the document is as follows. In section 2, prior literature related to financial literacy will be reviewed. In section 3, data analysed in this paper will be introduced, alongside a description of socio-demographic variables. Section 4 describes the IRT models. In section 5, the IRT model will be utilised to construct the FLI. The regression tree and the Lasso regression model will be used to determine important socio-demographic factors to financial literacy. Financial literacy levels across different socio-demographic factors will be examined by a regression model. Section 6 concludes the paper and proposes future works.

## **2. Review of prior literature**

Bernheim (1995) was among the early researchers to reveal a lack of financial literacy among most households in the United States. The findings were later confirmed by a comparative study of financial literacy between people from the United States and Japan (Cutler, 1997). Cutler concluded that the public fails to make well-informed decisions about financial affairs in both countries.

Whether people are really financial literate or not has become a prominent research and social topic. The academic literature has investigated and analysed the circumstances and theories of personal financial literacy in developed countries, such as the United States, Germany, the

Netherlands, Italy, Australia, New Zealand, Japan and Korea (Lusardi and Mitchell, 2008; Beal and Delpachitra, 2003; Lusardi and Mitchell, 2007b; Bucher-Koenen and Lusardi, 2011; Lusardi, 2011), as well as developing countries, such as Chile, India and Mexico (Arenas et al., 2006; Cole et al., 2011; Hastings and Tejada-Ashton, 2008). Financial illiteracy was found to be widespread in these countries. Other scholars have confirmed global financial illiteracy as well (Bernheim, 1995; Bernheim, 1998; Bernheim and Garrett, 2003; Hilgert et al., 2003; Mandell, 2004; OECD, 2005; Agnew and Szykman, 2005; Lusardi and Mitchell, 2007a; Christelis et al., 2010; Bruine de Bruin et al., 2010; Lusardi and Mitchell, 2011b; Lusardi, 2011).

More worryingly, consumers tend to be overconfident about their financial skills. Regardless of their financial performance, people are inclined to rate themselves as financially literate or knowledgeable, overstating their actual knowledge (Hogarth, 2002). A considerable number of households have limited literacy, to the extent that most are not aware of the vulnerability of their finances (van Rooij et al., 2011b).

### *2.1 Definition of financial literacy*

Although an increasing amount of literature focuses on financial literacy, there are no systematic theories and the standard definition and measurement is still disputable and ambiguous (Huston, 2010). Table 1 summarises different definitions of financial literacy according to prior literature.

[Table 1 here]

Financial literacy was defined as “the ability to make efficient decisions with regard to money management” in Noctor et al. (1992), which mainly focused on financial skills. Similar definitions concentrating on the skills and the applications of financial knowledge were found in later literature, such as in Hung et al. (2009), who defined financial literacy as “the ability to apply skills to manage money efficiently for long-term financial well-being”. A number of other studies applied and cited definitions of financial literacy in terms of financial skills, including Schagen and Lines (1996); Cude et al. (2006); Servon and Kaestner (2008).

Other researchers define financial literacy in terms of financial knowledge. For example,

financial literacy has been defined as “understanding key financial terms and concepts needed to function daily in society” (Bowen, 2002), or simply “numeracy and financial knowledge” (Foster et al., 2015). McDaniel et al. (2002) expanded the definition by introducing the knowledge of cash flows, management compensation and internal control related items.

A more reasonable definition consists of both financial knowledge and its application to financial practices. Hogarth (2002) combined the two aspects, denoting financial literacy as “knowledge of basic financial conceptions and the ability to apply financial knowledge to plan and make decisions”. Beal and Delpachitra (2003) considered specifically the working of financial institutions, services and a variety of practical skills directed to financial matters. Huston (2010) simplified the definition as “measuring how well a person can understand and use personal knowledge related to financial issues”.

Accordingly, with the rapid growth and development of financial markets that create a more complicated financial environment for individuals, the appropriate concept of financial literacy covers a wide range of information far beyond financial knowledge and skills.

## *2.2 Effects of financial literacy*

People today are undertaking more responsibility for their day-to-day financial management than before and are therefore exposed to more financial risks (Perry, 2008).

According to Milevsky and Salisbury (2006), today’s retirees are mainly faced with two financial risks, longevity risk and investment returns risk. Since people are living longer than before, it is possible that they will outlive their money when they approach old age. Longevity risk can be more important if they are financially illiterate. Compared to those with low financial literacy, highly-literate people are more likely to make a well-informed retirement plan to manage this risk (Orth, 2006), since they tend to know their financial resources well (Lusardi and Mitchell, 2011b).

Investment returns risk mainly results from the unstable fluctuation of financial markets (Burtless, 2000), and hence, the investment returns are unpredictable and not secured. van Rooij et al. (2011b) found that financially literate retirees are more likely to diversify and minimise their financial risks.

On the positive side, higher levels of public and personal financial literacy are expected to contribute more to economic development, national savings and employment (Jappelli, 2010). At the household level, households with adequate financial knowledge and skills tend to have better understandings of the financial markets and products, make wise judgements and avoid making mistakes or being misled about financial affairs (Lusardi and Mitchell, 2007b; Mandell, 2008). They are more likely to make well-informed saving decisions, keeping savings liquidity and a healthier financial well-being (Garman et al., 1999; Bernheim and Garrett, 2003).

In addition, Calvet et al. (2006) found that literate households are more likely to invest in stock markets efficiently. They are more skilled in selecting mutual funds with lower costs than people with low financial literacy (Lusardi and Mitchell, 2007a; Hastings et al., 2010).

Current diversified kinds of financial instruments and services challenge consumers' financial literacy. On the negative side, those who lack financial literacy tend to make less efficient choices (Joo and Grable, 2000; Kim and Garman, 2004) and are more likely to make financial mistakes (Shen et al., 2016), which ultimately results in unhealthy national economic well-being (Remund, 2010). Also, low financial literacy has been found to be associated with serious social problems, such as physical and mental illness, divorce and so forth (Kinnunen and Pulkkinen, 1998; Yeung and Hofferth, 1998).

With respect to household debt and credit behaviours, low-literacy households are more likely to take debts with high costs and make poor loan strategies (Lusardi and Tufano, 2015). Agarwal et al. (2009) showed that the high-cost credit instruments are chosen by low literacy consumers, who often pay housing loans or mortgages with higher interest rates.

In addition, there is a relationship between financial literacy and individual behaviours. Low levels of financial literacy could lead to poor financial decision making (Lusardi, 2012; Cheah et al., 2015; Nguyen et al., 2017), worse saving behaviour (Lusardi, 2003; Butt et al., 2017), lack of portfolio diversification (Banks and Oldfield, 2007), less net wealth accumulation (Gustman et al., 2012; van Rooij et al., 2012) and ineffective retirement planning (Lusardi and Mitchell, 2005, 2011a). It is clear that the importance of financial literacy in financial markets should not be neglected.

### *2.3 Financial literacy and retirement*

There are also a number of national studies that focus on the relationship between financial literacy and retirement (Hastings and Mitchell, 2011; Bucher-Koenen and Lusardi, 2011; van Rooij et al., 2011b; Earl et al., 2015; Eugster, 2017; Niblock et al., 2017). Financial illiteracy has negative ramifications on retirement. The majority of older populations are not well-equipped with advanced, or even basic financial knowledge and skills, and are thus less likely to plan for retirement (Behrman et al., 2010). This will result in limited savings and less wealth accumulation (Kapteyn et al., 2005; Bateman, 2006), or in the worst scenario, exhausting their assets early in old age (Orth, 2006).

A cause for concern is that employees who are preparing for retirement and the newly retired are overconfident in their savings for retirement life (Parker et al., 2012). Retirees with low financial knowledge tend to borrow more and accumulate less wealth (Stango and Zinman, 2009). More worryingly, little is known about the reasons why they fail to make a retirement plan (Lusardi and Mitchell, 2005).

Not surprisingly, retirees with higher levels of literacy are more likely to plan for their retirements and stick to their plans (Blanchett and Kaplan, 2013) and Lusardi and Mitchell (2011a). Thus, professional planning for retirement is recommended for retirees by other research (Klapper and Panos, 2011). The important role of financial literacy in retirement life should receive more attention.

### *2.4 Financial literacy and socio-demographics*

Among early studies, Volpe et al. (1996) examined the financial literacy of American university students, concluding that the low levels of financial literacy are typically found in young females with non-business majors and little or no work experience. The lack of financial knowledge and skills among young adults was further confirmed by Roy Morgan Research (2003), Lusardi and Mitchell (2009) and Lusardi et al. (2010).

Females are also more likely to have low levels of financial knowledge (Worthington, 2004). Lusardi and Mitchell (2008), in a study of the financial literacy of women, found that those who



are less educated and unmarried tended to score lower on a number of financial literacy questions, with older women performing worst.

With respect to marital status, Lusardi and Mitchell (2008) and Servon and Kaestner (2008) both found that the unmarried are less financially literate than the married. Those unmarried have to make financial decisions by themselves, which may result in their taking less efficient financial strategies than those of their married counterparts (Fonseca et al., 2012).

In addition, there has been little attention on the relationship between health, residence owning type and financial literacy. The survey used in this paper has a wide range of socio-demographic characteristics which will be analysed and presented in more detail in section 3.

### *2.5 Summary of prior research*

Prior research has developed integrative views of the definition of financial literacy. The relationship between financial literacy and financial behaviours has also been analysed by a number of studies. However, measurement of financial literacy in previous studies is associated with information loss (detail is shown in section 4). In addition, financial literacy within the elderly group has been rarely examined in Australia. Moreover, prior studies only focused on the relationship between financial literacy and a few demographic factors and therefore have not provided a comprehensive view.

The IRT model is utilised in this paper to construct a financial literacy index (FLI), which is able to make use of more information relative to extant approaches such as factor analysis. At the same time, we focus specifically on elderly Australians. Lastly, the relationship between a wide range of socio-demographic characteristics and financial literacy has been examined. Socio-demographic information will be further explained in the next section.

## **3. Data**

The data analysed in this paper were collected through a survey conducted in August 2010. The survey investigated 15,000 elderly Australians aged 55 or above, who were members of National Seniors Australia (NSA) and were randomly selected. Within two months, 3,484 of

them completed the survey, representing a response rate of 23.23%.

More detail about the survey can be found in Higgins and Roberts (2011), who provided an overview of the survey and reported preliminary findings by analysing part of the data. The primary goal of the survey was to understand financial issues of the elderly population in Australia. Three questions in this survey assessed financial literacy. Details of these questions are as follows:

- **Q3.11:** Which of the following investment options do you think is most likely to lead to a loss of money over a one year period?  
A. Conservative/Cash, B. Growth/High Growth, C. Balanced, D. Don't know
- **Q3.12:** Which of the following investment options do you think is least likely to lead to a loss of money over a one year period?  
A. Conservative/Cash, B. Growth/High Growth, C. Balanced, D. Don't know
- **Q5.9:** If you had a choice between receiving \$10,000 now, or a greater amount of money one year from now, what is the minimum amount you would need to receive in one year in order for you to choose this option instead of \$10,000 now? (numeric response)

The definitions of Growth/High Growth, Balanced and Conservative/Cash investment options are explained in the survey as follows:

- **Growth/High Growth:** a higher concentration of shares, and a lower concentration of fixed interest, property and cash than balanced.
- **Balanced:** a more even mix of shares, fixed interest, property and cash.
- **Conservative/Cash:** a greater concentration of cash and/or fixed interest, and a low to negligible concentration of shares.

The questions were set to test two aspects of the respondents' financial literacy: investment strategy and risk (Q3.11 and Q3.12); and time value of money (Q5.9). In section 5.1, we will apply the IRT model to construct FLI based on these three financial literacy questions.

Information about the respondents' socio-demographics was also collected in the survey. Twelve socio-demographic factors regarding the respondents and two factors regarding their partners were included in this paper. Table 2 summarises the socio-demographic information. As shown in Table 2, only 50.55% and 37.11% of respondents provided responses to *Earning*

and *Partner's Earning* questions. It is consequently not surprising that these two variables are removed by the Lasso regression model in section 5.2.1.

[Table 2 here]

#### 4. Item Response Theory (IRT) model

Although many attempts have been made to construct a financial literacy index (FLI), a standard measurement of financial literacy has not been formed yet (Huston, 2010). A number of researchers have utilised factor analysis (FA) with regard to categorical data to calculate a FLI (Lusardi and Mitchell, 2007a,b, 2008, 2009, 2011a,b; van Rooij et al., 2011a,b, 2012). However, one disadvantage of FA is that in constructing an index it will lose part of the information (Thompson, 2004), because FA involves reducing a large number of variables into fewer underlying factors.

In order to measure people's financial literacy more precisely, it is necessary to use an index with the least amount of information loss. Less information loss is one advantage of the IRT models (Gibbons and Hedeker, 1992). The iterative process of the Expectation–Maximization (EM) algorithm is applied to estimate parameters in the IRT models (Bock and Aitkin, 1981). It is able to make use of information repeatedly during the iterations. Accordingly, the IRT models outweigh other techniques in constructing the FLI. We thus utilise the IRT model to obtain the FLI with less information loss.

Another advantage of the IRT model is that the characteristics of the survey questions themselves are taken into account when constructing the FLI. Specifically, in obtaining the FLI, the IRT model incorporates item-difficulty information – that is, how difficult it is for respondents to answer each question correctly. Since there are three financial literacy questions in the survey that vary in their difficulty, the IRT model is appropriate because it incorporates this information.

#### 4.1 Introduction of IRT model

Item response theory (IRT) models are mainly used to solve questions with respect to categorical response variables, which are usually derived from questionnaires and tests. The response variables are designed to measure unobserved abilities of the respondent. The IRT model is applied to describe the relationship between the latent variable and the response variables. Since financial literacy cannot be observed directly, the IRT model is applied to calculate the FLI based on the three financial literacy questions in the survey.

According to Rabe-Hesketh et al. (2004), there are two types of IRT models: 1-parameter logistic (1PL) IRT model and 2-parameter logistic (2PL) IRT model. The 1PL and the 2PL models are used for dichotomous response variables. For multi-nominal (polytomous) issues, partial-credit model (PCM) and rating scale model (RSM) can be implemented (Zheng and Rabe-Hesketh, 2007).

#### 4.2 Structure and estimation of IRT model

The one-parameter logistic (1PL) IRT model is the fundamental IRT model (Rasch, 1960). It describes the relationship between item difficulty (the difficulty of each response variable) and the latent variable. The formula of the 1PL model is shown below:

$$\Pr(x_{in} = 1 | \theta_n) = \frac{\exp(\theta_n - \delta_i)}{1 + \exp(\theta_n - \delta_i)} \quad (1)$$

where  $i = 1, 2, \dots, m$ ,  $m$  is the number of response items (variables) and  $x_{in}$  is the response to  $i^{\text{th}}$  item.  $\delta_i$  is the item difficulty parameter, described as the ability level (financial literacy level) at which people have a 50% chance of providing correct answers to the item.  $\theta_n$  is the latent variable (financial literacy level) of person (respondent)  $n$ .

As can be seen from the formula, the 1PL-IRT model reflects the relationship between the probability of answering response items (literacy questions) correctly and the latent variable. Based on equation (1), the following equation can easily be obtained:

$$\ln \frac{\Pr(x_{in} = 1 | \theta_n)}{\Pr(x_{in} = 0 | \theta_n)} = \theta_n - \delta_i \quad (2)$$

This equation shows that the log odds is a linear function of the item difficulty parameter ( $\delta_i$ ), which can make the calculation process more parsimonious and efficient. This means that the larger the item difficulty parameter, the lower the chance of answering the question correctly.

The two-parameter logistic (2PL) IRT model, proposed by Birnbaum (1968), added a slope parameter (or discrimination parameter,  $\lambda_i$ ) to the 1PL model, which aimed to measure the extent to which item  $i$  distinguishes persons of different trait abilities (financial literacy levels). With a discrimination parameter added, the 2PL is more flexible to reflect the relationship between item difficulty and latent trait than the 1PL model. The formula of the 2PL-IRT model is listed below:

$$\Pr(x_{in} = 1 | \theta_n) = \frac{\exp\{\lambda_i(\theta_n - \delta_i)\}}{1 + \exp\{\lambda_i(\theta_n - \delta_i)\}}. \quad (3)$$

Masters (1982) extended the basic 1PL-IRT model to the 1PL partial-credit model (PCM). In the 1PL-PCM, the response items are polytomous with  $j$  categories ordered as  $1, 2, \dots, k_i$  for item  $i$ . The formula of the 1PL-PCM is shown as following:

$$\Pr(x_{in} = j | \theta_n) = \frac{\exp\{\sum_{m=2}^j (\theta_n - \delta_{im})\}}{1 + \sum_{l=2}^{k_i} \exp\{\sum_{m=2}^l (\theta_n - \delta_{im})\}}. \quad (4)$$

According to Zheng and Rabe-Hesketh (2007),  $\delta_{ij}$  is called “step difficulty parameter” related to category  $j$  of response item  $i$ , representing the added difficulty transferring between the two categories (from  $j - 1$  to  $j$ ).

The rating scale model (RSM) is a special PCM with  $k_i = k$  (Dodd, 1990). In the case where  $k_i = k = 2$ , the PCM and RSM become a basic IRT model.

In this study, among the 3 financial literacy questions, responses to Q3.11 and Q3.12 are categorical, whereas responses to Q5.9 are numeric. We thus characterised these numeric responses to 3 categories with respect to degree of correctness, namely correct, partially correct and incorrect. Since Q5.9 is now a polytomous variable, the PCM will be utilised to construct the FLI.

In addition, Muraki (1992) incorporated the 2PL model to the PCM by adding the slope parameter, which is known as the 2PL-PCM. The structure of the 2PL-PCM is shown below:

$$\Pr(x_{in} = j | \theta_n) = \frac{\exp\{\sum_{m=2}^j \lambda_i(\theta_n - \delta_{im})\}}{1 + \sum_{l=2}^{k_i} \exp\{\sum_{m=2}^l \lambda_i(\theta_n - \delta_{im})\}}. \quad (5)$$

Following the similar simplification procedure produces the simplified 2PL-PCM:

$$\ln \frac{\Pr(x_{in} = j | \theta_n)}{\Pr(x_{in} = j-1 | \theta_n)} = \lambda_i(\theta_n - \delta_{ij}). \quad (6)$$

As proposed in Zheng and Rabe-Hesketh (2007), the 1PL models are harder to be realised in practice. Therefore, the 2PL-PCM will be applied to construct the FLI in this paper.

## 5. Empirical analysis

### 5.1 Measurement of financial literacy

The 2PL-PCM has been applied to estimate the financial literacy index (FLI) based on three financial literacy questions in the survey. The software to implement the 2PL-PCM is the R package *ltm*.

The parameter estimations of the 2PL-PCM are listed in Table 3. The item difficulties of Q3.11 and Q3.12 are about -0.18 and 0.14 respectively. The first step difficulty of Q5.9 is around 1.78 and the figure for the second step is about 2.54. As explained in section 4.2, the larger the item difficulty parameter, the more difficult the question is. The results thus indicate that Q5.9 is the hardest financial literacy question, followed by Q3.12. Q3.11 is the easiest question to be answered. For Q5.9, it is much harder to move from “Partly correct” to “Correct” than from “Incorrect” to “Partly correct”.

[Table 3 here]

The values of the discrimination parameters are approximately 2.72, 5.23 and 0.40 respectively, indicating that Q3.12 has the greatest discrimination power to distinguish respondents with high literacy from low literacy, followed by Q3.11. In comparison, people with different financial literacy abilities cannot be easily distinguished through Q5.9.

The 2PL-PCM applies the difficulty parameters and discrimination parameters to obtain the

FLI, which is the advantage of the IRT model as mentioned in section 4. Figure 1 demonstrates the distribution of the estimated the FLI. The FLI ranges from -0.722 to 0.830 with mean of -0.001 (close to 0) and median of -0.056. It is easy to find that approximately 27% (934) of respondents have the lowest financial literacy ability (-0.722). On the other hand, only about 7% (243) people possess the highest literacy ability (0.830).

[Figure 1 here]

Figure 2 presents the mean FLI by *Wealth* and *Income*, and by *Gender*. In the figure, there is a clear overall pattern that the mean FLI increases as wealth and income become greater. Higher level of financial literacy is thus associated with greater net wealth and higher income. Males appear to be more financially literate than females over almost every wealth and income level.

[Figure 2 here]

Figure 3 shows the mean values of FLI in terms of *Age*, *Marital Status*, self-assessed *Health*, *Tenure* (residence owning type), *Education* and *Occupation*.

[Figure 3 here]

Younger elderly people possess higher levels of financial literacy. Their FLI drops largely when aged in their 70s, especially for women. Their literacy abilities continue to decrease dramatically as they approach older age. Within the same age group, men perform much better than women before 80 years old.

As expected, married respondents tend to have higher FLI than unmarried ones. People in good and better health appear to be more financially literate than those who assessed themselves as fair or poor. Notably, women who are very healthy do not perform as well as men in good health.

A similar pattern has been found in the residence owning type. Outright residence owners have financial literacy superior to those who were mortgagors or renting. Females who owned their homes outright have even lower FLI than males with mortgages or renting.

Individuals with higher educational attainment and better occupation tend to be well-equipped with adequate financial knowledge and skills. They can make efficient investment decisions and

enjoy a comfortable retirement life.

This section has measured financial literacy of elderly Australians and provides a preliminary insight with respect to the relationship between financial literacy and some socio-demographic features. Whether the findings are robust and meaningful will be examined by regression modelling.

## 5.2 Socio-demographic variable selections

A contingency table of demographic information is shown above in Table 2. The 14 questions reflect the main demographic characteristics of the respondents.

We processed the five variables - *Wealth*, *Income*, *Loan*, *Earning* and *Partner's Earning* - as continuous variables, which is the same as done by Higgins and Roberts (2011). *Age* is also a numeric response. The categorisations of the remaining variables have been explained in section 3. Note that the FLI is regarded as the dependent variable in all regression models.

Before fitting the regressions, dimension reduction techniques are used to select independent variables. The “Least Absolute Shrinkage and Selection Operator” (Lasso) was proposed in Tibshirani (1996), and aims to shrink some coefficients of the explanatory variables to zero and hence select the subset as the input variables to interpret the model. The Lasso method is utilised in this paper to reduce the number of demographic variables. As suggested by Tibshirani (1996), another advantage of applying the Lasso is to circumvent the collinearity problem.

In addition, the interactions between the explanatory variables must not be ignored. Before implementing the Lasso regression, we first use a regression tree to detect the interaction items (De'ath and Fabricius, 2000). Figure 4 illustrates the pruned tree of all responses. The interactions shown in the pruned tree are summarised in Table 4.

[Figure 4 here]

[Table 4 here]

As listed in Table 4, ten interaction items were assessed using a Lasso regression to determine whether they were important enough to remain.

Consider the interaction between *Wealth* and *Income* for example. Table 5 presents the results



of the Lasso regression model with and without this interaction item. The Lasso parameter  $\lambda$  chosen is the minimum  $\lambda$  value based on cross-validation (CV). It is clear that this interaction should be excluded since the coefficient is 0. At the same time, the coefficients of the demographic variables are the same between the two models, suggesting that the interactions between *Wealth* and *Income* cannot explain the variability in responses (FLI) and thus should not be included. Similar results have also been found in the other 9 interaction items, indicating rejection of all ten potential two-way interactions in the regression models.

[Table 5 here]

The variables with a coefficient of 0 also include *PEarning*, *PEmploy2*, *PEmploy1*, *Health1* (good) and *Earning*. It is noted that *Health1* is excluded but *Health2* (very good or excellent) is not. This results suggest re-classifying *Health* and hence we combine good, very good and excellent as “Healthy or above”.

With the new *Health* variable we re-estimate the model without any material changes to other variables. The results show that the coefficients of *PEarning*, *PEmploy2*, *PEmploy1* and *Earning* are 0, whereas *Health* is retained with a coefficient of 0.0536.

The Lasso regression is used again on the remaining dataset (11 variables). *Retire*, *Employ1* (pink collar) and *Loan* are excluded this time. A similar issue happens again: *Employ1* should be removed but *Employ2* (white collar) should not. By following the same approach, we combine white collar and pink collar together, and re-estimate the model again. The estimation results are presented in Table 6.

[Table 6 here]

The Lasso parameter  $\lambda$  chosen herein is the one standard error  $\lambda$  value. The change from using the minimum  $\lambda$  value is because the CV plot is almost flat and thus the minimum  $\lambda$  criterion has little power to make selections. The CV plots are available upon request.

As shown in Table 6, *Retire* and *Loan* are excluded. *Employ* remained with a coefficient of 0.0192. The results keep constant after re-estimation. The remaining 9 socio-demographic variables are thus selected, specifically *Wealth*, *Income*, *Gender*, *Age*, *Edu*, *Health*, *Tenure*, *Marital* and *Employ*.

### 5.3 Regression modelling

These nine explanatory variables selected by the Lasso regression are applied to obtain a final model with which to examine the relationship between financial literacy and socio-demographics. The results of the generalised regression model are listed in Table 7.

[Table 7 here]

People with a higher level of financial literacy were more likely to be younger (within the elderly group) married males with greater net wealth and higher income, and white- or pink-collar occupation, who were in good health, owned their homes outright and were more highly educated.

In order to make comparisons, the summary of findings in a number of prior studies is listed in Table 8. It is easy to find that other than *Age*, all the other factors are consistent with our results. Reasons for the inconsistency of *Age* are discussed later. We contribute new findings to the existing literature by studying the relationship between financial literacy and self-assessed health as well as residence owning type.

[Table 8 here]

As expected, white- or pink-collar people, with greater wealth accumulation and higher income are likely to be financially engaged. More participation in financial activities equips them with more advanced financial knowledge and skills, and this ultimately improves their financial literacy. The result is consistent with Roy Morgan Research (2003) and Beal and Delpachitra (2003).

As mentioned before, the findings in the relationship between financial literacy and age are inconsistent with prior research - younger people tend to be the least financially literate, as has been shown in the Roy Morgan Research (2003) and Lusardi et al. (2010). A likely explanation is that the respondents covered in the survey were all aged 55 or above. They are not the same “young” age group as people investigated in prior literature. The “young” people in this paper refer to those who are on the verge of retirement or in its early stage.

Younger elderly people engage in financial products and services more actively because of access to superannuation. As people approach older age, they are more likely to have health problems, and thus are less likely to spend much time on learning new financial products, engaging in financial practice, or making efficient investment decisions. This is possibly why their financial literacy levels decrease dramatically when they turn 80.

Males appear to have a higher level of financial literacy than females. The poor financial literacy among females is consistent with results in section 5.1 as well as previous studies (Volpe et al., 1996; Bernheim, 1998; Hilgert et al., 2003; Roy Morgan Research, 2003; OECD, 2005; Agnew and Szykman, 2005; Lusardi and Mitchell, 2005, 2007a, 2008, 2009, 2011b).

In addition, married (or de facto) respondents are expected to possess higher levels of financial literacy than the unmarried. They tend to integrate the family's financial knowledge to make financial strategies and decisions. They are less financially vulnerable than unmarried people. This gap in financial literacy becomes increasingly larger as they age.

Those in good health tend to have good life styles. People with superior life habits are likely to have more time to spend on learning how to manage their money and searching for financial advice. They are thus more likely to be financially literate.

People renting or paying off their homes are more worried about their budgets. On the contrary, outright residence ownership leads to more wealth accumulation and less financial concern. It is hence not surprising to find that higher financial literacy ability is associated with outright residence ownership.

It is also expected that people who are more educated tend to learn a wider range of financial knowledge and know better how to apply the knowledge to practice, and this has also been confirmed by prior studies.

## **6. Conclusions and future work**

People within the current pension plan scheme are taking more responsibility for their pension accounts (Loretto et al., 2000) and they are therefore required to be equipped with a higher level of financial literacy. Since financial literacy is unobservable, measuring financial literacy is of high importance.

Researchers have applied factor analysis (FA) to create a financial literacy index (FLI) (Lusardi, 2003; Lusardi and Beeler, 2006; Lusardi and Mitchell, 2008; van Rooij et al., 2011b). However, using FA to construct a FLI will lead to information loss (Thompson, 2004). In comparison, one advantage of the Item Response Theory (IRT) model is that it makes use of more information. It also combines characteristics of survey questions themselves and their relations with financial literacy when obtaining the FLI. The IRT model is thus utilised in this study to create the FLI based on three financial literacy questions in a 2010 survey (Higgins and Roberts, 2011).

In addition, 14 socio-demographic factors are also collected through the survey. The regression tree is used to detect the interaction effects among these factors and the Lasso regression is implemented to determine socio-demographic variables important to financial literacy.

Nine variables are selected, including wealth, self-assessed health, tenure (residence ownership type), marital status and occupation. To be noted, health and residence owning type are rarely analysed in prior literature. We contribute to the existing literature about their relationships with financial literacy.

In this paper, we have focused specifically on the elderly. The empirical results indicate that people with higher levels of financial literacy are more likely to be relatively younger married males with greater net wealth and higher income, white or pink collars, outright residence owners, in good health and more educated.

We recommend that superannuation, insurance and other fund providers design tailored and customised products to elderly customers, particularly focused on those with low financial literacy levels. Personalised products would be much easier to understand and make users more likely to optimise their income streams.

A number of studies recommend financial education programs to improve people's financial literacy (Gerrans and Heaney, 2016). However, those who are much older and face declining health are less likely to engage in those education programs. We also recommend access to user-friendly financial tools for those people, such as a superannuation, retirement income and insurance needs calculator, and budget and spending planners. The challenge is to have a simple user-interface without compromising on accurate, individualised calculations in the background.

It is clear that elderly Australians are engaging with technology. A 2017 survey reveals 64% of Australians aged between 50 and 64 own a tablet, 75% a smartphone, 66% a laptop and 67% own a desktop computer (Sensis, 2017). For Australians aged 65 and over, 50% own a tablet, 47% a smartphone, 55% a laptop and 66% own a desktop computer (Sensis, 2017). In addition, there were 1.67 million Facebook users aged between 55 and 64, and 1.29 million aged 65 and over in Australia as of 1 January 2017 (Statista, 2017). We therefore suggest there should be freely available online and mobile apps that are specifically designed to engage elderly Australians and that gamify learning how to invest and choose retirement income products properly. One example would be to extend the Brand's (2017) interactive app that won the South Australian Premier's Ageing Well Challenge in 2017 to incorporate a financial literacy dimension.

Lastly, for working Australians, particularly for pre-retirees, financial education is an efficient way to improve their financial knowledge, such as a greater understanding of superannuation. They are consequently more likely to plan well for their retirement and enjoy a more comfortable retirement life. We therefore suggest that policy makers allocate more resources to designing and promoting financial education programs so that the next generation of elderly Australians have improved financial literacy.

In future studies, the FLI constructed in this paper will be used as variable measure to investigate further financial issues covered in the survey, such as the relationship between financial literacy and changes in consumption patterns over the course of retirement, the role of financial literacy in choosing financial strategies to manage financial risks and so forth.

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## Appendix

### Relevant Survey Questions

**Q7.2:** Which of the following occupation groups most closely matches your primary occupation for the majority of your paid working life? (leave this blank if you never participated in paid work)

- Manager (e.g. chief executive, general managers and legislators, farmers and farm managers, specialist managers, hospitality, retail and service managers)
- Professional (e.g., arts and media, business, human resource, marketing, design, engineering, science, transport, education, health, information and communication technology, legal, social and welfare professionals, etc...)
- Technician and Trades worker (e.g., engineering, information and communication technology, science, automotive and engineering, construction trades, telecommunications, food trades, skilled animal and horticultural workers)
- Community and Personal Service worker (e.g., health and welfare support, carers and aides, hospitality, protective services, sports and personal service workers)
- Clerical and Administrative worker (e.g., office managers, personal assistants and secretaries, general clerical, inquiry clerks and receptionists, clerical and office support workers)
- Sales worker (e.g., sales representatives and agents, sales assistants and salespersons, sales support workers)
- Machinery operator and drivers (e.g., machine and plant operators, road and rail drivers, storepersons)
- Labourer (e.g., cleaner and laundry workers, construction and mining labourers, factory process workers, farm, forestry and garden workers, food preparation assistants)
- Other (please specify) [text response]

**Q7.12:** Which of the following occupation groups most closely matches your spouse or partner's primary occupation for the majority of your paid working life? (leave this blank if you never participated in paid work)

- Manager (e.g. chief executive, general managers and legislators, farmers and farm managers, specialist managers, hospitality, retail and service managers)
- Professional (e.g., arts and media, business, human resource, marketing, design, engineering, science, transport, education, health, information and communication technology, legal, social and welfare professionals, etc...)
- Technician and Trades worker (e.g., engineering, information and communication technology, science, automotive and engineering, construction trades, telecommunications, food trades, skilled animal and horticultural workers)
- Community and Personal Service worker (e.g., health and welfare support, carers and aides, hospitality, protective services, sports and personal service workers)
- Clerical and Administrative worker (e.g., office managers, personal assistants and secretaries, general clerical, inquiry clerks and receptionists, clerical and office support workers)
- Sales worker (e.g., sales representatives and agents, sales assistants and salespersons, sales support workers)
- Machinery operator and drivers (e.g., machine and plant operators, road and rail drivers, storepersons)
- Labourer (e.g., cleaner and laundry workers, construction and mining labourers, factory process workers, farm, forestry and garden workers, food preparation assistants)
- Other (please specify) [text response]

**Q8.3:** In the 2008/2009 financial year, what was your total household income, before taxes?

Household income is income from all sources from all members of your household.

- Don't know
- Less than \$20,000
- \$20,000 to \$29,999
- \$30,000 to \$39,999
- \$40,000 to \$49,999
- \$50,000 to \$59,999
- \$60,000 to \$69,999
- \$70,000 to \$79,999
- \$80,000 to \$89,999
- \$90,000 to \$99,999
- \$100,000 or more
- I do not want to answer this question

**Q8.4:** In the 2008/2009 financial year, what were your earnings from paid work, before taxes ?

- Don't know
- Less than \$20,000
- \$20,000 to \$29,999
- \$30,000 to \$39,999
- \$40,000 to \$49,999
- \$50,000 to \$59,999
- \$60,000 to \$69,999
- \$70,000 to \$79,999
- \$80,000 to \$89,999
- \$90,000 to \$99,999
- \$100,000 or more
- I do not want to answer this question

**Q8.5:** In the 2008/2009 financial year, what were the earnings of your spouse/partner from paid work, before taxes ?

- Don't know
- Less than \$20,000
- \$20,000 to \$29,999
- \$30,000 to \$39,999
- \$40,000 to \$49,999
- \$50,000 to \$59,999
- \$60,000 to \$69,999
- \$70,000 to \$79,999
- \$80,000 to \$89,999
- \$90,000 to \$99,999
- \$100,000 or more
- I do not want to answer this question

**Q9.1:** In total, about how much money would you say you (and your partner, if you have one) currently have in savings and investments, including investment or holiday properties and money in superannuation, but excluding your home?

- Don't know
- Less than \$25,000
- \$25,000 to less than \$50,000
- \$50,000 to less than \$100,000
- \$100,000 to less than \$200,000
- \$200,000 to less than \$300,000
- \$300,000 to less than \$400,000
- \$500,000 to less than \$750,000
- \$750,000 to less than \$1 million
- \$1 million or more
- I do not want to answer this question

**Q9.2:** Apart from any mortgage(s) that you may have over your own residence, what is the total amount of money you (and your partner, if you have one) owe, on all personal loans, credit cards, investment property loans, etc.?

- Don't know
- Less than \$25,000
- \$25,000 to less than \$50,000
- \$50,000 to less than \$100,000
- \$100,000 to less than \$200,000
- \$200,000 to less than \$300,000
- \$300,000 to less than \$400,000
- \$500,000 to less than \$750,000
- \$750,000 to less than \$1 million
- \$1 million or more
- I do not want to answer this question

**Q9.3:** Do you or your family own your own residence outright, are you paying it off, or are you renting?

- Own outright
- Paying off
- Renting
- Other (please specify) [text response]

**Q10.1:** What is your year of birth?

**Q10.2:** Sex

- Male
- Female

**Q10.3:** What best describes your current marital status?

- Single
- Married
- De facto
- Widowed
- Separated or divorced

**Q10.6:** What is your highest level of education that you have completed?

- University degree or higher
- Trade certificate or apprenticeship
- Other certificate or diploma
- Year 12 or equivalent
- Year 10 or 11
- Year 9 or below
- Never attended school
- Other (please specify) [text response]

**Q10.7:** In general, would you say your health is:

- Excellent
- Very good
- Good
- Fair
- Poor



## Tables and Figures

### Tables

Table 1

#### Definitions of financial literacy

Key feature	Description	Related literature
Financial skills	The ability to manage money well	Noctor et al. (1992) Schagen and Lines (1996) Cude et al. (2006) Servon and Kaestner (2008) Hung et al. (2009)
Financial knowledge	Understanding key financial terms and concepts	McDaniel et al. (2002) Bowen (2002) Foster et al. (2015)
Financial skills and knowledge	Understanding financial knowledge and apply it to practice	Hogarth(2002) Beal and Delpachitra (2003) Huston (2010)

Table 2

#### Demographic information

Variable	Response Rate	Type	Category	Level	Count	Proportion
Wealth	84.18%	Continuous			2933	
Age	97.88%	Continuous		≥80	855	25.07%
				70 - 79	1027	30.12%
				60 - 69	1292	37.89%
				<60	236	6.92%
Gender	98.28%	Categorical		Female	1523	44.44%
				Male	1904	55.56%
Marital Status	90.67%	Categorical	Unmarried	Single	223	6.51%
				Widowed	364	10.63%
				Separated/divorced	302	8.82%
			Married	Married	2408	70.33%
				De facto	127	3.71%
Health	98.22%	Categorical	Very Healthy	Excellent	415	12.13%
				Very good	1288	37.64%
			Healthy	Good	1112	32.50%
				Unhealthy	Fair	493
				Poor	114	3.33%
Tenure	95.72%	Categorical	Outright	Outright	2601	77.99%
				Not Outright	Paying off	565
				Renting	169	5.07%

Table 2 (continued)

Variable	Response Rate	Type	Category	Level	Count	Proportion
Income	87.54%	Continuous			3050	
Education	90.67%	Categorical	Higher Education	University degree or higher	993	31.43%
			Other	Trade certificate or diploma	318	10.07%
				Other certificate or diploma	742	23.49%
				Year 12 or equivalent	313	9.91%
				Year 10 or 11	540	17.09%
				Year 9 or below	208	6.58%
				Never attended school	3	0.09%
				Other education attainment	42	1.33%
Occupation	68.40%	Categorical	White Collar	Manager	463	15.31%
				Professional	1197	39.58%
			Pink Collar	Community and Personal Service worker	133	4.40%
				Clerical and Administrative worker	616	20.37%
				Sales worker	101	3.34%
			Blue Collar	Technician and Trades worker	341	11.28%
				Machinery operator and driver	81	2.68%
				Labourer	92	3.04%
Retirement Status	100%	Categorical	Retired		2234	64.12%
			Pre-retired		1250	35.88%
Loan	77.38%	Continuous			2696	
Earning	50.55%	Continuous			1761	
Partner's Occupation	86.80%	Categorical	White Collar	Manager	267	11.20%
				Professional	686	27.79%
			Pink Collar	Community and Personal Service worker	179	7.51%
				Clerical and Administrative worker	574	24.09%
				Sales worker	169	7.09%
			Blue Collar	Technician and Trades worker	260	10.91%
				Machinery operator and driver	90	3.78%
				Labourer	158	6.63%
Partner's Earning	37.11%	Continuous			1293	

Note: Detail of the survey questions is listed in Appendix

Table 3

## Parameter estimations of the 2PL-PCM

Question	Parameter	Value	Standard error	$\theta$
Q3.11	$\hat{\delta}_1$	-0.1834	0.0877	5.6917
	$\hat{\lambda}_1$	2.7211	0.4051	6.7176
Q3.12	$\hat{\delta}_2$	0.1393	0.3469	-2.0100
	$\hat{\lambda}_2$	5.2282	1.8346	2.8497
Q5.9	$\hat{\delta}_{32}$	1.7830	0.0396	-18.0339
	$\hat{\delta}_{33}$	2.5415	0.0635	-16.0535
	$\hat{\lambda}_3$	0.4009	0.0349	11.4859

Table 4

## Main interaction items

Variable	Interact with
<i>Wealth</i>	<i>Income, Age, Edu and Gender</i>
<i>Age</i>	<i>Edu, Gender and Income</i>
<i>Sex</i>	<i>Income and Edu</i>
<i>Income</i>	<i>Edu</i>

Table 5

## Estimations of the Lasso regression

Exclusion Order	14 variables		14 variables with interaction item	
	Variable	Coefficient	Variable	Coefficient
1st	<i>PEarning</i>	0	<i>PEarning</i>	0
2nd	<i>PEmploy2</i>	0	<i>PEmploy2</i>	0
3rd	<i>PEmploy1</i>	0	<i>Wealth*Income</i>	0
4th	<i>Health1</i>	0	<i>PEmploy1</i>	0
5th	<i>Earning</i>	0	<i>Health1</i>	0
6th	<i>Marital</i>	0.0287	<i>Earning</i>	0
7th	<i>Age</i>	-0.0029	<i>Marital</i>	0.0287
8th	<i>Loan</i>	-0.0103	<i>Age</i>	-0.0029
9th	<i>Retire</i>	-0.0452	<i>Loan</i>	-0.0103
10th	<i>Employ1</i>	-0.0541	<i>Retire</i>	-0.0452
11th	<i>Health2</i>	0.0366	<i>Employ1</i>	-0.0541
12th	<i>Income</i>	0.0054	<i>Health2</i>	0.0366
13th	<i>Employ1</i>	-0.1398	<i>Income</i>	0.0054
14th	<i>Edu</i>	0.0470	<i>Employ1</i>	-0.1398
15th	<i>Tenure</i>	0.1138	<i>Edu</i>	0.0470
16th	<i>Gender</i>	0.1442	<i>Tenure</i>	0.1138
17th	<i>Wealth</i>	0.0433	<i>Gender</i>	0.1442
18th			<i>Wealth</i>	0.0433

Table 6

## Updated estimations of the Lasso regression (11 variables)

Exclusion order	Variable	Coefficient
1st	<i>Retire</i>	0
2nd	<i>Loan</i>	0
3rd	<i>Employ</i>	0.0192
4th	<i>Marital</i>	0.0057
5th	<i>Tenure</i>	0.0344
6th	<i>Health</i>	0.0269
7th	<i>Edu</i>	0.0499
8th	<i>Age</i>	-0.0051
9th	<i>Gender</i>	0.1153
10th	<i>Income</i>	0.0117
11th	<i>Wealth</i>	0.0404

Table 7

## Estimations of the Generalised Regression Model

Variable	Estimate	Standard error	<i>t</i> -value	Baseline level
Intercept	0.0322	0.1063	0.3025	
<i>Wealth</i>	0.0415	0.0051	8.1548	
<i>Age</i>	-0.0105	0.0014	-7.4326	
<i>Gender</i>	0.1939	0.0264	7.3512	Female
<i>Marital</i>	0.0173	0.0308	0.5598	Unmarried
<i>Health</i>	0.0695	0.0325	2.1427	Unhealthy
<i>Tenure</i>	0.1127	0.0302	3.7322	Not Outright
<i>Income</i>	0.0136	0.0052	2.6302	
<i>Edu</i>	0.0912	0.0257	3.5498	Other
<i>Employ</i>	0.1055	0.0342	0.0342	Blue Collar

Table 8

## Summary of prior findings

Prior literature	Low level of financial literacy
Volpe et al. (1996)	Young, female
Roy Morgan Research (2003)	Young, less educated, low income, unemployed
Beal and Delpachitra (2003)	Less educated, low income, unemployed
Worthington (2004)	Female
Lusardi and Mitchell (2005,2007a,2008,2009,2011b)	Young, female, less educated, unmarried, worker
Higgins and Roberts (2011)	Female, less educated
Lin et al. (2017)	Less educated

## Figures

Figure 1

Distribution of the FLI

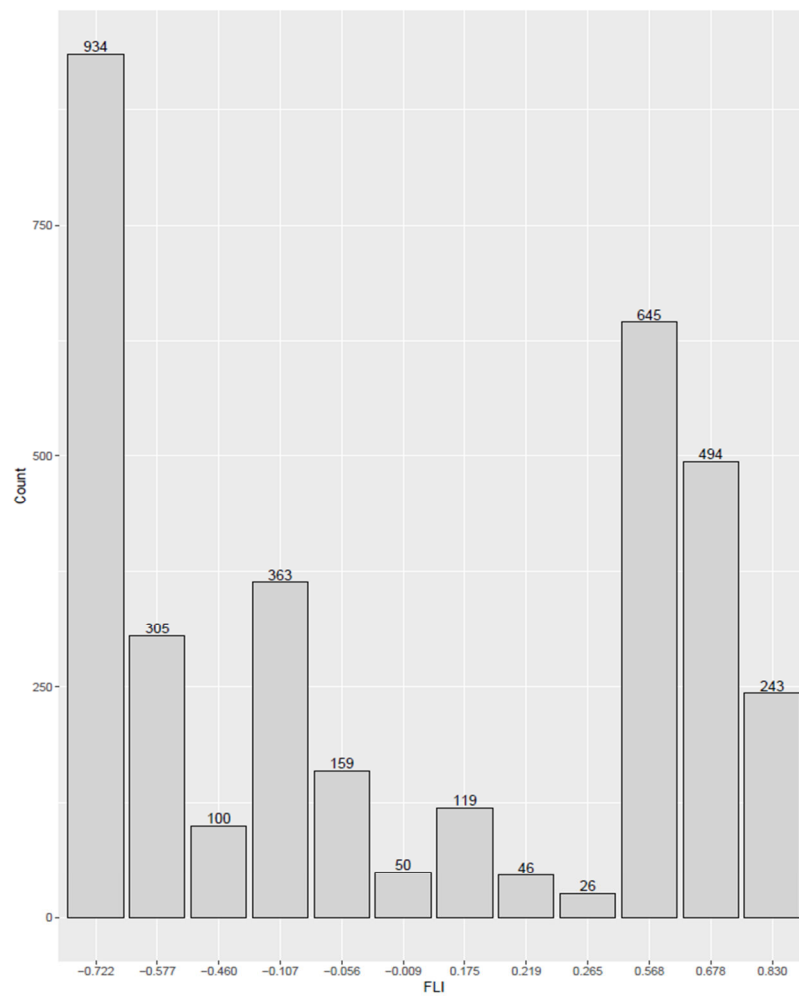


Figure 2

Mean FLI by *Wealth* (top) and *Income* (bottom), and by *Gender*

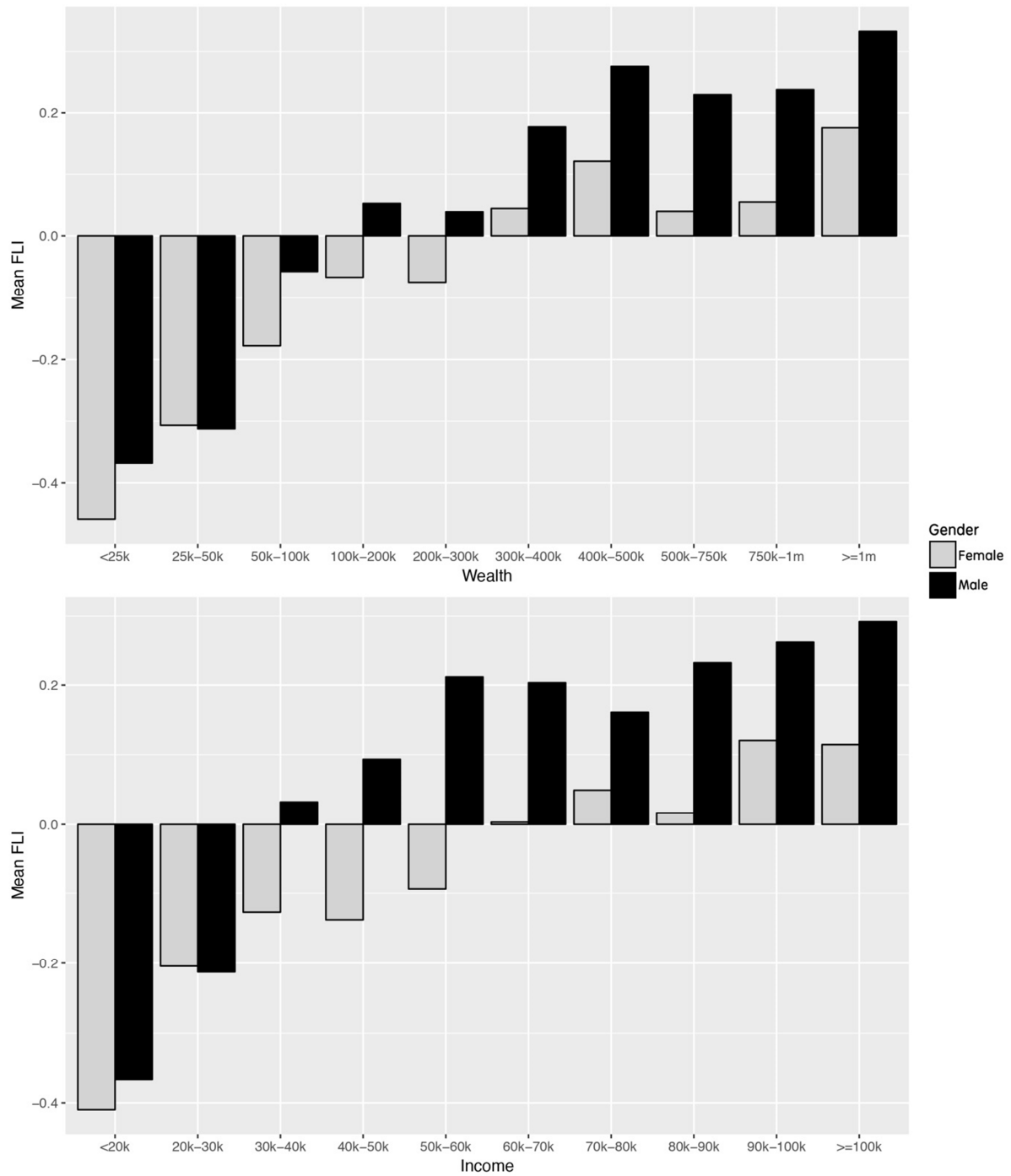


Figure 3

Mean FLI by other socio-demographics, and by *Gender*

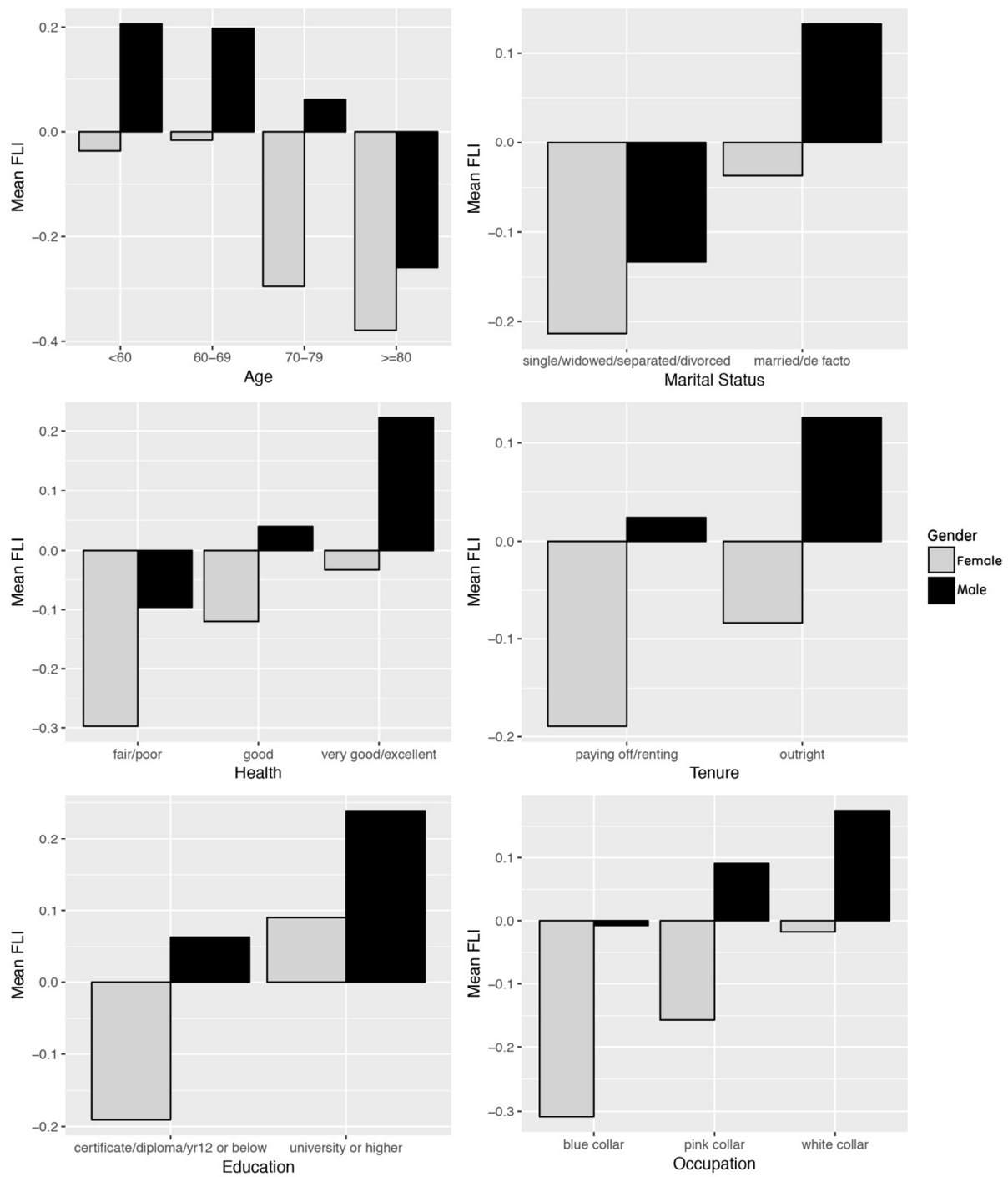




Figure 4  
Pruned tree of all responses

