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Financial Literacy and Suboptimal Financial Decisions at Older Ages

Abstract

Over the life-cycle, wealth holdings tend to be highest in the early part of retirement. The quality of financial decisions among older adults is therefore an important determinant of their financial security during the asset drawdown phase. This paper assesses how financial literacy shapes financial decision-making at older ages. We devised a special module in the Singapore Life Panel survey to measure financial literacy to study its relationship with three aspects of household financial and investment behaviors: credit card debt repayment, stock market participation, and adherence to age-based investment glide paths. We found that the majority of respondents age 50+ has some grasp of concepts such as interest compounding and inflation, but fewer know about risk diversification. We provide evidence of a statistically significant positive association between financial literacy and each of the three aspects of suboptimal financial decision-making, controlling for many other factors, including education. A one-unit increase in the financial literacy score was associated with an 8.3 percentage point greater propensity to hold stocks, and a 1.7 percentage point higher likelihood of following an age-appropriate investment glide path. The financial literacy score is only weakly positively linked with timely credit card balance repayment, both in terms of statistical significance and estimate size.

Keywords: Retirement, financial literacy, credit card debt, stock market nonparticipation, life-cycle investment, household portfolio

JEL Codes: D14, E21, G11, J32

Financial Literacy and Suboptimal Financial Decisions
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1. Introduction

Successful management of financial matters is important at any stage of the life-cycle, but sound financial decision-making often becomes more challenging as people grow older (Hammond et al., 2017). This is important inasmuch as older people tend to have more wealth and resources to manage than during their working lives. Another reason is that financial liberalization has led to a proliferation of new financial products and services, many of which are unfamiliar to retirees. This increased complexity can be exacerbated by declining cognitive abilities at older ages. Older adults are thus at increased risk of making financial decisions that would be considered suboptimal according to standard consumer finance theory (Agarwal et al., 2009; Choi et al., 2011; Klapper et al., 2013).

A large literature has examined the variety of poor financial choices or financial mistakes that households commit.[1] For instance, with regard to credit card financing, several studies report that people often fail to repay their card loans in a timely manner and end up paying excessive fees (Agarwal et al., 2009; Jørring, 2018; Scholnick et al., 2013; Stango and Zinman, 2009). Other studies examining saving and investment decisions document that people tend to save too little, fail to diversify their investment portfolios (Bhamra and Uppal, 2019), and fail to annuitize in retirement (Calvet et al., 2007; Choi et al., 2011; Madrian and Shea, 2001). Problem behavior in the mortgage market includes failure to understand adjustable rate mortgages and refinancing

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[1] Economists have used the terms suboptimal financial decisions and financial mistakes interchangeably. A financial mistake is typically defined as a financial decision where an unambiguous optimal choice exists, and this optimal choice is not chosen by the consumer. This follows from the literature on household finance which has identified numerous consumer choices that are hard to rationalize using models of optimal choice (see, e.g., Campbell 2016; Jørring 2018).

opportunities (Andersen et al., 2015; Keys et al., 2016). There is also evidence that many people do not participate in the stock market (Klapper et al., 2013; van Rooij et al., 2011). Nevertheless, few previous studies have examined financial decisions of the older population, and there is some ambiguity in what to expect. For instance, it is possible that older adults perform better in some aspects of financial decision-making, but worse in other regards. In addition, it is unclear whether the determinants of suboptimal financial behavior are common across the various types of errors. For instance, if education and financial knowledge are associated with stock market participation, are the same factors also associated with good credit card repayment behavior?

This paper analyzes how financial literacy is associated with three types of consumer financial decisions pertinent to older individuals. Specifically, we focus on how well older adults manage credit card repayments, whether they invest in the stock market, and whether they take on levels of risk in their wealth holdings that are deemed age-appropriate. To measure financial literacy and assess its relationship to financial decision-making, we have developed and fielded a special module for the Singapore Life Panel (SLP®) survey, a panel data set covering a representative sample of adults aged 50-70 in Singapore. These questions are linked to a rich set of data on socio-demographic and health characteristics, as well as investment holdings. The SLP stands out for the richness of the information it collects. Most importantly for this study, it collects detailed high-quality economic information on assets, income, and *monthly* information on household spending and credit card repayment, following the same households over time (Vaithianathan et al., 2018). We use the high-frequency panel nature of the SLP to observe households' credit card repayments behavior on a monthly basis over the course of two years.

We find that many older adults in Singapore appear to make less than optimal financial decisions: 58% do not hold stocks, and 82% fail to diversify their wealth holdings. Most older

adults, however, demonstrate good credit card repayment behavior and do not roll over their credit card debts. Among the handful (4.3%) of credit card holders who fail to repay credit card debt despite having sufficient liquidity, avoidable annual interest costs range from S$240 to S$2,460, depending on the number of repayment errors committed each year. Importantly, we find that the correlation among the three types of suboptimal behavior (credit card repayment error, stock market non-participation, and age-inappropriate risk exposure) is low. As a result, they are not simply concentrated among a small fraction of the population, but instead the vast majority exhibits at least one. All three measures investigated in this paper are significantly associated with financial literacy. Specifically, a one-unit increase in the financial literacy score is associated with a 0.6 percentage points lower likelihood of credit card repayment error; 8.3 percentage points greater propensity to hold stocks; and a 1.7 percentage points higher likelihood of following an age-appropriate investment glide path, other factors held constant. The financial literacy index proved to be only weakly positively linked with timely credit card balance repayment, both in terms of statistical significance and estimate size.

Our work is distinguished from prior studies in that we consider not one but three suboptimal financial behaviors. We document the prevalence of each and how it varies by individual and household characteristics. The focus on older adults in Singapore, a city-state in Asia, also fills an important gap in the literature. Specifically, it is useful to determine whether the associations between financial literacy and stock market participation – and separately, between financial literacy and credit card repayment errors – observed in data from the U.S., Canada, the Netherlands, and other Western industrialized nations, also hold in the Asian context. Singapore is an interesting setting for such investigation since the country has been a developed nation for many years and it is widely seen as having an educated populace and well-informed investors.

Despite important differences in institutional settings across industrialized countries, there are common patterns in individuals' financial behaviors.

In what follows, we first review prior studies on financial literacy and financial behaviors, particularly those relating to credit card debt and stock market participation. Next, we describe the dataset including the financial literacy measure, and we explain how we constructed the three measures of suboptimal financial behaviors that we study. Subsequently we report the results of our empirical analysis, followed by discussion and robustness checks. A final section concludes.

2. Prior studies

One explanation for apparent errors in household financial decision-making is financial illiteracy, and Bernheim (1998, 1995) was among the first to show that many U.S. households could not perform very simple financial calculations due to their lack of basic financial knowledge. Using a database of U.S. credit transactions, Agarwal et al. (2009) found that many households paid too-high interest rates on credit card debt, home equity loans, and mortgages. Moreover, such behaviors were more prevalent among those with the lowest levels of financial knowledge. Scholnick et al. (2013) studied the relationship between wealth/income and credit card repayment mistakes in Canada, and they reported that poorer individuals made such mistakes because of lower levels of financial literacy, education, and financial sophistication. Importantly, their subjects did not understand the unnecessary costs they incurred for failing to pay on time.

Other work has also examined the links between financial literacy and investment choices. Calvet et al. (2007) showed that many Swedish households held under-diversified portfolios or did not participate in financial markets at all, with non-negligible welfare costs. Yet because the authors lacked good financial literacy measures, they relied mainly on proxies for financial

sophistication such as wealth, education, and the ratio of private pension contributions to income. Bucher-Koenen and Ziegelmeyer (2014) found that Germans with low levels of financial literacy were less likely to have invested in the stock market, and they also reacted to financial crises by selling assets that lost value. Using Dutch data, van Rooij et al. (2011) assessed the links between financial literacy and stock market participation, testing the direction of causality between literacy and stock market participation by including instrumental variables for respondents' literacy levels (e.g. financial experiences of the respondents' family and peers). They concluded that financially unsophisticated people were less likely to invest in stocks and tended to rely on family and friends as their main source of financial advice.

Also related to this topic is a large literature on the stockholding puzzle: in a nutshell, analysts find it puzzling that many households do not hold any stocks at all, despite the fact that shares tend to pay higher expected returns than safer instruments (Campbell, 2006). One explanation for this phenomenon is that there may be entry costs to access the stock market, so that people only buy shares when the expected excess return from participation exceeds the fixed costs. An implication of this is that wealthy investors will be more likely to be stockholders, a hypothesis corroborated by Guiso et al. (2003) who found that wealth and stock market participation were positively associated across many industrialized countries.[2] The costs can be monetary as well as non-monetary in nature, such as the effort required to become informed about investing in the stock market. The effort to acquire relevant knowledge is likely to be higher for people with low cognition and/or low financial knowledge (Delavande et al., 2008), implying that it may be rational for some low wealth households not to hold stocks. Other possible explanations for stock nonparticipation include inertia, borrowing or short sale constraints, lack of trust,

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[2] Moreover, the higher return earned in the stock market applied to their higher wealth helped wealthier households more.

inability to plan ahead, influence of peers, and low financial literacy. In particular, van Rooij et al. (2011) found that financial illiteracy reduced Dutch households' propensity to buy stock.

In sum, the literature to date on household financial decision-making and investment choices has suggested that several factors could drive suboptimal financial behaviors including financial illiteracy, poor education, and low wealth. Nevertheless, none of these studies has focused on older persons, notwithstanding the fact that this group is likely to have accumulated more wealth than the younger population. In what follows, we evaluate financial behavior among the older population in Singapore whose population has one of the highest life expectancies in the world. Singaporean older households may have to finance spending at older ages for many years in a setting with limited annuitized retirement income. Poor financial decision-making may increase the risk of running out of money at advanced old age. Accordingly, it is of interest to learn whether and how financial literacy may be associated with financial decision-making as older persons near and move through retirement, particularly in Singapore.

3. Data: The Singapore Life Panel

Singapore is one of the world's most rapidly aging nations. According to UN estimates, the share of Singapore's population age 60+ will rise from 19.5% today to 42.7% by 2060 (United Nations, 2018). As an ethnically diverse country, its population is mainly composed of Chinese, Indians and Malays. Although there is a suggestion that working-age Singaporeans rank well against their peers in other countries in terms of financial literacy, the country also has many older residents with relatively low education, implying substantial heterogeneity across the population (OECD, 2016). A 2016 survey, for example, found that Singapore topped the Asia-Pacific region in terms of financial literacy (assessed based on knowledge of basic money management, financial

planning, and investment matters), outperforming 16 other regional markets including Hong Kong, South Korea, and Japan (Lee, 2016). A different market survey reported that around 60% of all adult Singaporeans were financially literate, compared to 18% in Nepal and Cambodia (Karekar, 2015). Koh et al. (2018) using SLP data documented that financial literacy among older adults in Singapore was comparable to, but slightly lower than, levels of similar-aged persons in the United States. Nonetheless, to date, there is little evidence on the extent to which older Singaporeans undertake suboptimal financial decisions, and whether poor financial choices are linked to financial illiteracy.

To investigate these associations, we rely on data from the 2015-2017 SLP®, a high-frequency internet-based survey conducted by the Centre for Research on the Economics of Ageing at the Singapore Management University.[3] It is a longitudinal survey of Singaporean citizens and permanent residents initially aged 50-70 as well as their spouses. About 15,000 individuals have participated in the monthly surveys since August 2015 and about 8,000 interviews are completed on average every month. Thus far, over 45 waves have been completed and the response rates have remained remarkably stable. The interviews are conducted over the internet, and respondents who need assistance or lack internet access can answer the survey over the phone or at centers located conveniently around Singapore. Respondents receive modest compensation for the effort of participating in the surveys, and the survey team conducts various outreach efforts to keep respondents engaged. Consequently, attrition rates are low. The SLP® collects extensive information on respondent and household socio-demographic characteristics, such as health, wealth and income, investments, retirement expectations, family support, and spending.

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[3] See Vaithianathan et al. (2018) and https://crea.smu.edu.sg/singapore-monthly-panel for a detailed description of the SLP® and a discussion of data quality.

Particularly valuable for our study is the high frequency at which the survey is carried out. The monthly observations on credit card debt rollover behavior allows us to assess the number of months in a year that credit card balances were not paid off resulting in penalty interest charges. Our full analytic sample is composed of respondents aged 50-70 in the SLP® Dec 2015 wave who answered all three financial literacy questions and who responded to the annual asset and income modules (N=6,573). Further sample restrictions are applied as called for in each of the three specific analyses (these are detailed in the next section and summarized in Table A1). Our analyses are conducted at the respondent level, assuming resource sharing in married households. Most asset information, including credit card ownership, are elicited at the household level (i.e. respondent and spouse for married persons). Financial literacy is assessed at the individual level.

4. Measurement of suboptimal financial behaviors

This section first describes how each of the three suboptimal financial behaviors are measured. We then outline how financial literacy is assessed, as well as the other control variables used in the analyses.

4.1 Three suboptimal financial behaviors

Credit card repayment errors. Previous work has defined the incurrence of an avoidable credit card late fee and/or penalty interest charges as an unambiguous financial mistake (Scholnick et al., 2013; Stango and Zinman, 2009). A credit card late fee or penalty interest charge is deemed avoidable if, on the due date for payment, the consumer had sufficient cash in a deposit account to cover the credit card bill.[4] Thus, for our purpose, a credit card repayment error is deemed to have

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[4] Some studies also allow an additional provision for a month of average consumption expenditures, to allow for normal consumption patterns after paying off the minimum balance.

occurred in a given month if the respondent rolled over credit card debt despite having sufficient checking and saving balances, leading to the imposition of an interest charge for that month.

Credit card repayment errors are evaluated among respondents who owned at least one credit card and who participated in at least nine monthly surveys in a given year (n=4,321, or 66% of the full sample). The latter selection criteria ensures that we extract sufficient information on credit card repayment habits on an annual basis (see Table A1 for details).[5] We extract monthly records of individuals' credit card debt rollovers to identify those who reported at least one rollover transaction in 2016 or 2017. For these persons, we evaluate for each of their rollover transaction(s) whether it constituted a repayment error: if the dollar amount of their credit card debt rolled over in a given month was less than the respondent's total deposits in checking and saving accounts, then a repayment error is coded as having occurred (else not).

The SLP® elicits checking and saving account balances only annually at the start of each year. For our evaluation we therefore use the nearest observation on checking and saving balances prior and the nearest following the month the rolled over credit card debt is observed. For example, if a rollover transaction occurred in the month of June 2016, we check whether the rolled over credit card debt exceeds checking and saving balances in January 2016 and January 2017.[6] If it is smaller than the checking and saving balances in both of the nearest observations on checking and savings then we consider this a repayment error.

We define two dependent variables as follows: (1) whether committed any credit card repayment error over the two-year period (indicator variable=1, else 0), and (2) average number

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[5] The SLP question is phrased as: "Do you and/or your spouse have one or more credit cards?" Therefore, among married respondents we do not observe whether both or only one of the spouses holds one or more credit cards. In the absence of detailed information on ownership, we assume that both respondents in a couple have access to a credit card if the respondent answers the credit card ownership question with yes. See Appendix B for the wording of the relevant survey sequence.

[6] For the very small number of missing values for checking and saving balances (<10 cases) in 2016, 2017, or 2018, we impute using the observed balances in the adjacent year.

of repayment errors per year (continuous variable, range 0-12). The average number of repayment errors per year is the sum of all errors committed in 2016 and 2017, divided by two. This yields one observation per respondent. For some respondents, we only have enough information to assess credit card repayment behavior in one calendar year. For persons who committed repayment errors, we then extract the corresponding penalty interest charges for each rollover transaction from the data. This information is employed to compute the annual costs associated with the observed repayment errors by respondent across the two years of observation (see Appendix B for details).

Stock market non-participation. Stock market non-participation constitutes a suboptimal financial behavior in that households who hold no stocks at all forego the equity risk premium. In Singapore, older adults can invest in stocks or mutual funds using both non-pension and pension monies. Retail customers must open accounts with authorized brokers to buy and sell stocks or mutual funds using their private assets. Members of the national defined contribution scheme, the Central Provident Fund (CPF), may also use their pension savings to buy and sell shares. The CPF program is mandatory, has almost universal coverage, and requires current contribution rates ranging from 37% of wages (17% by employers and 20% by employees) for young working adults aged 35 and below, to 12.5% of wages for those aged 65 or older.[7] Investment in stocks or mutual funds using CPF savings is allowed via the CPF Investment Scheme, subject to the CPF member meeting certain saving balance thresholds.[8]

Following van Rooij et al. (2011), we consider stock market participation through both direct holdings of stocks, and indirect holdings via participation in mutual funds. The latter include

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[7] Contribution rates decline progressively from 37% to 12.5% over seven age bands. (See https://www.cpf.gov.sg/Employers/EmployerGuides/employer-guides/paying-cpf-contributions/cpf-contribution-and-allocation-rates/otherstab#Others.)

[8] CPF members can invest their pension accumulations under the CPF Investment Scheme only after setting aside $20,000 in their Ordinary Account (OA) and/or $40,000 in their Special Account (SA). In addition, investment of CPF-OA savings in stocks or shares is capped at 35% of investible savings.

managed funds and unit trusts, which in turn, hold shares, bonds, and other investments. The SLP®

elicits direct holdings of stock and/or mutual funds at the household level and asks separate

questions for the respondent's and the spouse's (if applicable) stock holdings in the CPF system.

We thus define stock market non-participation as an individual holding no stocks or mutual funds

over the entire two-year period (indicator variable=1, else 0). Given that accessing the stock market

would require some fixed costs and a minimal level of wealth, we exclude respondents living in

households with extremely low net worth (≤S$1,000). The subsample used for analysis here is

n=6,177, representing 94% of the full sample.

Failure to follow an age-based investment glide path. The third suboptimal behavior we

examine concerns age-appropriate investment decisions. Strictly speaking, decisions with respect

to investment risk exposure are a function of peoples' risk preferences, knowledge of the financial

instruments, liquidity, and several other factors. While a complete optimal assessment at the

individual is quite complicated, the "100-minus-age" rule (defined as the portfolio share of equity

is equal to one's age subtracted from 100) has been shown to be a good proxy for rising risk

aversion with age (e.g. Arshanapalli and Nelson, 2012; Bodie and Crane, 1997; Lankford, 2005;

Mayer et al., 2011). It is also consistent with theoretical work by Bodie et al. (1992) who showed

that it is sensible to reduce one's portfolio risk at older ages, so as to maintain a constant overall

risk exposure due to declining human capital. For a typical 60-year-old, the age-based investment

glide path would suggest 40% of the portfolio be held in stocks (or risky assets, overall), and the

remaining 60% in relatively safe assets like bonds.

We categorize investments in stocks and mutual funds as risky assets. As described above,

such investments may be made using non-pension and/or pension monies. The net value of a

respondent's primary residence, and where applicable, the net value of a secondary residence, are

also considered risky assets. This approach is broadly consistent with numerous studies in the literature on household life cycle models (e.g. Cardak and Wilkins, 2009; Chang et al., 2018; Yao and Zhang, 2005; Yogo, 2016, to name just a few). Fig. 1, which plots the residential house price index in Singapore, documents the evolution of house values over the last four decades. It indicates that during the 2008 financial meltdown, residential property prices fell by over one quarter in real terms.

[Fig. 1 here]

We define the household's risky investment share as the net value of stocks, mutual funds, and real estate, divided by total net wealth in 2017.[9] Our dependent variable indicates failure to follow the 100-age rule within a +/-10% bound: for instance, if a 60-year-old invested 30-50% of his portfolio in risky assets, he would be following the 100-age rule (indicator variable=0). Conversely, if the respondent's risky share did not fall within +/-10% of the 100 minus his age percent, his financial behavior would deviate from this rule (indicator variable=1). Consistent with our sample selection criteria for stock market participation, we exclude respondents living in households with extremely low net worth (≤S$1,000). We also drop respondents with incomplete information on portfolio allocation (*n*=6,318, or 96% of the full sample).

It is important to keep in mind the institutional framework for saving and investment in Singapore, and how its evolution over time has influenced older Singaporeans' portfolios. For example, the CPF provides a risk-free rate of return of 2.5-5% on funds held in its default account and limits how much of government-managed CPF accounts can be held in equity. Furthermore, the government has provided financial incentives to purchase housing with CPF funds. As a result, stock holdings are relatively low while housing makes up a large share of portfolios among many

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[9] We used asset information from 2017 instead of 2016 for this analysis because additional details on asset allocation was included in the Jan/Feb 2017 module.

older Singaporean households and the possibilities to diversify may be constrained. For example, a household that is "house-rich" thanks to house price appreciation, having used CPF balances to purchase a home many years ago, cannot easily withdraw equity from the house to invest the funds in a safe asset instead, nor would this necessarily be an advantageous move.[10] Nevertheless, even if these institutional factors provided a reasonable explanation for observed portfolio structures that often do not conform to the age-rule, households will be exposed to the associated imbalanced portfolio risk. Hence, we argue that it is useful to examine older Singaporean's adherence to the age-rule in a way that can be compared to household investment behavior in other countries.

4.2 Financial Literacy Score

Financial literacy is measured using the "Big Three" questions testing key concepts underlying economic saving and investment decisions (Lusardi and Mitchell, 2008, 2011*a, b*).[11] These concepts include numeracy and capacity to do calculations related to interest rates; understanding of inflation; and understanding of risk diversification. Specifically, SLP® respondents were asked:

(i) 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: **more than today**, equal to today, less than today.

(ii) Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, would you be able to buy: more than, exactly the same as, or **less than today** with the money in this account?

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[10] Housing monetization schemes have been introduced by the Singapore government in recent years e.g. Lease Buyback Scheme, to help older households to reduce their housing equity over time, but take-up has been limited.
[11] The Big Three financial literacy questions perform well in the population at large, though more detailed and sophisticated questions have been devised for more financially-savvy subpopulations; see Clark et al. (2017).

(iii) Do you think that the following statement is true or **false**? "Buying a single company stock

usually provides a safer return than a Unit Trust (or Mutual Fund)."

Correct answers are shown in bold-face here, but that was not the case in the survey instrument.

We use responses to these three questions to compute a FinLit Index (range 0-3) which equals the

total number of questions each person answered correctly. If the respondent checked "Don't know"

it was treated the same way as an incorrect answer. Respondents who did not answer all three

financial literacy questions (i.e., left one or more questions blank) were excluded from the

analysis.[12] Breakdowns by question item show that 81% of respondents answered the interest rate

question correctly, 72% answered the inflation question correctly, and 46% answered the risk

diversification question correctly. See Koh et al. (2018) for detailed analyses how FinLit varies in

the Singapore population.

4.3 Other control variables

Multivariate regressions include the following additional demographic controls: indicator

variables for sex, marital status, education (<secondary, secondary, >secondary education),

race/ethnicity, and age (in Dec 2015) in four age bands (50-54, 55-59, 60-64, and 65-70). We

control for home ownership and self-employment to account for those exposed to real estate and

labor market risk, who may therefore be less likely to hold stocks (Heaton and Lucas, 2000). We

also control for whether the respondent indicates managing the household's finances, to account

for individuals with experience in managing household finances and who therefore might be less

likely to engage in suboptimal financial behaviors. An indicator for high risk tolerance concerning

financial decisions is also included. Finally, we include total household income and total household

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[12] 7,766 out of 7,882 persons (or 98%) aged 50-70 in December 2015 responded to all three questions (see Table A1).

net worth in logs (van Rooij et al., 2011), and indicators for missing values in key control variables. For further details on question wording and variable definitions, see the Appendix B.

Table 1 presents descriptive statistics for the full sample (N= 6,573). Respondents' mean age is 58.8; slightly over half (52%) are female; and over one-third (38%) has a post-secondary education (10+ years of schooling).[13] The mean of the FinLit index score is 2.02 with a standard deviation of 0.97, implying that older Singaporeans average two of three correct answers to the "Big Three" questions fielded. Only 46% answered the last question on risk diversification correctly, suggesting that older adults in their 50s and 60s are not well-informed about stocks and mutual funds. Most respondents are married (81%) and own a home (88%). Respondents exhibit general low risk tolerance: only 15% score greater than 5 on a 0-10 scale, where 10 represents highest risk tolerance. Slightly more than half of the sample report that they are currently employed and working for pay.[14] Average annual household income is S$60,554 (US$42,393) and median income is S$27,700 (US$19,390). Mean and median total net worth are S$1.16M (US$0.81M) and S$0.66M (US$0.46M) respectively. Most of the elderly respondents are in good health, while about one-third (34%) report fair/ poor health.

[Table 1 here]

5. Results

We begin by presenting descriptive statistics on each of the three potentially suboptimal financial behaviors.

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[13] Prior to higher education, Singaporean students attend primary and secondary school for a combined total of 10 years: six years in primary and four years in secondary. Some students then proceed to junior colleges for another two years of education (junior college graduates would have attained the equivalent of a U.S. high school education) before entering university.

[14] Many respondents were still participating in the labor force since the statutory retirement age in Singapore is 62, with re-employment encouraged up to age 67.

5.1 Credit card repayment error

Of the 6,573 older SLP respondents, about two-thirds (66%) held at least one credit card. This is consistent with recent evidence suggesting that credit card use is relatively lower among older Singaporeans as compared to their younger counterparts because the former exhibit a greater reliance on debit card spending (Agarwal et al., 2015).[15] Among older cardholders, 91.3% (or 3,943) paid off any accrued balances every month over the 24-month period; 4.4% (190) rolled over their credit card debt with insufficient balances in their checking and saving accounts, and 4.3% (188) rolled over credit card debt despite having sufficient saving balances. The 188 respondents who did not pay off their credit card debt despite having sufficient liquidity are deemed to have committed a credit card repayment error.

Fig. 2 shows the 188 respondents with repayment errors sorted by their frequency of errors. The primary vertical axis of the Figure depicts the frequency (in percent) of the average number of errors committed per year in this subsample; the secondary vertical axis shows the corresponding average annual penalty charges. These interest charges are avoidable since the respondents had sufficient savings to settle the debt.[16] A sizeable proportion of these individuals (43%) made one or fewer repayment errors per year on average (≤1 bin), costing them $236 on an annual basis. One-fifth (23%) of the sample committed >1 to 3 errors annually, at an average annual cost of around $415; 15% of the sample committed >3 to 6 errors annually costing them $1,050 on average; and 10% had >6 to 10 avoidable charges per year, costing them $2,241 annually. Finally, 9% of this group had over 10 avoidable interest charges costing them $2,462 annually in average interest payments.

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[15] This could be because credit card firms require a minimum income for card application, or due to older peoples' preference to carry and use cash for daily transactions.
[16] To estimate the average annual cost of errors, we tally the repayment errors with non-zero interest charge across all persons in a given bin and compute the average dollar interest charge incurred; see Appendix for details.

[Fig. 2 here]

Table 2 reports the demographic and financial characteristics of respondents living in households with at least one credit card, sorted by the average number of repayment errors they made per year. The first column represents people making no repayment error in the 24-month period, while the next four columns focus on those making at least one error, sorted into quartiles.[17] Interestingly, we find that respondents who committed no errors tend to be older, have higher FinLit scores, and have higher mean as well as median net wealth. The mean total net wealth of respondents making no repayment error ($1.52M) is substantially higher than that of those making at least one error ($0.85-1.41M). The patterns for financial net wealth are similar. Average income across the repayment error bins varies less: $80,640 for respondents with none, and $59,050-95,460 for respondents with errors. The latter finding is consistent with Jørring (2018) who showed that U.S. consumers who paid avoidable late fees were less wealthy than those who rarely exhibited these costly financial behaviors. As such, credit card debt rollover behavior can exacerbate wealth inequality over the life-cycle.

[Table 2 here]

5.2 Stock market non-participation

Next, we analyze investment in stocks and mutual funds for respondents with total net wealth exceeding S$1,000. Table 3 shows that some 59% of the older sampled respondents did not invest in stocks or mutual funds over the two-year survey period, and hence they were deemed to not have participated in the stock market. The remaining 42% invested in stocks or mutual funds: 26% (or 1,596 persons) invested in both years, and 16% (or 1,012 persons) in a single year. Among older Singaporeans who invested, shares (or stocks) were the preferred asset class. For example,

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[17] When computing quartiles there were ties around the quartile values. In those cases we assigned observations at random to the two adjacent quartiles to achieve equal-sized quartile groups.

88% of those who invested in both years owned individual stocks and no mutual funds (the corresponding percentage among those who invested in a single year was 80%). Also noteworthy is that most respondents who participated in the stock market did so using private monies, rather than pension assets. Among respondents who invested both years, 74% used private savings only, 7% used CPF savings only, and 19% used both channels (among respondents who invested in a single year, 84% used private monies only, 11% used CPF savings only, and 4% used both).

[Table 3 here]

Table 3 also reports the demographic and financial characteristics of respondents by stock market participation. Those who did not participate were less educated and scored lower on the financial literacy index: specifically, only 25% of those not holding stocks had post-secondary education, compared to older adults who held stocks of whom 48-63% had a post-secondary education. In addition, the average FinLit index score of those who did not participate in the stock market was only 1.8, lower than the average score of 2.3-2.5 for those who held shares. Older adults not holding stocks also had substantially less net wealth and lower household income: for instance, the net worth of those who consistently held stocks averaged S$2.21M, almost three times that of those owning no stocks (S$0.73M). The median of financial net wealth among those not participating in the stock market was S$14,000. The last row in the Table indicates that there is no evidence that individuals who do not participate in the stock market were more prone to credit card delinquency.

5.3 Failure to follow an age-based investment glide path

We analyze adherence to the age-based investment glide path among respondents with total net wealth exceeding $1,000 and having provided complete information on how their assets were allocated. We find that the vast majority, or 82% (5,202), failed to adhere to the 100-minus-age

investing rule within +/-10% bounds. According to this criterion, most older Singaporeans did not follow an age-based glide path frequently recommended by financial advisors. Almost two thirds of the total sample "over-invested" in risky assets, while 17% "under-invested" (see Table 4). Of the three risky asset classes considered (stocks, mutual funds, and property), real estate investment typically constituted the largest component of the risky asset share. Consequently, persons who under-invested either did not own a home or had relatively low home equity.[18] Conversely, older adults who over-invested (i.e. took on high risk) were those with considerable net property assets. For instance, 79% (3,259 of 4,138) of those holding risky portfolios for their age had home values exceeding 50% of their net wealth, while 52% (2,171 of 4,138) had home values exceeding 70% of their net wealth. Such large holdings in risky home equity surpasses the risky asset bounds prescribed by the 100-minus-age rule, which based on the sample's mean age of around 60 works out to only 40%.

[Table 4 here]

We recognize that the government of Singapore has encouraged homeownership among the population over the past five decades. In fact, the CPF explicitly permits borrowing for buying a property, allowing young workers to contribute to their CPF accounts and then take out a mortgage repaid from their CPF contributions.[19] Accordingly, it is not surprising that so many Singaporeans have invested heavily in a single property. Nevertheless, recent evidence indicates that housing has turned out to be a rather risky investment, inasmuch as those inhabiting older flats are now learning that these are depreciating assets (Silvam, 2018). Having a home of course

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[18] The average gross value of the primary residence is S$184,000 among those who under-invested, S$559,000 among those who invested in accordance to the age-rule, and S$782,000 among those who over-invested.

[19] McCarthy et al. (2002) note that Prime Minister Lee Kuan Yew introduced the Home Ownership Scheme in 1968 which allowed workers to use their CPF accumulations to purchase public housing built under the auspices of the Housing Development Board (the government authority controlling most of the island's housing stock). HDB 'standardized' flats were constructed in the thousands by government-operated firms and sold at highly subsidized rates to workers with mortgages of 99 years.

provides a stream of housing services free of price fluctuations (while living in the same home), and as an investment, a home can provide old-age resources. Yet it is also important to note that older peoples' home values are uncertain in the current environment. For this reason, we included property values in the risky set of assets held at older ages.

5.4 Propensity to engage in multiple suboptimal financial behaviors

When considering all three suboptimal financial behaviors jointly, we focus on the subset of respondents holding credit cards (*n*=4,321), so that all are at risk of engaging in up to three suboptimal behaviors. For this subsample, we find that 14% engaged in none of them (see Table 5), whereas 49% engaged in one, 35% in two and the remaining 2% engaged in all three suboptimal behaviors. Those who managed to avoid all of them scored highest on financial literacy, were better educated and healthier, and were more likely to manage their household finances. They were also more well-to-do with higher total net worth and annual household income.

[Table 5 here]

It is also worth evaluating whether people exhibiting one type of suboptimal financial behavior also exhibited other types. To this end, we examined the correlation across the three behaviors (credit card delinquency, stock non-participation, and not following the 100-age glide path). Inasmuch as those without credit cards cannot make a card repayment error, the correlation analysis uses only the subset of 4,321 credit card holders (or 66% of the full sample).[20] Table 6 shows that the correlation between credit card repayment errors and not participating in the stock market is -0.013, while it is 0.139 for stock non-participation and not following the glide path. The correlation between credit card repayment errors and deviation from the 100-age glide path is 0.015. These low correlations may be attributable to different factors driving each behavior. For

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[20] This is the same subsample identified in Table 2.

instance, those who do not pay off their credit cards may lack self-discipline or have poor financial habits (see, e.g., Thaler, 2000). Stock non-participation may be the result of ambiguity aversion (Dimmock et al., 2016), while not following the 100-age glide path may reflect individuals' lack of awareness of the riskiness of holding much wealth in a single home.

 [Table 6 here]

5.5 Regression results: individual suboptimal financial behaviors

Table 7 reports the estimates from various multivariate regression models corresponding to the behavioral outcomes of interest. The first column reports the marginal effects from a probit estimation among credit card holders of the propensity to make any credit card repayment errors. We find a statistically significant association between the outcome variable and the main covariate of interest, however the effect size is small: a one unit higher FinLit score is associated with a propensity to make credit card repayment errors that is 0.6 percentage points ($p<0.05$) lower. Higher wealth was a predictor of a lower probability of making a credit card repayment error, while high risk tolerance and working for pay was predictive of a higher probability of credit card repayment errors. One possible explanation for why Singaporeans who work for pay were more likely to make credit card repayment errors attracting penalty interest charges might be that they are more likely to be pressed for time, as argued by Hamermesh and Lee (2007). Results in the second column show that the literacy score is not statistically significantly associated with the number of repayment errors in a multivariate linear regression model (although it has the same sign as in the probit estimation), holding other factors constant.

[Table 7 here]

The third column of Table 7 provides the marginal effects from a probit regression of the probability of stock non-participation. Results confirm that financial literacy is significantly and

negatively associated with this outcome, holding other factors constant. The estimated marginal effect of -0.083 for financial literacy indicates that, on average, a one-point higher FinLit score is associated with a propensity of not investing in stocks that is 8.3 percentage point lower ($p<0.01$). In other words, those who are more financially savvy are more likely to own stocks and/or mutual funds.

While some people may stay away from the stock market due to lack of knowledge, other individuals do so because they lack the means. Our results show that higher income and wealthier older adults are more likely to participate in the stock market, indicating support for the entry cost hypothesis discussed earlier. Investing in stocks and mutual fund require fixed learning and setup costs, which are worthwhile only if deployable assets are sufficiently large. Better-educated individuals are also more likely to participate in the equity market. Conversely, those who are married, currently working, and own a house, are less likely to invest in stocks. Similar results in other countries have been reported by van Rooij et al. (2011), Calvert et al. (2007), and Guiso et al. (2003).

In contrast with studies focusing on Western populations, stock market participation in Singaporean increases with age. The negative significant coefficients for age groups 60-64 and 65-70 imply that elderly people are more likely to own stocks. We find that respondents aged 60+ are about 5% more likely to participate in equity markets compared to those in the age 50-54 reference group. This finding is consistent with Koh et al. (2008) who showed that older Singaporean CPF members were more concentrated in shares and unit trust investments. This may be a unique cultural phenomenon where older Singaporeans demonstrate a general preference for stock investing and taste for risk, while having more time devote to investments.

The last column of Table 7 shows the marginal effects from a probit regression of not following the prescribed 100-age investment rule of thumb. Here again, more financially savvy respondents are more likely to conform to this investment rule, although the estimated effects are smaller than for stock market participation. On average, a one-point increase in the FinLit score is associated with a 1.7 percentage points decrease in the probability of not following an age-based investment glide path ($p<0.01$), holding other factors constant. We also learn that the probability of not following the chronological age glide path is higher among relatively older groups. For instance, respondents age 60-64 were 7.5% more likely to fail to adhere compared to their younger counterparts, while those age 65-70 were 12.5% more likely to do so. This may be because the large investment holding in (risky) home equity surpasses the rather narrow risky asset bounds prescribed by 100-minus-age rule, for individuals at advanced ages.[21] Similar to the regression results for stock non-participation, both income and total net wealth are negatively associated with not following the investment age-rule at the 1% significance level.

5.6 Regression results: multiple suboptimal financial behaviors

It is also interesting to investigate whether financial literacy is a predictor of the number of suboptimal financial behaviors among older Singaporeans. Recall here that the degree of correlation is relatively low across the three types of behaviors examined (credit card delinquency, stock non-participation, and not following the 100-age glide path). Results from a multivariate linear regression model using the number of suboptimal behaviors as the dependent variable are shown in Table 8. We find that the number of non-optimal behaviors is negatively and significantly associated with financial literacy, controlling for other factors: a one-unit increase in the FinLit score was associated with an estimated 0.10 unit ($p<0.01$) decrease in the number of suboptimal

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[21] In empirical extensions presented in the next section, we investigate less stringent bounds by using +/- 20% of the recommended 100-minus-age investing rule instead of 10%.

financial behaviors, holding other factors constant. Higher-educated, wealthier persons and those with higher income are likely to engage in fewer suboptimal behaviors on average, as do those with higher financial risk tolerance. By contrast, those who are older (aged 65-70), married, or own a home, tend to exhibit more types of suboptimal behaviors. *[Table 8 here]*

6. Robustness Analysis

We conducted sensitivity analyses along two dimensions. First, we explored whether the main results are robust when we use financial net wealth in the regressions in lieu of total net wealth. Arguably, financial net wealth comes into sharper focus when evaluating credit card delinquency and stock market participation behaviors, since it better proxies liquid resources that individuals have to repay their credit card debts or with which to buy stocks.[22] The effects of the FinLit index, our main explanatory variable of interest, is largely robust to this empirical variation (see Table A2). In the probit regression of any credit card repayment errors, a one unit increase in FinLit score is associated with a 0.5% (p <0.10) lower likelihood of committing an error which is close to the earlier point estimate in the regression using total net wealth. With respect to non-participation in the stock market, controlling for financial net wealth we find a one-point higher FinLit score is associated with a 6.8% (p <0.01) greater probability of stock market participation, holding other factors constant.

Second, we explore how the proportion following the 100-age rule changes if wider risky asset bounds are used and how that affects our estimation results. We found in the preceding

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[22] We did not include in this set of reported robustness checks the model for the investment age-rule, because the investment rule derives a recommendation for the fraction of *total* wealth that should be invested in risky assets. While the recommendation is independent of the wealth level, to the extent that there are fixed costs and returns to scale, total wealth may nevertheless have predictive power in these descriptive regressions for whether or not someone adheres to the age-glide path.

analysis that many older Singaporeans continue to hold large investment holdings in (risky) home equity into advanced ages. Allowing for wider risky asset bounds might better account for this investment practice, for instance using +/- 20% (instead of +/- 10%) bounds. Doing so implies that a 60-year-old could hold 20-60% (instead of 30-50%) of his/her portfolio in risky assets without being seen as contravening the conventional age-based glide path. Using this wider bound reduces the number of respondents violating the investment rule from 5,202 to 4,186, equivalent to 82.3% and 66.3% of the analytical sample. Results are reported in Table A3. The point estimate of the coefficient on financial literacy is double the size of the original specification: a one-unit higher FinLit score is now associated with a 3.7% lower probability of *not* following the age-based investment glide path ($p < 0.01$), holding other factors constant.

7. Conclusions

As the population ages, it is of interest to evaluate whether older persons are likely to exhibit suboptimal financial behaviors in later life, and to determine how financial literacy may alleviate these problems. Using the Singapore Life Panel, we find that costly investment and asset allocation choices are prevalent among older Singaporeans, in that 6 of 10 older respondents do not invest in stocks or mutual funds, despite publicly-available schemes allowing pension monies and private savings to be channeled to such investments. Findings from other industrialized countries are similar: for example, in the Netherlands, about 70% of older adults above age 50 do not participate in the stock market.[23] Most of the older adults in our sample (82%) allocated their assets in ways that did not follow the age-linked glide path commonly proposed by financial

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[23] Comparative statistics are available from van Rooij et al. (2011) who used data from the 2005-2006 De Nederlandsche Bank Household Survey. See also Campbell (2006) for statistics on levels of stock ownership among U.S. households.

investors, mainly due to illiquid home equity. Government policies in Singapore have encouraged home ownership by providing financial incentives. However, for many older households, this has resulted in asset portfolios that are disproportionally invested in housing. On a more positive note, we did find that the vast majority of older Singaporeans who held credit cards managed their credit card accounts well. Only 4.3% of credit card holders failed to pay their card debts despite having sufficient deposit balances.

Our empirical results also indicate that financial knowledge tends to be associated with more competent financial behaviors. Financially savvy individuals were more likely to make better investment decisions. A one-unit increase in the literacy score was associated with a 0.6 percentage points ($p<0.05$) lower likelihood of making any credit card repayment error; 8.3 percentage points ($p<0.01$) greater chance of stock market participation, and a 1.7 percentage points ($p<0.01$) higher chance of adherence an age-appropriate investing guideline, other factors held constant. However, the financial literacy score was only weakly associated with credit card repayment errors, both in terms of effect size and statistical significance.

These findings are generally consistent with the literature on adults in Western countries which report a positive relationship between financial literacy and investment skill (Calvet et al., 2007; Klapper et al., 2013; Scholnick et al., 2013; Stango and Zinman, 2009; van Rooij et al., 2011). It is also worth recalling that – similar to their Western counterparts – older Singaporeans we studied were relatively sophisticated: 7 in 10 respondents grasped the concepts of interest compounding and inflation, and about half knew the basics of risk diversification. Whether this is true for older adults in other Asian countries is not yet known.

We further verified that the strong association observed between financial literacy and each of the three potentially costly financial behaviors is not due to high inter-correlations of the

behaviors themselves. Indeed, pairwise correlations across the behavioral measures are low, implying that they are picking up different aspects of suboptimal financial behavior. This distinction across the financial behaviors examined here is critical to explaining some of our empirical findings. For example, we found that education is an important predictor of diversified household investment portfolios, but not for credit card repayment errors, while also controlling for financial literacy.[24] One interpretation is that investment-related decisions are linked to an individual's capacity to acquire knowledge and learn concepts (e.g. workings of the stock market) which increases with education, whereas credit card repayment behavior is tied more closely to personal habits, financial discipline, or time pressure. Another interpretation follows from Scholnick et al. (2013)'s observation that education can have a significant impact when the decisions are rare and difficult to understand (e.g., investment-related decisions), but it can have a smaller impact when decisions to be taken are frequent and easy to understand (e.g., monthly credit card repayments).

Our findings are relevant to the policy discussion. The fact that credit card rollovers are concentrated among a small group of older individuals, while lack of diversification is widely prevalent, suggests that policy interventions can be differentially targeted. Financial literacy programs on investment and saving can aim for broad reach through platforms such as school-based programs and the training for the elderly.[25] By contrast, financial education on debt and credit card management are likely to be more effective if targeted at specific groups of the older population, specifically those lacking financial discipline. Regulators and industry could explore financial products that help "nudge" older consumers' behaviors: for example, automatic bill

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[24] Similar to earlier studies, our results show that literacy is not necessarily a good proxy for schooling and it is important to separate the independent effect of financial knowledge from the impact of education level.

[25] For instance, the National Silver Academy launched in 2015 in Singapore comprises a network of course providers including universities and polytechnics offering non-examinable courses to seniors age 50+.

payment systems can help elders reduce credit card fees.[26] It is also worth noting that financial products permitting homeowners to extract equity from their properties, like the Lease Buyback Scheme in Singapore, would be beneficial, in terms of helping older individuals better diversify their asset holding. However, only few households have taken advantage of this since its introduction in 2009. Life-cycle fund investing can also encourage older individuals to invest in age-linked glide paths. Some effort has been made towards this direction in recent years in the Singaporean context; for instance, the government has announced plans to set up a new CPF investment scheme offering savers the chance to invest their pension monies in a few well-diversified low cost and passively managed life-cycle funds.[27]

Our discussion of empirical findings has couched the discussion in terms of associations rather than causal relationships. This is because a causal model of financial behaviors would recognize that people's decisions are influenced by behavioral and economic factors where investing in financial knowledge is endogenous. While we do not pursue the identification question here, there is substantial evidence supporting the conclusion that financial knowledge does drive more saving, better retirement planning, better investment outcomes, and more informed decisions about retirement payouts (Lusardi and Mitchell, 2014). Nevertheless, there is evidence that consumers must devote time and money to learn about financial products and the workings of the capital market, and consequently the least-educated and lowest-paid may optimally invest little in financial literacy (Kim et al., 2016; Lusardi et al., 2018). An implication of that research is that

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[26] The GIRO (General Interbank Recurring Order) system in Singapore refers to an automatic electronic payment service permitting one to make monthly auto-payments to a billing organization from one's bank account directly, as long as there are sufficient balances in the account.

[27] This program, known as the CPF Lifetime Retirement Investment Scheme, is still under discussion (see Fong and Koh, 2018).

peoples' financial literacy can be endogenously related to their wealth and portfolio diversification, requiring care to identify the causal relationships.

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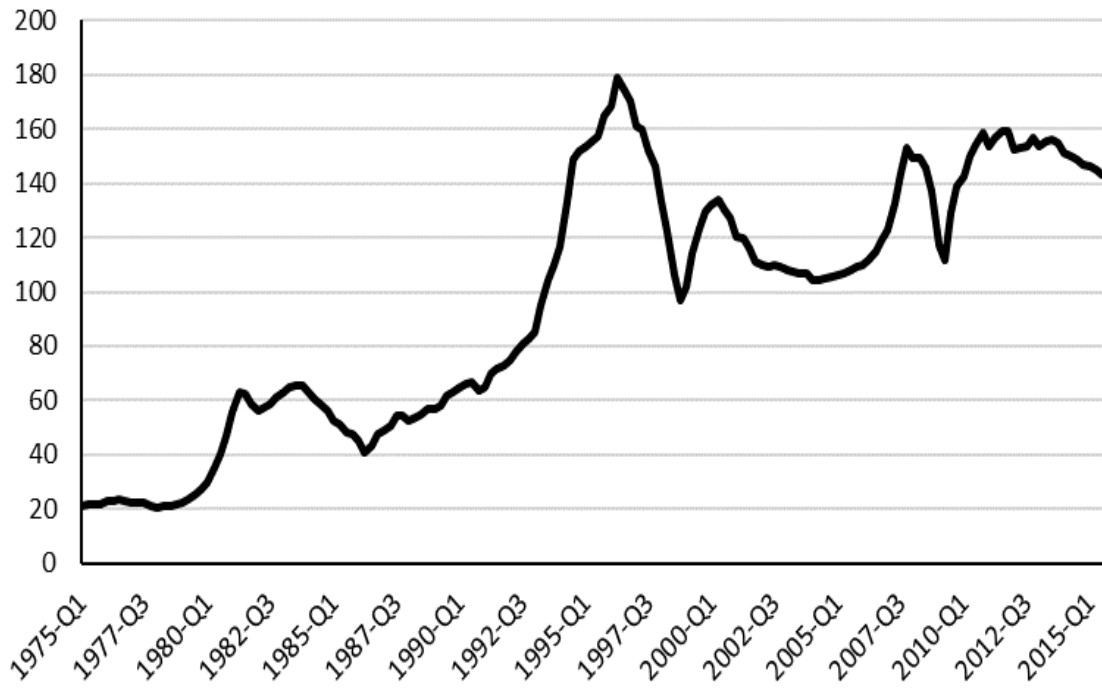
Fig 1. Singapore residential house price index over time. The figure displays the time series of the residential house price index in Singapore from January 1975 through December 2015. The nominal house price index is then adjusted to real terms using the annual consumer price index with base year 2014. Data is sourced from Koh (2016) and DOS (2019).
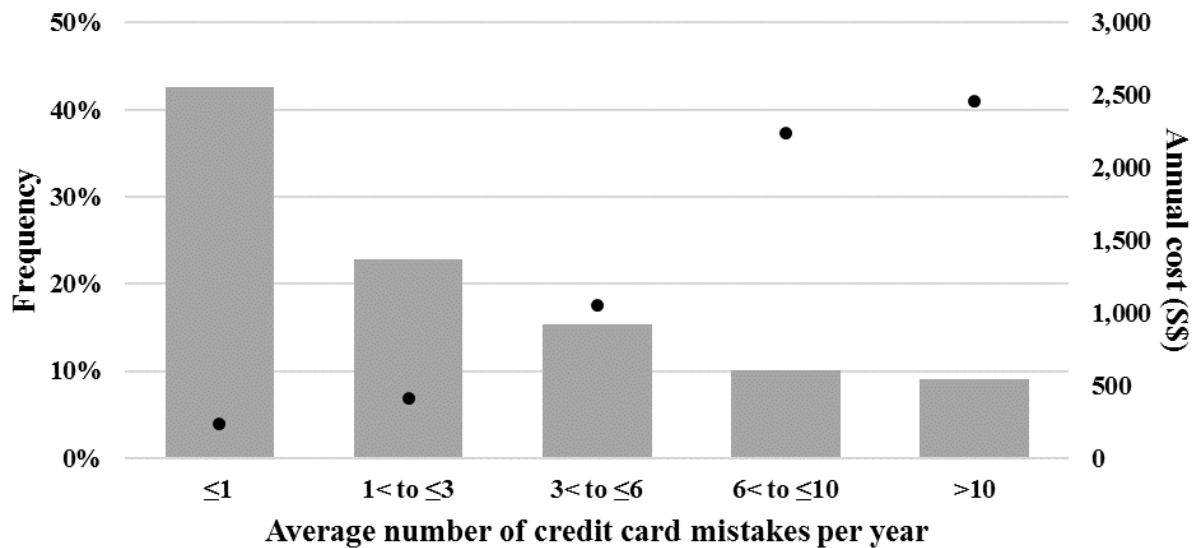
Fig 2. Frequency of credit card repayment errors and annual costs. The figure displays the distribution of credit card holders who rolled over debt despite having sufficient liquidity at least once during the 24-month period. The 188 persons with repayment errors are sorted into bins based on their average number of errors committed per year. Annual penalty interest charges incurred by individuals are then summed and averaged, within each bin, to derive the annual cost estimates (shown by the black dots).

Table 1
Descriptive statistics of full sample.
The sample includes respondents age 50-70 who answered the financial literacy questions, as well as relevant financial and investment questions fielded in other survey waves; see text for details. Percentages are shown for categorical variables. Means (and standard deviations in parenthesis) are shown for continuous variables.

Variable	Means (SD)
Female	52%
Married	81%
FinLit Score	2.02
	(0.97)
Baseline age	58.8
	(5.46)
Age bands	
50-54	27%
55-59	31%
60-64	23%
65-70	20%
Education	
Less than secondary	21%
Secondary	41%
Post-secondary	38%
Homeowner	88%
High risk tolerance	15%
Work for pay	54%
Manage household finances	84%
Fair/poor health	34%
Annual Income (S$)	60,554
	(145,422)
Median Annual Income (S$)	27,700
Total net wealth (S$'000s)	1,161
	(1,725)
Median total net wealth (S$'000s)	662
Financial wealth (S$'000s)	196
	(421)
Median financial wealth (S$'000s)	50
N	*6,573*

Table 2
Characteristics of respondents with and without credit card repayment errors.
This table provides the summary statistics of 4,321 credit card holders based on their credit card repayment behavior. The 'no error' category comprises persons without credit card debt rollover activity for all waves participated, and those who rolled over debt but did not have sufficient liquidity for all waves participated. Respondents who committed at least one repayment error are split into quartiles. When there were ties at the quartile cut-offs so that an observation might be assigned to one quartile of the next higher quartile then we randomized the assignment for these observations to achieve quartiles of equal size. Mean values of the characteristics are shown unless otherwise stated.

| | | No error | With errors | | | |
			Lowest Errors=0.5	2Q $0.5 \leq errors \leq 1.5$	3Q $1.5 < errors \leq 5$	Highest $5 < errors \leq 12$
Baseline age		58.2	59.3	55.8	57.2	57.0
FinLit score		2.2	2.1	2.1	1.8	2.1
Post-secondary education		50%	57%	49%	43%	57%
Manage household finances		87%	89%	83%	79%	87%
Total net wealth (S$'000s)		1,519	994	854	1,409	1,323
Median total net wealth (S$'000s)		928	860	661	648	830
Financial wealth (S$'000s)		279	205	101	104	269
Median financial wealth (S$'000s)		105	95	25	16	59
Annual income (S$)		80,635	75,736	60,233	59,051	95,458
Median annual income (S$)		46,070	58,500	45,520	46,406	55,320
	N	*4,133*	*47*	*47*	*47*	*47*

Table 3
Characteristics of respondents with and without stock market participation.
This table shows the summary statistics of the 6,177 respondents by their level of participation in stock markets over 2016 and 2017. Only respondents with non-missing information on total net wealth and asset allocation, and total net wealth >S$1,000, are included in this tabulation. The 'did not participate' column comprises respondents who held no stocks or mutual funds over the entire two-year period, and thus exhibit suboptimal behavior. Mean values of the characteristics are shown unless otherwise stated.

	Participated		Did not participate
	both years	**one year only**	
Baseline age	58.8	58.5	58.8
FinLit score	2.5	2.3	1.8
Post-secondary education	63%	48%	25%
Manage household finances	89%	86%	82%
Annual income (S$)	108,532	75,697	39,535
Median annual income (S$)	61,567	43,020	19,957
Total net wealth (S$'000s)	2,211	1,362	726
Median total net wealth (S$'000s)	1,495	874	509
Financial wealth (S$'000s)	517	201	68
Median financial wealth (S$'000s)	287	99	14
% who make credit card mistake	3%	4%	3%
N	*1,596*	*1,012*	*3,569*

Table 4
Characteristics of respondents by whether they follow investment age-rule.
This table classify the 6,318 respondents by whether they follow the investment age-rule in 2017. Only respondents with non-missing information on total net wealth and asset allocation, and total net wealth >S$1,000, are included in this tabulation. The 'not follow age-rule' columns comprise respondents who have allocations in risky assets that were outside +/-10% of 100 minus their individual age, and thus exhibit suboptimal behavior. Mean values of the characteristics are shown unless otherwise stated.

		Follow age-rule	Not follow age-rule	
			Under-invested	Over-invested
Baseline age		56.7	58.0	59.6
FinLit score		2.3	1.9	2.0
Post-secondary education		52%	35%	35%
Manage household finances		88%	81%	85%
Home owner		95%	60%	94%
Annual income (S$)		86,672	65,992	54,282
Median annual income (S$)		58,833	18,435	25,679
Total net wealth (S$'000s)		1,350	816	1,238
Median total net wealth (S$'000s)		1,039	455	637
Financial wealth (S$'000s)		291	167	185
Median financial wealth (S$'000s)		160	25	35
% who make credit card mistake		4%	3%	3%
	N	*1,116*	*1,064*	*4,138*

Source: Authors' calculations using the SLP®. **Note:**

Table 5
Characteristics of respondents by the number of non-optimal behaviors.
The three types of suboptimal financial behaviors evaluated are: making credit card repayment error, stock market non-participation, and did not follow investment age-rule. Subsample of 4,321 respondents who are credit card holders are included in this analysis; respondents without any credit cards are excluded.

| | Number of suboptimal behaviors | | | |
	Zero	One	Two	All Three
Baseline age	56.8	58.6	58.2	57.8
FinLit score	2.5	2.3	1.9	1.8
Female	45%	50%	50%	43%
Married	86%	84%	84%	88%
Post-secondary education	61%	57%	37%	33%
Home owner	96%	91%	89%	94%
Risk tolerance	21%	22%	12%	18%
Work for pay	62%	56%	58%	63%
Manage household finances	88%	88%	84%	83%
Fair/poor health	28%	30%	33%	36%
Annual Income (S$)	100,717	95,177	53,653	47,859
Median Annual Income (S$)	75,023	54,712	30,720	32,830
Total net wealth (S$'000s)	1,730	1,869	954	700
Median total net wealth (S$'000s)	1,372	1,123	633	532
Financial wealth (S$'000s)	427	369	97	40
Median financial wealth (S$'000s)	260	170	24	13
N	*594*	*2,110*	*1,533*	*84*
N (in %)	*14%*	*49%*	*35%*	*2%*

Table 6
Correlation matrix for the three types of suboptimal financial behavior.
Number of credit card repayment errors per year: continuous variable (range 0-12). Stock market non-participation: = 1 if respondent held no stocks or mutual funds over the 24-month period. Did not follow investment age-rule: =1 if % total net wealth in risky assets outside +/-10% of 100-minus-age investing rule, 0 else. The subsample of 4,321 respondents who are credit card holders are included in this analysis; respondents having no credit cards are excluded.

	Any credit card repayment errors	Stock non-participation	Did not follow investment age-rule
Any credit card repayment errors	1.000		
Stock non-participation	-0.013	1.000	
Did not follow investment age-rule	0.015	0.139	1.000

Table 7
Effect of financial literacy on individual suboptimal financial behaviors.
This table shows the effect of financial literacy on credit card (CC) repayment, stock market participation, and portfolio risk exposure. The first column reports Probit estimates of financial literacy on CC repayment errors (=1 if make at least one error, 0 else; mean= 0.04). The second column shows OLS estimates of the effect of financial literacy on number of CC repayment errors (range 0-12; mean= 0.14). The third column reports the Probit estimates of financial literacy on stock market non-participation (=1 if no stocks or mutual funds held over entire 24-month period, 0 otherwise; mean= 0.58). The last column reports the Probit estimates of financial literacy on whether follow investment age-rule (=1 if % total net wealth in risky assets outside +/-10% of 100-minus-age investing rule, 0 otherwise; mean= 0.82). Other controls not shown include indicator variables for race and for missing values of controls. Marginal effects are reported for all Probit models.

	Any CC repayment error		Number of CC repayment errors		Stock non-participation		Not follow investment age-rule	
	Probit		OLS		Probit		Probit	
FinLit Score	**-0.006**	**	**-0.032**		**-0.083**	***	**-0.017**	***
	(0.003)		**(0.023)**		**(0.009)**		**(0.006)**	
Female	-0.001		-0.042	*	-0.028	**	0.015	*
	(0.004)		(0.025)		(0.012)		(0.008)	
Married	-0.002		0.032		0.120	***	-0.016	
	(0.007)		(0.040)		(0.021)		(0.013)	
Age (Base group: 50-54)								
55-59	-0.010	*	-0.027		-0.012		0.040	***
	(0.005)		(0.041)		(0.019)		(0.011)	
60-64	-0.009		-0.017		-0.050	**	0.075	***
	(0.006)		(0.047)		(0.022)		(0.011)	
65-70	-0.004		-0.021		-0.050	**	0.125	***
	(0.007)		(0.060)		(0.025)		(0.010)	
Education (Base group: Less than secondary)								
Secondary	0.005		-0.023		-0.215	***	-0.087	***
	(0.010)		(0.076)		(0.022)		(0.017)	
Post-secondary	0.009		0.004		-0.301	***	-0.097	***
	(0.010)		(0.078)		(0.025)		(0.019)	
Home owner	0.013	*	0.076	*	0.195	***	-0.054	***
	(0.007)		(0.045)		(0.032)		(0.015)	
Risk tolerance	0.020	***	0.116	**	-0.113	***	0.014	
	(0.007)		(0.051)		(0.021)		(0.013)	
Ln annual income	0.002		0.014		-0.031	***	-0.014	***
	(0.002)		(0.010)		(0.005)		(0.004)	
Ln total net wealth	-0.009	***	-0.034	**	-0.182	***	-0.017	***
	(0.002)		(0.015)		(0.013)		(0.005)	
Work for pay	0.012	**	0.043		0.051	***	-0.028	***
	(0.005)		(0.036)		(0.016)		(0.010)	
Manage HH finances	-0.009		-0.035		-0.003		-0.007	
	(0.008)		(0.047)		(0.020)		(0.013)	

	Any CC repayment error	Number of CC repayment errors	Stock non-participation	Not follow investment age-rule
	Probit	**OLS**	**Probit**	**Probit**
Fair/poor health	0.001	-0.003	-0.014	0.000
	(0.005)	(0.031)	(0.016)	(0.010)
N	*4,321*	*4,321*	*6,177*	*6,318*
BIC	*1,669.8*	*12,379.9*	*6,520.5*	*5,578.3*

Note: Robust standard errors clustered at household level in parentheses; ***$p < 0.01$, **$p < 0.05$, *$p < 0.10$.

Table 8
Effect of financial literacy on the number of suboptimal financial behaviors.
This table reports the OLS estimates of the effect of financial literacy on the number of suboptimal financial behaviors (range 0-3; mean =1.26). The three suboptimal financial behaviors are credit card repayment error, stock market non-participation and not following the investment age-rule. Other controls not shown include indicator variables for race and for missing values of controls. The data are from the 2015-2017 SLP survey.

	# suboptimal financial behaviors	
FinLit Score	-0.103	***
	(0.013)	
Female	-0.003	
	(0.018)	
Married	0.059	*
	(0.030)	
Age (Base group: 50-54)		
55-59	0.016	
	(0.029)	
60-64	0.044	
	(0.031)	
65-70	0.117	***
	(0.034)	
Education (Base group: Less than secondary)		
Secondary	-0.205	***
	(0.036)	
Post-secondary	-0.272	***
	(0.038)	
Home owner	0.083	**
	(0.037)	
Risk tolerance	-0.049	*
	(0.027)	
Ln annual income	-0.025	***
	(0.008)	
Ln total net wealth	-0.133	***
	(0.016)	
Work for pay	0.037	
	(0.023)	
Manage HH finances	-0.029	
	(0.031)	
Fair/poor health	0.003	
	(0.023)	
N	*4,321*	
Adjusted R2	*0.15*	
BIC	*8,817.8*	

Note: Robust standard errors clustered at household level in parentheses; ***$p < 0.01$, **$p < 0.05$, *$p < 0.10$.

Appendix A

Table A1
Data source and Sample selection criteria for each suboptimal behavior

Description	N
Responded to Dec 2015 wave, and age 50-70 in Dec 2015	7,882
Answered all 3 FinLit questions	7,766
Non-missing HH net wealth in Jan/Feb 2016	7,325
Non-missing HH net worth in Jan/Feb 2017	6,573
Final input sample to subsequent analyses (Full Sample)	**6,573**
Added restriction for credit card repayment error analysis, starting with Full Sample	6,573
Respondent owns credit card(s) in any month in 2016 or 2017	4,479
CC repayment behavior observed at least 9 months in 2016 and/or 2017+	4,323
Dropped observations with identified payment error due to outlier value for interest charge	4,321
Final sample for CC repayment error analyses	**4,321**
Added restriction for analyzing stock market participation, starting with Full Sample	6,573
Dropped persons with HH net wealth ≤ S$1,000 in asset module 2016 or 2017	6,177
Final sample for analyzing stock market participation	**6,177**
Added restriction for analyzing whether follow investment age-rule, starting with Full Sample	6,573
Dropped persons with HH net worth ≤ S$1,000 in asset module 2017	6,318
Dropped persons with insufficient information to compute portfolio allocation reported in 2017 asset module	6,318
Final sample for analyzing whether follow investment age-rule	**6,318**

Table A2
Sensitivity analysis for multivariate analysis of individual suboptimal financial behaviors.
This table shows the effect of financial literacy on credit card (CC) repayment and stock market participation. This table is analogous to Table 7 except that financial net wealth is used as a control instead of total net wealth. The first column reports Probit estimates of financial literacy on CC repayment errors (=1 if make at least one error, 0 else; mean= 0.04). The second column reports OLS estimates of financial literacy on number of CC repayment errors (range 0-12; mean= 0.14). The third column reports the Probit estimates of financial literacy on stock market non-participation (=1 if no stocks held over entire 24-month period, 0 else; mean= 0.58). Marginal effects are reported for all Probit models. Other controls not shown include indicator variables for race and for missing values of controls. The data are from the 2015-2017 SLP survey.

Variable	Any CC repayment error	Number of CC repayment errors	Stock non-participation
	Probit	OLS	Probit
FinLit Score	**-0.005***	**-0.025**	**-0.068*****
	(0.003)	**(0.023)**	**(0.009)**
Female	0.000	-0.034	-0.014
	(0.004)	(0.025)	(0.013)
Married	-0.005	0.026	0.068***
	(0.007)	(0.039)	(0.021)
Age (Base group: 50-54)			
55-59	-0.010*	-0.021	-0.016
	(0.006)	(0.042)	(0.020)
60-64	-0.008	-0.006	-0.041*
	(0.006)	(0.048)	(0.023)
65-70	-0.001	-0.001	-0.015
	(0.008)	(0.061)	(0.025)
Education (Base group: Less than secondary)			
Secondary	0.009	0.000	-0.217***
	(0.010)	(0.071)	(0.023)
Post-secondary	0.013	0.038	-0.295***
	(0.010)	(0.071)	(0.025)
Home owner	0.007	0.042	0.033
	(0.008)	(0.041)	(0.027)
Risk tolerance	0.024***	0.128**	-0.112***
	(0.008)	(0.052)	(0.022)
Ln annual income	0.003*	0.027**	-0.020***
	(0.002)	(0.011)	(0.006)
Ln financial net wealth	-0.009***	-0.059***	-0.124***
	(0.002)	(0.018)	(0.006)
Work for pay	0.011**	0.029	0.040**
	(0.005)	(0.035)	(0.016)
Manage HH finances	-0.010	-0.026	-0.002

Variable	Any CC repayment error	Number of CC repayment errors	Stock non-participation
	Probit	**OLS**	**Probit**
	(0.008)	(0.048)	(0.021)
Fair/poor health	0.001	-0.008	-0.016
	(0.005)	(0.035)	(0.016)
N	*4,321*	*4,321*	*6,177*
BIC	*1,637.3*	*12,350.9*	*6,061.0*

Note: Robust standard errors clustered at household level in parentheses; ***$p < 0.01$, **$p < 0.05$, *$p < 0.10$.

Table A3
Sensitivity analysis for investment age-rule financial behavior
This table reports the Probit estimates (marginal effects) of financial literacy on whether follow investment age-rule (=1 if % total net wealth in risky assets outside +/-20% of 100-minus-age investing rule, 0 else; mean= 0.66). This table is analogous to the results in the last column of Table 7 except that 20% bounds are used instead of 10% bounds. Other controls not shown include indicator variables for race and for missing values of controls. The data are from the 2015-2017 SLP survey.

Variable	Not follow investment age-rule	
	Probit	
FinLit Score	**-0.037**	***
	(0.008)	
Female	0.020	*
	(0.011)	
Married	-0.051	***
	(0.017)	
Age (Base group: 50-54)		
55-59	0.071	***
	(0.015)	
60-64	0.162	***
	(0.015)	
65-70	0.265	***
	(0.014)	
Education (Base group: Less than secondary)		
Secondary	-0.113	***
	(0.020)	
Post-secondary	-0.122	***
	(0.023)	
Home owner	-0.118	***
	(0.021)	
Risk tolerance	0.005	
	(0.018)	
Ln annual income	0.001	
	(0.014)	
Ln total net wealth	-0.051	***
	(0.013)	
Work for pay	-0.031	***
	(0.007)	
Manage HH finances	-0.061	***
	(0.017)	
Fair/poor health	-0.026	***
	(0.005)	
N	*6,318*	
BIC	*7,186.8*	

Note: Robust standard errors clustered at household level in parentheses; ***$p < 0.01$, **$p < 0.05$, *$p < 0.10$.

Appendix B

B.1. Variable definitions

The financial literacy questions were fielded in the Singapore Life Panel® in Dec 2015 (wave 5). Based on these, we construct our key variable of interest, the Financial Literacy Index, which counts the number of correct answers among those who answered all three financial literacy questions. Most of the other control variables are also drawn from the Dec 2015 wave including age, marital status, work for pay, and self-reported health. The asset and income module is fielded annually in the January/ February wave of the SLP® survey. For the present study, we extracted wealth (including home ownership) and income variables from the Jan/Feb 2016 wave,[28] elicited just one month after the financial literacy questions. *Total net wealth* is defined as the sum of financial wealth, bank accounts, insurance, pensions, vehicles, as well as primary and secondary residences, all net of debt.

Time-invariant characteristics such as sex, race and education are taken from the baseline survey that respondents completed when recruited into the SLP. Whether the respondent managed household finances is also reported in the baseline wave. We conducted the analyses at the respondent level, using individual-level information on financial literacy. Several other variables are elicited at the household level in the SLP, such as assets and income items. For those variables, we attach the household-level information to the individual-level records. See Table B1 below for detailed definitions.

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[28] To increase the number of available observations on assets and annual income, the asset and income module is also fielded in February to respondents who did not complete the survey in the preceding January wave.

Table B1
Detailed definitions of variables

Variable	Definition
Made credit card repayment error	=1 if R rolled over CC debt (in any month of calendar years 2016 or 2017) and debt amount < savings balances in the Jan month of the same year and the Jan month of the year after, 0 otherwise
Stock non-participation	=1 if R reports not having stocks or mutual funds (inclusive of CPFIS stocks and mutual funds) in both 2016 & 2017, 0 otherwise
Not follow investment age-rule	=1 if R's % of total net wealth that is held in risky assets (stocks +mutual funds+primary & secondary housing) is not within +/-10% of 100-minus-age rule, 0 otherwise. Sensitivity analysis considered +/-20% of 100-minus-age rule.
Number of suboptimal behaviors	=0-3, sum of three types of suboptimal behaviors
FinLit total score	# of correct answers to 3 financial literacy questions in wv 5
Female	=1 if R is female, 0 otherwise (baseline)
Married	=1 if R is married, 0 otherwise in wv 5
Age	= age at wv 5, also used to define age bands 50-54, 55-59, 60-64, 65-70
Race	Indicator variables for Chinese, Malay, Indian and "others"
Education	Indicator variables for primary, secondary and post-secondary education
R manages finances	=1 if R manages household finance fully or partially, 0 otherwise
Home owner	=1 if R owns home, 0 otherwise in wv 6/7. For a few missing cases we used the nearest available observation from wv 18/19 and wv 30/31.
Risk tolerance	=1 if R reports willingness to take financial risks >5 on a scale from 0-10, 0 otherwise
Work for pay	=1 if R works for pay in wv 5, 0 otherwise
Fair/poor health	=1 if R reported health status fair or poor in wv 5, 0 otherwise
Ln household total net wealth	A continuous variable equal to log of household total net wealth (S$) in wv 18/19.
Ln household net financial wealth	A continuous variable equal to log of household net financial wealth (S$) in wv 18/19.
Negative total net wealth	=1 if household total net wealth<=0
Negative financial net wealth	=1 if household financial net wealth<=0
Ln annual household income	A continuous variable equal to log of household annual income (S$) in wv 18/19.

B.2. Question wording of key variables

Variables relevant to constructing credit card repayment error (elicited every wave)
C102. The next questions are about credit cards. Do [you and/ or your spouse] have one or more credit cards?
1 Yes
5 No

C103. Last month, did [you and/ or your spouse] pay off all your credit card debt or was there an unpaid debt that you carried over to this month?
1 Paid off all
2 Carried over unpaid debt

C104. How much credit card debt did [you and. or your spouse] carry over from last month to this one?
We would like to know the amount on which you are charged interest.
If you paid off the amount required to avoid interest charges, then please enter zero.

C105. How much interest were [you and/ or your spouse] charged last month on your credit cards?

Stock market non-participation (Jan/Feb'16; Jan/Feb'17)
A4240. Aside from anything you have already told us about, do [You and your spouse] have any shares or stocks?
1 Yes
5 No

A4400. Aside from anything you have already told us about, do [You and your spouse] have any managed funds, mutual funds or unit trusts; which hold shares, bonds, money and other investments?
1 Yes
5 No

A1110. Do you currently have any investments made through the CPFIS-OA scheme?
1 Yes
5 No
98 Don't know

A1122. Which assets have you invested in through the CPFIS-OA scheme? Please check all that apply.
1 Fixed Deposits
2 Government Bonds (Singapore Government Bonds, Statutory Board Bonds, Bonds Guaranteed by the Singapore Government)
3 Corporate Bonds
4 Annuities
5 Endowment Insurance Policies

6 Shares
7 Collective Investments such as Unit Trusts, Exchange Traded Funds, Fund Management Accounts, Property Funds, or Real Estate Investment Trusts
8 Investment-Linked Insurance Products
9 Gold

A1130. Do you have any investments made through the CPFIS-SA scheme?
1 Yes
5 No
98 Don't know

A1142 Which assets have you invested in through the CPFIS-OA scheme? Please check all that apply.
1 Fixed Deposits
2 Government Bonds (Singapore Government Bonds, Statutory Board Bonds, Bonds Guaranteed by the Singapore Government)
3 Annuities
4 Endowment Insurance Policies
5 Collective Investments such as Unit Trusts, Exchange Traded Funds, Fund Management Accounts, Property Funds, or Real Estate Investment Trusts
6 Investment-Linked Insurance Products

Age-rule mistake (asset variable from Jan/Feb'17 only)

Ragedobok. Respondent's age verified by module Demographics (Fixed from Baseline)

Hatotbw. Total wealth (housing own share - incl. secondary residence) (impw) Derived Variable

A4240. Aside from anything you have already told us about, do [You and your spouse] have any shares or stocks?
1 Yes
5 No

A4400. Aside from anything you have already told us about, do [You and your spouse] have any managed funds, mutual funds or unit trusts; which hold shares, bonds, money and other investments?
1 Yes
5 No

A1110. Do you currently have any investments made through the CPFIS-OA scheme?
1 Yes
5 No
98 Don't know

A1122. Which assets have you invested in through the CPFIS-OA scheme? Please check all that apply.

1 Fixed Deposits
2 Government Bonds (Singapore Government Bonds, Statutory Board Bonds, Bonds Guaranteed by the Singapore Government)
3 Corporate Bonds
4 Annuities
5 Endowment Insurance Policies
6 Shares
7 Collective Investments such as Unit Trusts, Exchange Traded Funds, Fund Management Accounts, Property Funds, or Real Estate Investment Trusts
8 Investment-Linked Insurance Products
9 Gold

A1130. Do you have any investments made through the CPFIS-SA scheme?
1 Yes
5 No
98 Don't know

A1142 Which assets have you invested in through the CPFIS-OA scheme? Please check all that apply.
1 Fixed Deposits
2 Government Bonds (Singapore Government Bonds, Statutory Board Bonds, Bonds Guaranteed by the Singapore Government)
3 Annuities
4 Endowment Insurance Policies
5 Collective Investments such as Unit Trusts, Exchange Traded Funds, Fund Management Accounts, Property Funds, or Real Estate Investment Trusts
6 Investment-Linked Insurance Products

A5050. Primary residence
What would that house or apartment be worth if sold?
Raw integer plus imputed bracket values & winsorized

A5080. Primary residence mortgage owed
About how much do you still owe on the mortgage?
Raw integer plus imputed bracket values & winsorized

A6010. Secondary residence
If you sold all those properties about how much money would you get?
Raw integer plus imputed bracket values & winsorized

A6060. Secondary residence mortgage owed
About how much in total do you still owe on the mortgage?
Raw integer plus imputed bracket values & winsorized

B.3. Construction of credit card repayment error variable and associated costs

A credit card repayment error is deemed to have occurred in a given month if the respondent rolled over credit card debt despite having sufficient saving balances, leading to a non-zero interest charge being imposed that month. Credit card repayment errors are evaluated only among respondents who own at least one credit card (*n*=4,321). Only credit card holders who participated in the SLP® survey for at least nine months during a year are included to ensure that ample monthly observations of credit card repayment behavior are available over a year.

Based on monthly records of credit card debt rollover, 378 of the 4,321 credit card holders had at least one rollover transaction during the 24-month period covering 2016 and 2017. For these 378 persons, we evaluate whether each of their rollover transaction(s) constituted a repayment error. If the dollar amount of credit card debt rolled over in a given month was less than the household's balances held in checking and savings accounts reported in the asset modules in the previous and the following annual assessment, then a repayment error occurred. For example, if the rollover transaction occurred in June 2016, we compare the amount rolled over against checking and saving balances in Jan/Feb 2016 and Jan/Feb 2017. If the rollover transaction occurred in February 2017, we compare the amount rolled over against saving balances in Jan/Feb 2017 and Jan/Feb 2018. This approach assumes that total checking and saving account balances of respondents do not vary widely over the year. We find that 188 of 378 persons with rollover transactions committed at least one credit card repayment error over the 24-month period. For these 188 persons, the "any credit card repayment error" indicator variable is set to 1.

Next, we sort these 188 persons into bins based on their frequency of errors and compute an annualized statistic which we define as the average number of credit card repayment errors committed per year. For most subjects (173 persons), the annualized statistic simply equals the

sum of all errors committed divided by two, since they were observed in both 2016 and 2017. If a subject had a positive number of errors in one year and zero error in the other year, we include both data points in computing the average. For the handful of subjects where sufficient information is only available in a single year, the annualized statistic is based on information from that year.

For persons who committed repayment errors, we then extract the corresponding penalty interest charges for each rollover transaction from the data. The SLP question is phrased as follows: "How much interest were [you and/ or your spouse] charged last month on your credit cards?" Any applicable fees for late payment were not queried and therefore are not included in our cost calculations. The records of interest charges are relatively complete: 88% of observed repayment errors were associated with a report of non-zero interest charges (7% had zero values, and the remaining 5% had missing values). We imputed the missing and zero interest charges using the mean interest charge of S$230. To estimate the average annual cost of errors by bin in Fig 2, we sum the annual interest charge incurred across all persons in a given bin and compute the average.

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