Essays on Financial Literacy, Cognitive Ability and Financial Decision-Making

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A thesis is submitted for the

degree of PhD in Finance

Essex Business School

University of Essex

September 2020

I thank my Heavenly Father who through Jesus Christ gave me His grace.

It is more than I deserve,

greater than I imagine,

and that is all that I need.

Acknowledgements

A special thank you to Dr Jose Manuel Linares Zegarra and Professor Michael Lamla.

You have kept keen eyes on everything from navigating this project with your insights and timely advice to providing the necessary encouragement to complete this work.

I can never thank you enough for your hours upon hours of dedication.

Family and friends,

thank you for your unceasing prayers which have given me the strength to persevere and not grow weary. I thank my God every time I remember you.

Abstract

This thesis consists of three empirical essays which analyse the impact of financial literacy and cognitive ability on financial decision-making. The first essay examines the relationship between financial literacy and stock market participation in the higher education context. Using a novel survey of Indonesian students, this essay provides evidence that advanced financial literacy is a key determinant of financial decision-making: students with higher advanced financial literacy are more likely to participate in the stock market. These findings have important policy implications for achieving higher levels of access to finance in Indonesia as the majority of youths only display basic financial knowledge, and few go beyond these basic concepts.

The second essay analyses the influence of exponential growth bias on portfolio allocation of retirement savings. Exponential growth bias refers to individuals' underestimation of the effects of exponential growth. Using a new survey of Indonesian employees from various sectors, the results show that exponential growth bias matters empirically for portfolio choice. Bias employees favour short-term over long-term assets in their portfolio and have propensity to acquire illiquid assets. This implies that bias can significantly affect employees' retirement wealth due to non-optimal planning.

The third essay assesses the relationship between cognitive ability as a key information-processing function and financial asset participation. Using the Indonesian Family Life Survey, which is representative of about 83% of the Indonesian population, the findings provide evidence that individuals with higher cognitive ability are more likely to hold financial assets than those with lower cognitive ability. Furthermore, the results show some evidence that the relation

between cognitive ability and financial asset holding is mediated by two behavioural parameters: risk tolerance and patience traits. These results have important policy implications for drawing individuals into the formal financial market and improving individual welfare in Indonesia.

Table of Contents

List of Tables

List of Figures

Chapter 1
Introduction

Throughout their lifetime, individuals are now more responsible for their personal finances than ever before. With life expectancies rising, changes in social demographics, and immature pension systems in most developing countries, the responsibility for retirement saving and investing has shifted away from governments towards individuals. Simultaneously, financial markets are rapidly changing with new and more complex financial products. The range of financial products people have to choose from is very different from what it was in the past, and decisions made in choosing these financial products have implications for individual well-being. In this context, it is important to understand of how well-equipped individuals are to make these challenging financial decisions, and to what extent their financial knowledge and ability affects financial decision-making.

Two essential indicators of individuals' ability to make financial decisions are their level of financial literacy and cognitive ability. The Organization for Economic Co-operation and Development (OECD, 2020) precisely defines financial literacy not only based on the knowledge and understanding of financial concepts and risks, but also the skills, motivation, and confidence to apply such knowledge and understanding in order to make effective decisions across a range of financial contexts; to improve the financial well-being of individuals and society; and to enable participation in economic life. Financial decision-making may involve not only financial literacy or

accumulated knowledge, but also involve aspects of cognitive ability, such as retrieving relevant financial information from memory and the ability to draw inferences about what is the best solution to a novel problem (McArdle, 2011). This thesis covers an analysis of financial literacy and cognitive ability and their importance in financial decision-making.

1.1. Background and Motivation

In the context of rapid changes and constant developments in the financial sector, it is important to understand whether people are financially knowledgeable enough to effectively make financial decisions. The importance of financial literacy is confirmed by studies assessing financial literacy across many countries. The first examination of financial literacy was conducted by Lusardi and Mitchell (2008), who devised a module of financial literacy for the 2004 U.S. Health and Retirement Study (HRS), which is a survey of Americans over the age of 50. Their questions aimed to test basic financial knowledge related to the workings of interest compounding, the effect of inflation, and risk diversification. Surprisingly, they found that financial illiteracy is widespread with only half of older Americans, who presumably had made many financial decisions in their lives, being able to answer the basic questions measuring their understanding of interest rates and inflation.

Over time, other countries have started to incorporate the same questions into their national surveys to measure financial literacy. Lusardi and Mitchell (2011b) report findings from 15 countries which show that financial illiteracy is widespread even when financial markets are well developed, such as in Germany, the Netherlands, Sweden, Italy, Japan, and New Zealand. The fact that levels of financial literacy are so similar across countries with

varying levels of economic development shows that income levels or ubiquity of complex financial products do not equate to a more financially literate population.

While financial illiteracy is widespread among adults, including the elderly, financial illiteracy is also prevalent among the young. The goal of evaluating youth financial knowledge around the world has been recently taken up by the Organization for Economic Co-operation and Development (OECD). The OECD's Programme for International Student Assessment (PISA) was conducted in both 2012 and 2015, determining that, on average, only 10% of 15-year-olds achieved maximum proficiency on a five-point financial literacy scale. As of 2015, approximately one in five students did not even have basic financial skills (OECD, 2017).

There is ample evidence of the impact of financial literacy on people's decisions and financial behaviour. Financial literacy has been proven to affect both saving and investment behaviour, and debt management and borrowing practices. Financially literate people are more likely to invest in the stock market which normally offers higher rates to return (van Rooij et al., 2011). Several studies have documented that those who have higher financial literacy are more likely to plan for retirement (Lusardi & Mitchell, 2007; van Rooij et al., 2012), probably because they are more likely to appreciate the power of interest compounding and are better able to perform calculations. Empirically, planning is a very strong predictor of wealth; those who plan arrive close to retirement with two or three times the amount of wealth as those who do not plan (Lusardi & Mitchell, 2011a). With regard to debt behaviour, those who are more financially literate are less likely to have credit card

debt and more likely to pay the full balance of their credit card each month rather than just paying the minimum due (Lusardi & Tufano, 2009, 2015).

While the results from various surveys and research mentioned above focus on financial literacy in developed countries, empirical research in developing countries is scarce but does show a similar pattern, nonetheless. For example, research from the Indonesia Financial Services Authority (IFSA, 2017) suggests that Indonesians have limited knowledge about the stock market and its products. Moreover, across occupation groups, student and college students generally display a low level of financial literacy. A lack of financial literacy might be responsible for low participation in capital markets, fewer savings, and a small proportion of financial assets in portfolios which, in turn, has an impact on wealth accumulation.

The low levels of financial literacy both in developed and developing countries, and the impact that it has on financial behaviour, demonstrates the need for and importance of financial education. To remedy financial illiteracy, many countries have increased efforts in recent years to implement and provide financial education in schools, colleges, and workplaces. Nonetheless, the continuously low levels of financial literacy across the world indicate that a piece of the puzzle is missing. A key lesson is that when it comes to designing and evaluating the effectiveness of financial education, it is necessary to distinguish its effects on people's behaviour theoretically from practically (Lusardi and Mitchell, 2014). For example, the Indonesian government mandates financial education in schools with an objective to increase saving culture among students (IFSA, 2016). The programme's content includes a course on financial institutions in Indonesia. The knowledge about financial institutions might increase students' financial literacy as it is proven by high test scores in the end of the course. However, an increase in financial literacy theoretically

is not necessarily equal to an increase in actual savings as aimed for, because what matters to boost saving is, for instance, knowledge about compound interest that informs students of the effect of exponential growth on the future value of money they save today. Therefore, if the policy makers are intending to change people's behaviour practically, for example, to encourage citizens to participate in the stock market to shift a nation from a saving society to an investing society, or to urge workers to tilt their portfolio to long-term and high-return assets for retirement, they should identify the knowledge that empirically matters to targeted outcomes and then incorporate this knowledge into financial education programmes and solutions.

Accordingly, to be effective, financial literacy initiatives need to include specific and tailored content (Lusardi, 2019). Earlier studies suggest general education in financial literacy and personal finance to improve the level of financial knowledge (e.g. Morton, 2005; Lusardi & Mitchell, 2007). However, this general financial education is costing billions of dollars annually, but only explains 0.1% of the variance of the analyzed financial behaviours (Fernandez et al., 2014). More recent studies recommend financial education with specific content to achieve the targeted outcomes as an alternative to general financial education so that this approach would be more cost-effective (Foltice & Langer, 2017, 2018; Song, 2020).

Another issue of financial literacy is whether it measures knowledge or simply ability and cognition. Financial decision-making is often not straightforward for most individuals and may depend in part on several dimensions of cognitive ability. This may involve crystallized intelligence, i.e. the accumulated knowledge and skills from education and lifetime experience; and fluid intelligence, i.e. the ability to retrieve relevant financial information previously learnt from memory and to draw inferences about what is the best solution to a novel problem. In other

words, fluid intelligence can be thought of as the *thinking* part and crystallized intelligence as the *knowing* part (McArdle et al., 2011). Investment will be greater among individuals who have lower costs or greater efficiency in acquiring additional knowledge because of greater fluid intelligence or because they have more financial knowledge obtained in their formal education or on the job. Because financial decision-making involves fluid intelligence and financial knowledge as a component of crystallized intelligence (Delevande et al., 2008), one must control on measures of cognitive ability when seeking to disentangle the separate effect of financial literacy (Lusardi & Mitchell, 2014). Differentiating the effects of financial literacy from cognitive ability on financial decision-making has important implications for public policy and for the effectiveness of financial education programmes. For example, if cognitive ability influences stock market participation, financial literacy programmes may be less effective, and thus rather than delivering financial literacy education, it may be more appropriate to incorporate language or math courses into the school curriculum to increase cognitive ability.

This thesis aims to examine the effects of financial literacy and cognitive ability on financial decision-making in the real world. The second purpose of the study is to identify the component of financial knowledge that drives individual's financial behaviour by exploring different specific measures of financial literacy. Each measure of financial literacy will be assessed in Chapter 2 and Chapter 3, while the measure of cognitive ability will be examined in Chapter 4. Moreover, the findings of the thesis will be relevant in designing cost-effective financial education as the results will provide information about and insight into specific financial knowledge that matters for real world financial decisions.

1.2. Financial Education, Regulations and Policies in Indonesia

Indonesia is the fourth-largest country in the world and the third-largest country in Asia by population. It has a population of more than 270 million people spread out over 17,000 islands. The country's rapid development in the 1970s drove a high urbanization rate that started to skyrocket in the late 1980s and eventually surpassed the rural population in 2010. In 1970, the 83% of Indonesian lived in rural areas whereas the share reduced to 44% in 2019 (World Bank, 2020a). As an emerging middle-income country, Indonesia has made incredible gains in reducing poverty and has cut the country's poverty rate in half in twenty years, dropping it to 9.2% in 2019. Out of 270 million people, around 25 million still live below the poverty line and they are spread mostly in rural areas (60%) and the rest in urban areas (40%) (Indonesia Central Bureau of Statistics, 2020).

Compared to Western nations, Indonesia's population is quite young. The country's median age is 28.7 and although it is slowly rising, it is only predicted to hit 36 years of age by 2050. People aged 20 to 54 account over 50% of the country's total population, and this age group is of significant importance for their high earning and purchasing power. This age group accounts for almost 78% of the country's employed population and their gross income is 75% of the gross national income, making this youthful population the single biggest driver of the country's economy and consumerism (World Bank, 2020b).

Indonesia has an underdeveloped financial sector and a shallow capital market. The Indonesian financial sector remains small and far more dominated by banks than its regional peers. In 2013, financial sector assets to gross domestic product (GDP) were at 103% compared to approximately 194% for the Philippines, and over 300% of GDP for Malaysia, Singapore, and

Thailand. In the equity market, the market capitalization as a percentage of GDP is below 50%, whereas the ratio of the other ASEAN comparators all exceeded 90% of their respective GDPs (Ismail, 2015). Underdeveloped financial sector is synonymous with financial exclusion, i.e. a lack of access to, and use of, a range of formal financial services. Financially excluded people typically exhibit one or more of the following characteristics: a lack of a bank account and the financial services that come with it, a reliance on alternative forms of credit such as doorstep lenders, a lack of other key financial products such as insurance, savings and investment products, and pensions.

The use of informal financial services is common in Indonesia. Recent nationally representative survey of Indonesia financial inclusion (Financial Inclusion Insight, 2017) have shown that only about 16% of the adult population has borrowed money from the banking sector and that adults, particularly those living below the poverty line and in rural areas, typically access loans in cash from family, friends, or neighbours. Regarding savings behaviours, thirty-five percent of Indonesians said their savings exceeded their debt and 60 percent had ever saved in their lives. However, these savings are not making it into formal financial services. Thirty-four percent of adults said they only saved with informal institution, while 15 percent only saved with formal institutions.

There is also a culture of informal saving or lending groups – known locally as *arisan* – with people seeing it as a trusted loan-distribution system. In the *arisan* system, members pay in an agreed amount of money and then recoup a lump sum of money at a given moment. Of those who participate in these informal groups, 40% said it was to help one another with unexpected expenses such as funerals and 23% did so to save and lend money to members to be repaid with

interest (Financial Inclusion Insight, 2017). The number of *arisan* is estimated to be in the millions. Many people join more than one *arisan* for economic and social purposes, while others manage *arisan* as a side job. Farmers also commonly get in-kind loans of rice and farm inputs from traders or shopkeepers at prices higher than cash prices. Commercial money lenders are also still operating in rural areas and catering to the short-term needs of the poorest (Martowijoyo, 2007).

Financial exclusion might has its roots in Indonesia's national economic development strategy during the so called "New Order" era before Asian financial crisis in 1997-1998. During the New Order era (1966-1998) Indonesia experienced rapid economic development and annual growth rates of 6%-8% (Tambunan, 2015). The regime lowered rates of poverty through rural economic development based on agricultural modernisation and industrialisation. Although the government seriously tried address poverty issues in the country and initiated many pro-poor programmes, which led to a significant decline in poverty rates, the gap between the rich and the poor did not decline significantly. In fact, during this era, the adopted developing strategy was more exclusive rather than inclusive, as many regulations, policies, and facilities favoured a small group of big companies or conglomerates at the cost of micro, small, and medium-sized enterprises (MSMEs) (Tambunan, 2012).

The Asian financial crisis of 1997-1998 hit Indonesia particularly badly. Indeed, it was the most severe economic crisis to occur in Indonesia since the country's independence in 1945. It led to economic recession in 1998, with level of growth of –13% (Tambunan, 2015). Following Indonesia's recovery from the recession, the country has undergone a profound transformation. The new era that followed the Asian financial crisis was known as the "Reform" era. Wide reforms has been carried out in all areas of economic, social, and political policy. The political system has

been fundamentally transformed by the implementation of democracy and decentralisation. In social and economic terms, Indonesia had adopted a new development strategy, namely, "inclusive" economic development and growth. In this inclusive development, the Indonesian government had adopted a triple-tracked strategy, i.e. pro-growth, pro-job, and pro-poor. This strategy is considered important for Indonesia, given that despite robust economic growth after the 1998 crisis, Indonesia still faced serious poverty issues (Tambunan, 2012).

One important element of inclusive economic development is financial inclusion, which defined by Bank Indonesia – the Indonesian central bank – as broad or full public access to financial services, including the poor (Hadad, 2010). It focuses on creating economic opportunities and making them accessible to everyone in society at all levels. An economic development process is said to be inclusive when all members of a society participate in, and contribute to, that process equally regardless of their individual circumstances or backgrounds. Inclusive economic development therefore, is the process of ensuring that all marginalised and/or excluded groups within a society are included in the development process (Rauniyar & Kanbur, 2009).

Tambunan (2012) state that many countries, especially those in South Asia and some parts of Africa (notably sub-Saharan Africa), still struggle to lower poverty and have a large proportion of their citizens living in extreme states of deprivation. This happens because many groups, so called "disadvantaged" people, such as women, children, those suffering from HIV/AIDS, ethnic minorities, nomads, and people in conflict and/or refugee situations, have been marginalised or excluded from participation in economic development. Poverty is a

consequences and also a cause of disadvantage and thus, poverty will not be alleviated without including disadvantaged people in the economic development process.

The Indonesian Government strongly believes that improving access to finance and improving the use of financial services will raise people's welfare. The Government has recognised that the success of financial inclusion depends on many factors, the most important one is the level of financial literacy of the population. This factor is considered crucial because the average level of formal education in Indonesia is still low (the majority of the population only has a primary education). In turn, financial literacy is dependent on three factors: financial education, financial information, and the availability of financial tools (Wibowo, 2013).

Bank Indonesia has taken several concrete course of action since 2007 by making a blueprint of financial education and creating a timetable for the programme. From 2011 onward, they planned that education programmes would be offered to the public, including students, children, and youth. Form 2012 onward, the programme would be offered to migrant workers, and from 2013 onward to fishermen, communities in border and remote areas, and civil society. From 2014 onward it would be offered to cooperatives and MSMEs, and from 2015 onward to factory workers. The goals of financial education, as formulated by Bank Indonesia, are to: (1) build bank-mindedness and awareness in society, (2) build public understanding of banking products and services and awareness of customer rights and obligations, (3) build risk awareness in relation to financial transactions, and (4) disseminate information about the complaints and dispute-resolution mechanism for resolving problems with banks (Wibowo, 2013).

Financial education programme involve several activities. In 2008, a national campaign, called "Let's go to the bank", was conducted by Bank Indonesia in cooperation with all

commercial and rural banks, and was aimed at local communities, especially workers and students. Leaflets, booklets, brochures, and comics have been distributed from 2008 onward; and education car that visited public areas, such as schools, markets, housing complexes, and office buildings. Advertising began in 2009 for the Indonesian saving programme, called “My Savings”, which was launched in Jakarta – the capital and largest city of Indonesia – and 41 other big cities in Indonesia. The aim of the campaign was to improve consumer understanding of financial services, products, planning, management, and literacy (Hadad, 2010; Wibowo, 2013).

Given the course of action, a positive correlation would be expected between the financial education programme and financial inclusion. However, financial inclusion, financial literacy, and financial consumer protection policies need to evolve in parallel if they are to contribute to the financial well-being of the population and to inclusive growth. A well-designed consumer protection can generate consumer trust and confidence, leading to more active and appropriate use of financial products and services by consumers. Microfinance institutions in Indonesia have largely operated without a comprehensive regulatory framework to guide their operations, and with little supervision from Bank Indonesia. Many semi-formal and/or informal institutions such as rural credit fund institutions, microfinance cooperatives, credit unions, and non-government organisations, are outside the legal framework of banks, and do not have a clear legal status in the financial system. This might represent a risk for small depositors and create an unreliable source of cheap funds. In order to regulate the financial sector, including the operation of all microfinance institutions in the country, the Indonesia Financial Services Authority (IFSA) was established as an autonomous agency in 2011.

In order to strengthen the role of IFSA, the Government issued the Microfinance Institution Law No.1 of 2013, which was enacted on January 2013. The law governs all aspects of microfinance institutions operating in Indonesia. The IFSA is given extensive powers under the law to develop, regulate, and supervise microfinance institutions. Under the law, several requirements must be fulfilled for the establishment of a microfinance institution. It must have a legal status as either a cooperative or a limited liability company, and it must meet the capital requirements. It also must obtain a business license from the IFSA (Eddymurthy & Kolopaking, 2013). The IFSA also initiated a programme to increase public knowledge about financial literacy called the "National Financial Literacy Strategy" in 2013. This programme has three aims, namely to boost financial literacy education through public campaigns, to strengthen financial infrastructure, and to develop accessible and affordable financial services products (Qorib & Sidauruk, 2013). Table 1.1 reports the evolution of financial sector in Indonesia which has been affected by political, social and economic changes.

Table 1.1. The Evolution of Financial Sector in Indonesia.
This table reports the main events of political, social, and economic changes which influence the evolution of financial sector in Indonesia before and after Asian financial crisis in 1997-1998.

1966 – 1998	During the New Order era, the development process was indeed exclusive and favoured only certain groups in society, i.e. those who were considered important by policy makers.
1997 – 1998	Indonesia was badly affected by the Asian financial crisis and, following that, by social and political disturbances and conflicts. This multidimensional crisis led to the fall of New Order regime in May 1998.
1998	Asian financial crisis in 1997-1998, which hit Indonesia particularly badly, led to an economic recession in 1998.
After 1998	In the new era that followed the Asian financial crisis, known as the Reform era, government attention has been shifting toward inclusive economic development.

	One important element of inclusive development is financial inclusion, which means broad access to financial services. This implies an absence of price and non-price barriers that might deter people from obtaining financial services.
2007 – 2015	Bank Indonesia implemented financial education to the public, lower class, society in remote or border areas, society with certain types of works which is assumed lack of financial knowledge. The goals of financial education are building bank-mindedness in society, build public understanding of banking products and services, awareness of customer rights and obligations, risk awareness in relation to financial transactions, and informing public about dispute resolution mechanism for resolving problems with banks. Activities in the financial education program include: (1) The launch of a national campaign "Let's Go to the Bank" in 2008 which was conducted by Bank Indonesia in cooperation with all commercial and rural banks, and was aimed at local communities, especially workers and students, (2) the launch of Indonesian saving program, "My Savings" in 2009 in Jakarta – the capital city – and 41 other big cities in Indonesia.
2011	The Indonesia Financial Services (IFSA) was established as an autonomous agency in order to regulate the financial sector, including the operation of all microfinance institutions in Indonesia.
2013	The Microfinance Institution Law No.1 of 2013 was issued in order to strengthen the role of the IFSA. The law governs all aspects of microfinance institutions operating in Indonesia, from their establishment, to their areas of operation and their permitted activities. The IFSA has initiated National Financial Literacy Strategy to increase public knowledge about financial literacy. This programme aims to develop well literate and financially inclusive society.

Indonesia has a strong reason for adopting financial inclusion as its national development policy objective given that only a small part of Indonesia's total population has access to formal financial services; the financial sector is highly concentrated, i.e. dominated by banks, and with a low penetration of pension funds, insurance, and other non-bank financial institutions; and poverty is still a serious problem in Indonesia (Tambunan, 2015). The most frequently used indicator to measure the level of financial inclusion is the ownership of financial institution

account. Column 2 of Table 1.2 shows the percentage of adults with age above 15 who report having an account (by themselves or together with someone else) at a bank or another type of financial institution, such as credit union, a microfinance institution, a cooperative, or having debit card in their own name (World Bank, 2017). The 2014 Global Financial Inclusion Index from the World Bank (World Bank, 2017) shows that there is wide variation in account ownership among countries in East Asia and Pacific region, even within income groups. Consider the lower-middle-income group, where the share of adults with an account varies from about 13 percent in Cambodia to as high as 53 percent in India. Among upper-middle-income countries, the share with an account ranges from 78 percent in Thailand to 81 percent in Malaysia. Account ownership is nearly universal in high income economies, where 93 percent of adults have an account. In developing economies – those classified by the World Bank as low or middle income – the share is 54 percent. Further, Column 3 of Table 1.2 shows the percentage of adults who reported saving or setting aside any money in the past 12 months for old age in 2014. The share who saved for pension is relatively low in lower-middle-income countries compared to upper-middle-income countries. Old-age saving in developing economies is only 20 percent in contrast to high income economies with 38 percent.

Overall, developing economies are characterised by low access to banking services or formal financial institutions and low retirement saving which suggests an increased need to improve financial literacy of individuals given the transfer of a range of financial risks to consumers, growing complexity and evolution of financial products/ markets. Financial literacy is therefore play an important role in protecting consumers and further building trust and confidence in the financial sector. Cognitive ability also supports financial inclusion by equipping

individuals with skills to gather, process, and understand financial information in making optimal financial decisions. Thus, financial literacy and cognitive ability are especially relevant in developing economies such as Indonesia, many of which have low, but rapidly increasing, levels of access to financial services.

Table 1.2. Financial Institution Account Ownership and Saving for Old Age across Countries, Region, and Income Groups.

The selected countries are in East Asia and Pacific region. Column 1 shows the income group classification according to World Bank. Low-income economies are defined as those with a gross national income (GNI) per capita of $1,035 or less; lower-middle-income economies are those with a GNI per capita between $1,036 and $4,045; upper-middle-income economies are those with a GNI per capita between $4,046 and $12,535; high-income economies are those with a GNI per capita of $12,536 or more. Column 2 shows share of adults, age above 15, who reported having an individual or joint account at a bank or another type of formal, regulated financial institution in 2014. Column 3 shows share of adults, age above 15, who reported saving or setting aside any money in the past 12 months for old age in 2014.

	Income group	Share of population with financial institution accounts (%)	Share of population who saved for old age (%)
	(1)	(2)	(3)
Country			
Cambodia	Lower middle	13	29
Myanmar	Lower middle	23	16
Philippines	Lower middle	28	25
Vietnam	Lower middle	31	23
Indonesia	Lower middle	36	27
India	Lower middle	53	10
Thailand	Upper middle	78	59
China	Upper middle	79	39
Malaysia	Upper middle	81	54
Region/Income Groups			
East Asia & Pacific		72	37
Developing economies		54	20
Low income economies		17	7
Lower middle income economies		41	12
Upper middle income economies		72	30
High income economies		93	38

1.3. Research Findings

There exists a large literature from developed countries which explains the so-called "stockholding puzzle", i.e. the fact that many individuals do not hold stocks (Haliassos & Bertaut, 1995; Campbell, 2006). Nonetheless, the stock market non-participation puzzle is less investigated in developing countries, particularly in Indonesia. A prominent feature of Indonesia's emerging market is the size of capital market products utilization which is the lowest among other financial products, with a relatively low financial literacy of capital markets compared to financial literacy of other financial institutions, products, and services; Moreover, students and college students display relatively low levels of financial literacy across occupation groups (IFSA, 2017). The low level of stock market participation is the concern of the Indonesian government as Indonesians may fail to take advantage of the equity premium on stock holding. Therefore, investigating the determinant that prevents individuals from participating in the stock market is a challenge in the study of personal finance.

Given the limited stock participation and low capital market literacy, especially among youths, we assess financial literacy as a potential barrier to stock ownership in Chapter 2. Fixed learning and setup costs capturing both time and money are required in order to invest in the stock market are often regarded as barriers to entering the stock market. Financial literacy may reduce these costs and thereby encourage stock market participation (Haliassos & Bertaut, 1995; Campbell, 2006; Calvet et al., 2007; Jappelli and Padula, 2015).

The study uses a new data set of University students in Indonesia, based on two special modules of financial literacy widely used in the literature (van Rooij et al., 2011). The first module aims to assess basic financial literacy, which covers topics on interest rates, interest

compounding, the effect of inflation, discounting, and nominal versus real values. The second module measures more advanced financial literacy covering topics such as the working of the stock market and its products. Questions from this module have been used to construct two indices: a basic and an advanced financial literacy index.

The results show that the majority of students have some grasp of basic financial literacy, but many of them lack advanced financial knowledge. Freshmen and younger students are the groups displaying the lowest amount of financial literacy. Most importantly, students with low advanced literacy are less likely to participate in the stock market. These findings imply that many youths avoid the stock market because they have little knowledge of stock market instruments and how the stock market works. These are in concordance with the literature that financial illiteracy might increase participation costs and thus, can act as barriers for participation in the stock market.

Shifting Indonesians from a saving society to an investment society by encouraging stock market participation is not the only issue that concerns the government. Retirement saving preparedness is becoming an issue of growing importance in Indonesia as it has experienced prominent changes in social factors. Indonesians have traditionally relied upon their children to take care of their material needs in retirement. However, improvement in female education and better medical care have induced Indonesians to have fewer children and enabling them to live longer (Park & Estrada, 2012). Moreover, Indonesians do not have adequate social security pension benefit as a source of post-retirement income (OECD, 2019), implying that retirees would not be able to achieve a high standard of living in their old age. The combination of decreasing dependency on family, increasing retirement costs as people live longer lives, rising health care

costs, and inadequate social security pension benefit, is therefore a serious concern which highlights an urgent need for retirement saving preparedness. Hence, identifying the determinants of retirement savings and portfolio choice is of paramount importance for improving retirement welfare.

Optimal retirement saving behaviour requires an understanding of the relationship between current savings and income in retirement. Accordingly, Chapter 3 examines one specific definition of financial literacy: misunderstanding exponential growth, or more specifically, the effect of compound interest as a potential predictor of financial retirement decisions. Knowledge of compound interest is especially important for financial retirement decisions due to the long investment horizons. Previous study shows that exponential growth bias decreases long-term and high-yielding asset holding, but not short-term and low-yielding asset holding (Stango & Zinman, 2009). One explanation is that bias is more severe in long-term investment. When the compounding horizon lengthens, the value of investment will multiply more quickly. Consumers who neglect how quickly a given yield compounds will underestimate the expected future value by making it appear as a much lower return than the actual return and thus, making the long-term assets seem to be unattractive. On the other hand, the exponential effect becomes less significant in predicting future value in the short-term horizon and thus, even someone with severe exponential growth bias should correctly infer the future value of short-term assets. Therefore, bias should exert stronger effects over the long-term assets, but not short-term assets.

Knowledge of interest compounding is also a significant predictor for retirement planning, and individuals who plan for their retirement accumulate more wealth in home equity (Lusardi

& Mitchell, 2007). Nonetheless, it is possible that people acquire a house solely to meet their current basic necessities instead of a long-term asset to finance their retirement (Venti & Wise, 1990, 1991; Lusardi & Mitchell, 2007). Compound interest knowledge is also relevant in explaining savings behaviour. Individuals who neglect the effect of exponential growth believe that the expected return of savings is lower than the actual return and therefore decrease the likelihood of savings (Stango & Zinman, 2009; Levy & Tasoff, 2016; Goda et al., 2019). However, McKenzie and Liersch (2011) explain that highlighting the effect of exponential growth of retirement savings could decrease motivation to save, because people would realize that they will have more retirement savings than they otherwise expected. For a given saving goal at retirement, individuals can learn that they can save less than they thought and can still achieve their goal.

The study conducted a new survey of Indonesian employees from different industries. The survey asked employees to estimate a future value given a present value, time horizon, and interest rate. Future value bias measures the direction and magnitude of how responses deviate from accurate response. The findings of Chapter 3 show that employees displayed future value bias. Those who overestimate future value of savings are less likely to save; while those who underestimated the future value of savings have portfolios that tilt towards short-term and low-return assets rather than long-term and high-return assets, and they have propensity to acquire property merely to meet their current basic necessities. Furthermore, there is little evidence that exponential growth bias is a proxy for broader financial literacy. Financial sophistication is often defined as an input that reduces participation, learning, and setup costs (Campbell, 2006; Calvet et al., 2007; Christelis et al., 2010). Therefore, financial literacy will increase long-term asset

holding due to smaller fixed learning and setup costs (van Rooij, et al., 2011, 2012). If exponential growth bias captures broader financial illiteracy, we would see bias significantly decrease long-term asset holding. However, the results show that exponential growth bias has a small effect on long-term asset holding, implying exponential growth bias has a specific and distinct effect from financial sophistication defined more broadly.

Besides low stock participation and retirement preparedness, another important feature of emerging markets such as Indonesia is the small size of the formal financial market. The Indonesia Family Life Survey (IFLS) data from 1997 to 2014 (Frankenberg & Thomas, 2000; Strauss et al., 2004, 2009, 2016) confirm that only 1.29% of households hold financial assets, i.e. savings, certificate of deposits and/or stocks. On the contrary, the majority of the population tilt their portfolio towards non-financial assets, namely household furniture and utensils, appliances, vehicles, poultry, livestock, fishpond, a house and land occupied by the household, non-agricultural land, receivables and jewellery.

Participating in the financial market could return many advantages. A bank savings account can be an efficient saving technology, secure from theft, often paying interest, and potentially facilitating access to credit and other financial services (Cole et al., 2011). Stocks offer an opportunity to obtain equity premium and in turn, increase wealth (van Rooij et al., 2011). Therefore, understanding the determinants that prevent large sectors of the Indonesian population from holding financial assets is crucial in increasing individual's welfare and encouraging financial development in emerging markets.

Chapter 4 considers a setting in which cognitive ability may be one of the most important barriers to access financial market, as reported by OECD (2016) that Indonesians has the lowest

level of cognitive ability across countries and economics. Dealing with more information-intensive assets, such as financial assets, requires learning costs for which time and money must be spent to familiarise oneself with asset returns, volatility, and transaction costs. Low cognitive ability, which is manifested in a reduced ability to perform numerical calculations, to read and to recall information, might increase these costs and can act as a barrier preventing financial asset holding (Christelis et al., 2010).

Two channels may explain limited financial asset participation. First, cognitive limitations reduce individuals' ability to simultaneously consider all consequences of their decisions and subsequently, lead people to behave in a more risk averse manner due to failing to integrate individual risky decisions with future wealth (Read et al., 1999). Thus, lower cognitive ability that leads to risk aversion could be one mechanism to explain the limited financial asset participation. Second, higher cognitive ability results in being more patient and taking a longer-term view in intertemporal problems (McClure et al., 2004; Kirby et al., 2005; Parker & Fischoff, 2005; Shamosh & Gray, 2008), and more patient individuals are more likely to participate in the financial market (Benjamin et al., 2013). High levels of cognitive ability, which results in greater patience, could be another potential mechanism explaining financial asset holding.

In order to assess this causal mechanism, the study decomposes the effects of cognitive ability on financial asset participation into direct and indirect effects that are running through risk tolerance and patience channels. The data source for this study is the IFLS (Indonesia Family Life Survey) panel, a representative household survey of the Indonesian population conducted by RAND Corporation. The sample is representative of about 83% of the Indonesian population. The study uses panel data from 1997 to 2014. This study employs cognitive ability tests covering

language and maths tests, word recall tests that measure memory, and tests that measure fluid intelligence such as picture matching and pattern of number series. In addition to cognitive ability tests, this study also makes use of risk and time preference tests and financial asset participation available in IFLS.

The results show that cognitive ability affects financial asset participation. This implies that individuals with higher cognitive ability are more likely to hold financial assets, i.e. savings, certificate of deposits and/or stocks, than those with lower cognitive ability. It is also found some evidence that the relation between cognitive ability and financial asset ownership is mediated by risk tolerance and patience traits.

1.4. Research Contributions

Financial markets, both in developed and developing countries, have become increasingly accessible to the "small investor," as new products and financial services grow widespread. At the same time, most developing countries – in contrast to industrialized countries – do not yet have mature and well-functioning pension systems and, therefore, they are not well-prepared to provide economic security for retirees (Park & Estrada, 2012). The responsibility for saving and investing is increasingly forced onto workers, whereas in developed countries, most workers depend on government social security systems and private company pensions to smooth their consumption (McKee, 2006). Therefore, the ability to process economic information and make informed decisions about financial planning, wealth accumulation, and pensions is crucial, especially in developing countries such as Indonesia where stock market participation is low, formal financial market participation is low, and pension benefit is not adequate. Therefore,

investigating the determinants of financial decision-making in the real world is vitally important to increase individuals' welfare in an emerging economy.

This thesis identifies specific components of financial literacy which are important for financial decision making. Chapter 2 provides evidence that more advanced financial literacy – which covers topics such as the function of the stock market, the difference between stocks and bonds, and risk diversification – significantly encourages youths to participate in the stock market. Chapter 3 further explores another specific component of financial literacy, namely the knowledge about compound interest, and shows that it is an important predictor for employees' financial retirement decisions. Financial decision-making involves both knowledge and other aspect of cognitive ability, and so Chapter 4 examines cognitive ability and finds that cognitive ability affects financial asset ownership.

The thesis contributes to the personal finance and portfolio choice literature, especially in developing countries. It also brings some policy directions for effective financial education. First, it is empirically evident that financial literacy and cognitive ability are significant determinants of financial behaviour in the real world, recommending for financial literacy programmes and interventions designed to nurture cognitive abilities at an early stage of life with targeted school programmes, as evidenced that the early childhood environment has a strong impact on cognitive ability (Knudsen et al., 2006; Heckman et al., 2010; Chetty et al., 2011). Second, a component of financial literacy could have a specific and distinct effect from general financial literacy, suggesting that one should first identify specific financial literacy that significantly affects the targeted outcomes, and then incorporate this knowledge into financial education programmes. This should be of interest to policy makers as delivering specific financial

education might be more cost-effective than providing broader financial literacy or general personal finance education.

The thesis is organised as follows: Chapter 2 examines the relationship between financial literacy and stock market participation; Chapter 3 assesses knowledge about exponential growth and its association with financial retirement decisions; Chapter 4 tests the link between cognitive ability and financial asset ownership; and finally, Chapter 5 concludes.

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Chapter 2
Financial Literacy among Youths and Stock Market Participation

Abstract

The present paper uses survey data from Indonesia to analyze the relationship between financial literacy and stock market participation in the context of higher education. Youths' financial sophistication is measured by using basic and advanced financial literacy indices, based on the combination of numeracy skills and financial knowledge that individuals possess. Advanced financial literacy is a key determinant of financial decision-making: young people with higher advanced financial literacy are more likely to participate in the stock market. Results are robust to the endogenous characteristic of financial literacy. These results have important policy implications for achieving higher levels of access to finance in Indonesia as the majority of youths only display basic financial knowledge and few go beyond these basic concepts.

2.1. Introduction

There exists a large literature explaining a feature that has come to be known as the stockholding puzzle, i.e. the fact that many individuals do not hold stocks (Haliassos & Bertaut, 1995; Campbell, 2006). Previous papers suggest that household participation in the stock market is driven by factors such as trust in financial markets (Guiso et al., 2008), intelligent quotient (Grinblatt et al., 2011), cognitive abilities (Christellis et al., 2010), financial literacy (van Rooij et al., 2011; Jappelli and Padula, 2015), stock market literacy (Balloch et al., 2015), and sociability (Hong et al., 2004; Brown et al., 2008). While these studies focus on data from developed countries, the stock market nonparticipation puzzle is less investigated in developing countries, particularly in Indonesia.

An important feature of Indonesia's emerging market is the size of banking products utilization which dominates other financial products. The most recent national representative survey from Indonesia Financial Services Authority (IFSA, 2017) shows that 63.6% of the Indonesians hold banking products.[1] On the contrary, only 1.3% of Indonesians own capital market investment which is the lowest participation among other products from financial service industries, i.e. insurance, pension funds, financing companies, and pawn shops. Arguably, drawing these individuals into capital markets would potentially change saving behaviour to investing behaviour and, therefore, Indonesians would start to shift from being a saving society to an investing society.

Two leading views may explain limited stock market participation. First, because more sophisticated assets such as stocks involve high fixed costs, capturing time and money that must be spent in order to invest in the stock market, they are thus expensive to provide which may be the reason why low income individuals do not participate in the stock market. Indonesia is classified as a lower-middle-income country by the World Bank with a GDP below the world average (Amidjono et al., 2016). Given a lower-middle-income country, such high fixed costs might hinder Indonesians from stock market participation.

An alternative view argues that limited financial literacy serves as an important barrier to stock ownership; if individuals are not familiar or comfortable with certain products, they will avoid them. Low financial literacy is likely to increase these fixed costs and therefore could be a barrier for stock market participation, particularly for financially illiterate individuals (Campbell, 2006). The national survey conducted by IFSA (2017) indicated a relatively low financial literacy of the capital market compared to financial

[1] Indonesia Financial Services Authority (IFSA) is an Indonesian government agency which regulates and supervises the capital market and financial institutions, as well as that of Bank Indonesia (the central bank of Indonesia) in regulating and supervising banks, and to protect consumers of financial services industry.

literacy of other financial institutions, products, and services. The financial literacy index of the capital market is only 4.4% which is the lowest. On the other hand, the financial literacy index of banking is 28.9% which is the highest, whereas insurance, pension funds, financing companies, and pawn shop are in-between. This implies that Indonesians are not familiar with the stock market and have limited knowledge about its products and services.

The relatively higher knowledge of banking institution and products compared to other financial institutions might stem from financial education programme initiated by Indonesian government following Asian financial crisis 1997-1998 as part of national development strategy to increase financial inclusion. The Government has recognised that financial inclusion can be increased by improving the level of financial literacy of the population. Bank Indonesia, the central bank of Indonesia, thus has implemented financial education programme since 2007 with goals to build bank-mindedness and awareness in society and build public understanding of banking products and services. The financial education programme involves a national campaign, called “Let’s go to the bank” in 2008 and an advertising saving programme, called “My Savings in 2009. As reported in Table 1.1, Indonesian government has also implemented several financial regulations and policies to complement financial education programme in order to increase financial inclusion.

IFSA’s survey in 2017 also indicated that the levels of financial literacy are not evenly distributed among respondents. Across occupation groups, the highest level of the financial literacy index occurred among employees and professionals (39.9%), while financial literacy index of student and college students was only 23.4%. Accounting for 20% of Indonesia’s population, students are critical economic players. While young people may have limited savings to invest initially, they are potential future investors who may increasingly invest money into different types of investment products over time. At the same time, the range

of financial products becomes more complex and difficult to understand, especially for financially unsophisticated investors.

Since financial education for youths become increasingly important, Indonesia has initiated financial education as part of the national school and University curriculums to fight against financial illiteracy (IFSA, 2016). Although policy makers and educators have evaluated the effectiveness of the programme in improving financial literacy, the effectiveness of financial literacy in changing behaviour in the real world is less investigated. It might be worth disentangling the effect of financial education on changes in individuals' behaviour theoretically from practically since it could lead to different course content being delivered to students.

Our main goal in this paper is to assess the effect of financial literacy on important economic behaviour: stock market participation. To do so, we conduct a novel survey measuring financial literacy in the higher education context. The survey involves 952 University students in Indonesia. We make use of a special module on financial literacy designed by van Rooij et al. (2011). This module contains two set of questions. The first set of questions aims to assess basic financial literacy which covers topics ranging from the workings of interest rates and interest compounding, to the effect of inflation, discounting, and nominal versus real values. The second set of questions aims to measure more advanced financial knowledge which covers topics such as the function of the stock market, the difference between stocks and bonds, and risk diversification. Questions from this module have been used to construct an index of basic and an index of advanced financial literacy. We also collect information on respondents' stock market participation, i.e. a respondent holds stocks and/or mutual funds; their economics education; the need for understanding

economics in daily activities; parent's financial knowledge; and, demographic characteristics.

We find that the majority of respondents display a basic financial knowledge and have some grasp of concepts such as basic calculation, discounting, and nominal versus real values. However, few go beyond these basic concepts. Many respondents do not know the difference between stocks and mutual funds, the work of bonds, and characteristics of mutual funds. Furthermore, we find that freshmen and younger students are the groups displaying the lowest level of financial literacy, while there is little evidence that there is gender gap in financial literacy. Most importantly, advanced financial literacy significantly affects stock market participation: young people with advanced financial literacy are more likely to participate in the stock market. On the other hand, basic financial literacy is not significantly correlated with stock holding. Furthermore, we consider the fact that financial literacy is an endogenous characteristic which can be influenced by others' financial behaviour, for example, students can learn from negative experience of parents. We thus instrument advanced financial literacy with parent's financial knowledge and find that those whose parents have a low understanding of financial matters are more likely to have high financial literacy, and these individuals have higher propensity to participate in the stock market.

This paper makes four contributions to the existing studies. First, we develop two indices of financial literacy which allow us to distinguish among different levels of financial sophistication and convey different financial content. The first index is related to basic financial knowledge which covers concepts which lie at the basis of basic financial transactions, financial planning, and day-to-day financial decision making. The second index

captures more advanced financial knowledge related to investment and portfolio choice. Incorporating this information can significantly enhance the studies on portfolio choice.

Second, we provide a contribution towards an explanation for the stockholding puzzle, i.e. the fact that so many individuals do not hold stocks (Haliassos & Bertaut, 1995; Campbell, 2006). We show that many individuals avoid the stock market because they have little knowledge of stock market instruments and the workings of the stock market. Third, by conducting a new survey on University students in Indonesia, we consider a section of the Indonesian population that can be classified as being educated. Given the fact that educated young people lack stock market and investment knowledge, financial literacy could be even considerably lower for the average population. This finding improves the existing literature and has important policy actions to increase financial literacy among youths and the overall population.

Fourth, we show that the relationship between advanced financial literacy and stock market participation is robust even after we incorporate additional controls beyond basic demographics. We include economics education which is more important for stock ownership than the level of schooling as economics education is more closely related to financial literacy than the level of education. We also incorporate information about the need of economics understanding in daily activities as involved in a job or hobby that requires a lot of economics knowledge can increase one's financial literacy. Furthermore, we address the endogeneity characteristic of financial literacy by incorporating a question about the experiences of respondents' family members who can influence respondents' acquisition of financial knowledge.

This paper is organised as follows: In Section 2.2, we provide a review of the literature on financial literacy and stock market participation. In Section 2.3 we provide our

hypothesis. In Section 2.4 we describe our data set and introduce our measures of financial literacy. In Section 2.5, we report the results of our empirical work. In Section 2.6, we conclude.

2.2. Literature Review

The role of financial literacy has received increasing attention in both developed and developing countries. This is evident by a growing literature that measures financial literacy and its implication for financial decision-making. Lusardi and Mitchell (2008) designed a standard set of questions to measure financial literacy referred to as the "The Big Three". These questions include three financial concepts: (1) numeracy, (2) understanding of inflation, and (3) understanding of risk diversification. This standard set of questions have been implemented in numerous surveys both in the USA and around the world. Hastings et al. (2013) reviewed the evidence on financial literacy across countries that made use of The Big Three and found that the level of financial literacy in the lower-income countries (i.e. India and Indonesia) was much lower than other developed countries (i.e. Netherlands, USA, Japan, Germany). Nonetheless, surveys around the world show robust findings that financial literacy is low even in advanced economies with well-developed financial markets (Lusardi, 2019).

There is ample evidence based on surveys in developed countries that demonstrates a strong association between financial literacy and individuals' well-being. Financial literacy is associated with higher propensity to invest in more complex assets, such as stocks, which normally offer higher rates of return (van Rooij et al., 2011). Financial literacy is positively related to retirement planning (van Rooij et al., 2012). Financially literate people are more likely to accumulate wealth (Lusardi &

Mitchell, 2014). With regard to debt behaviour, those who are more financially literate are less likely to have credit card debt and more likely to pay the full balance of their credit card each month rather than just paying the minimum due (Lusardi & Tufano, 2009, 2015). Young people also struggle with debt, in particular with student loans. According to Lusardi et al. (2016), millennials know little about their student loans and many do not attempt to calculate the payment amounts that later be associated with the loans they take.

To improve financial literacy, many developed countries have initiated financial education which is expected to result in better financial outcomes. Bernheim et al. (2001) show that the high school financial curriculum mandates in the U.S. results in higher financial literacy, which is associated with higher savings rates and wealth accumulation during adulthood. Varcoe et al. (2005) evaluated the effectiveness of the curriculum on financial knowledge and behaviour of participants using the series. The findings indicated that using the curriculum improved the financial literacy of high school students in U.S. Behaviour changed in a positive direction, financial knowledge improved, and students appeared to have responded by making their money go farther. A more recent study by Lührmann et al. (2015) found that a short financial education programme for teenagers in German high schools significantly increased teenagers' interest and self-assessed financial knowledge, and they were also less likely to define themselves as impulse buyers. These studies have confirmed that abundant financial literacy results in more effective financial decisions.

Motivated by a compelling body of evidence from developed countries that demonstrates the positive effects of financial literacy on financial behaviour, the Indonesian government declared 2008 "the year of financial education" with a goal of improving access to and use of financial services by increasing financial literacy (Cole et al., 2011). In 2013, the

government launched economics and personal finance education as part of the national school curriculum (IFSA, 2016). The new curriculum implemented on primary (grades 1-6) and junior secondary (grades 7-9) included economics and personal finance content infused in the mandated social sciences subject area. At the senior high school level (grades 10-12), the new curriculum divides students into three specializations: Mathematics and Science, Linguistics, and Social Science. Under the new curriculum, economics is only mandated in Social Science specialty, although students in the Mathematics and Science or Linguistics specialties may take economics as an elective. At the University level, financial education includes banking, capital market, insurance, finance companies, pension funds, and financial planning modules.

There is reason to believe that personal finance education might be effective in promoting a change in certain financial behaviour – but only when the education content meets financial competencies needed to change the targeted outcomes. Therefore, identifying the financial competencies that lead to changes in financial behaviour should be the first step in delivering cost-effective financial education. The first contribution of this paper is to provide evidence of financial literacy as a significant determinant of stock market participation. To measure the causal relationship between financial literacy and stock market ownership, we conducted a new survey in Indonesia. By conducting this study in Indonesia, we consider a setting in which financial literacy may be one of the most important barriers of participation in the stock market.

We study one risky and sophisticated, but also high-return, investments: stocks and mutual funds. Stocks were chosen for this study for several reasons. First, the purpose of this paper to identify the determinant of stock market participation is in line with the IFSA strategy that aims to encourage Indonesian society to invest regularly in capital markets in

order to gain returns above the inflation rate and to increase welfare (IFSA, 2016). Second, equity is an attractive asset in which it will be a hedge against fluctuations in labour income and an advantageous asset to hold for young people who are at the early stage of the life cycle (Constantinides et al., 2002). Third, financially literate individuals accumulate more wealth because they take advantage of the equity premium on stock investments (van Rooij et al., 2012). Fourth, welfare losses from no stockholding amounting to four percent of wealth (Cocco et al., 2005).

Morawakage et al. (2019) analysed data on the excess returns of the Indonesian Stock Market from 2004 to 2013. The daily risk-free rates are deducted from the daily stock index returns in order to find the daily excess returns from 2004 to 2013. They found that the average daily equity premium in Indonesia is positive 0.066%. The lack of financial literacy, that might hinder individuals from participating in the stock market, raises concerns that they may fail to take advantage of stock market participation.

Our paper also makes contribution to the existing literature by developing two indices of financial literacy, which allow us to differentiate among different levels of financial sophistication. There exist previous studies which assess financial literacy but they often used literacy measures that are crude. For example, Lusardi and Mitchell (2008) rely on only three questions (which is known as The Big Three) to measure aggregate financial literacy and the questions do not distinguish the level of financial literacy, making it difficult to provide particular financial education to promote effective financial decision-making. Although The Big Three financial literacy questions have been implemented in numerous surveys around the world, there is little evidence as to whether this set of survey questions is the best approach or even a superior approach to measuring financial literacy (see Hastings et al., 2013). Our paper employs special modules of financial literacy developed by

van Rooij et al. (2011), which also includes the Big Three questions (Lusardi & Mitchell, 2008), but do develop this further. They complement advanced financial knowledge questions to The Big Three questions and therefore, by using these special modules, we are able to differentiate between basic and more advanced financial literacy.

There are some explanations as to why more financially literate people have higher propensity to participate in the stock market. Fixed learning and setup costs capturing both time and money must be spent in order to invest in the stock market are often regarded as barrier to enter the stock market. Financial literacy is often defined as an input that reduces these costs. Previous research show that financial awareness may lead to reduced pecuniary and non-pecuniary portions of participation cost, thereby encouraging stock market participation (Haliassos & Bertaut, 1995; Campbell, 2006; Calvet et al., 2007; Jappelli and Padula, 2015). Another entry barrier to the stock market can also arise from psychological fixed cost participation (Campbell, 2006). Some people may fail to invest in stocks in part because they are aware that they lack the skills to invest efficiently and therefore feel uncomfortable participating in an activity for which they are poorly prepared. Korniotis and Kumar (2011) point out that the perception of having limited abilities might also increase the cost of stock market participation.

There have been many economic programmes implemented that aim to provide financial education to consumers which are expected to reduced participation costs, thereby encouraging stock market participation. Khorunzhina (2013) argues that participation costs are lower for more educated investors. She finds that financial education and counselling alleviate the burden on consumers' time and effort necessary for making financial decisions and reduce the objective cost of stock market participation. Georgarakos and Pasini (2011) show that participation costs can be reduced through sociability which, in

turn, affects participation. They document that more sociable households decrease their participation costs through cheaper information sharing, thereby increasing participation.

Existing literature documents wealth as an important demographic characteristic that explains the probability of stockholding. Campbell (2006) shows that the American households in the bottom wealth distribution level hold only safe assets and vehicles, while those in the higher wealth distribution are more likely to hold equity. A more recent study by van Rooij et al. (2011) shows that stock market participation of Dutch households increases strongly with income and wealth. Literature reports some explanation of the positive relationship between wealth and stock market participation. Poterba and Samwick (2003) show that households with higher marginal tax-rates are more likely to hold tax-advantages assets, such as stock. High income or wealth levels may increase the willingness to take risks because they cushion the impact of bad realizations (Dohmen et al., 2011). Risky investments require fixed learning and setup costs. In the presence of entry costs, investors benefit from stockholding only if the expected excess return from participation exceeds these costs. These costs are worth paying only if the financial asset holding is sufficiently large. Therefore, wealthier individuals have more incentive to acquire financial literacy to be able to participate in the stock market because the expected returns are high (Calvet et al., 2007; Jappeli and Padula, 2015).

Financial illiteracy is particularly severe among women (Lusardi & Mitchell, 2014; Almenberg & Dreber, 2015; Lusardi, 2019). The gender gap in stock market participation is usually explained by women's lower financial literacy (Lusardi & Mitchell, 2008; van Rooij et al., 2012), lower numeracy (Almenberg & Dreber, 2015), lack of familiarity with financial products (Prast et al., 2015), or lower risk tolerance (Dohmen et al., 2011). There is further evidence of a gender gap in financial literacy in many Western society, but, interestingly,

Asian data show a different structure, as does some data on (former) communist countries (Klapper et al., 2015). Grohmann et al. (2016) find that well-educated, middle-class Thai women do not lag behind men regarding financial literacy. They argue that the results are driven by gender-equal levels of numeracy and high responsibility for financial affairs of women in Thailand. Similarly, Klapper and Panos (2011) report that the gender-equal education and working-life of men and women in (former) communist environments reduces gender-gaps in financial knowledge.

2.3. Hypothesis

Participation in risky investments requires fixed learning and setup costs capturing time and money must be spent, which may discourage individuals from participating in the stock market. Others may avoid stock market because they simply feel uncomfortable participating in an activity for which they feel incompetent, thus increasing the psychological fixed cost participation (Campbell, 2006; Korniotis & Kumar, 2011). Financial education and information reduce the burden on individuals' time and effort for making financial decisions and reduce the participation costs of stock market participation (Georgarakos and Pasini, 2011; Khorunzinam 2013). Financial literacy may lead to reduced pecuniary and non-pecuniary participation costs, thereby encouraging stock market participation (Haliassos & Bertaut, 1995; Campbell, 2006; Calvet et al., 2007; Jappelli and Padula, 2015). This leads to our hypothesis: *Financially literate individuals are more likely to participate in the stock market.*

2.4. Data and Methodology

2.4.1 Data

Existing empirical evidence shows that adults in both developed and emerging economies who have been exposed to financial education are subsequently more likely than others to save and plan for retirement (Lusardi, 2009; Cole et al., 2011). Other research from developed countries show evidence that those with higher financial literacy are more likely to participate in the stock market and perform better on their portfolio choice (Stango & Zinman, 2009; van Rooij et al., 2011). This evidence suggests a link between financial education and outcomes; it indicates that improved levels of financial literacy can lead to positive behavioural change.

Financial literacy is increasingly considered to be and essential life skill (G20, 2012; APEC, 2012). In fact, OECD (2005) advised that people should be educated about financial matters as early as possible in their lives. Young generations are likely to face more challenging financial decisions than older generations as they have to deal with increasingly sophisticated and innovative financial products and services, and own notably technological advances. Financial literacy will therefore have a role in equipping young people with the skills needed to understand more complex products and services, choose those most appropriate for them, and protect themselves from financial scams. As stated by OECD (2017), technology (e.g. investment simulators or budgeting apps) has the potential to facilitate financial decisions and calculations; but here too financial literacy can help ensure that youths understand how to use such tools responsibly. Similarly, the spread of digital financial services may open up new opportunities for those who are excluded from the formal financial system to gain access to it, but those services can also expose people to new security threats and risks of fraud that are compounded when low financial literacy is

combined with poor digital skills and limited awareness of cyber security. The increasing availability of online credit with hidden fees associated with various service providers (such as mobile phone plans), which are often targeted to young and/or inexperienced consumers, will pose further need for financial literacy.

Given the complexities of new financial systems and their constant evolution, the new and evolving competencies will thus have to be acquired early in life (OECD, 2005). Moreover, efforts to improve financial literacy in adulthood through the workplace or other settings can be severely limited by a lack of early exposure to financial education. It is therefore important to assess how financially literate young people are before they engage in major financial transactions and contracts as previous study show that the level of financial literacy before people enter the labour market influences their financial literacy throughout life (Jappelli & Padula, 2015). Accordingly, we collected a new dataset of students in a private University in Indonesia.

Universities in Indonesia are largely offered by the private sector. Out of 3,502 institutions, only 150 institutions are public, i.e. established and operated by the government. On the other hand, private universities depend almost entirely on student's tuition and fees for their revenue. Higher education programs are offered by five types of institution namely: academy, polytechnic, college, institute, and University. The first two are specialising in vocational education stream, whilst the last three are more comprehensive and allowed to offer all education streams. A sample is students from a private University in Bandung, the capital of West Java province where the distribution of higher education institutions is concentrated (43.7%), whilst 29.1% is distributed in Sumatera and only 3.4% is in Maluku and Papua Island (Moeliodihardjo, 2014).

The sample University is ranked 7th among twenty private Universities in Bandung regarding the number of student and academic staff (DGHE, 2019). We collected a sample of 952 students out of 8,261 students in the University. The participation in this survey was voluntary and there was no incentive for students to take the survey. Survey participants were asked to complete a written questionnaire that was distributed either in classes before or after University lectures. In addition, the questionnaires were also be distributed to the students and graduates who trade in the Stock Trading Gallery, which is available as a collaboration between the University and Indonesian Stock Exchange. Students were instructed to answer the questions without consulting additional information or using a calculator. The data collection period was from 1st May until 30th May, 2016.

The respondents in our sample were on average 21 years old and 52% were female. Majority of the respondents were students in Management Department (38%) and Accounting Department (21%). The 52% students who studied management are female and 48% are male. While the proportion of students who studied management is not much different between female and male, it seems that female students prefer studying accounting than male students. There are 63% female students who studied accounting compared to only 37% male students.

It was found that 60% of the student participants saved less than 30% of their income, while only 30% saved between 30-65% of their income. Around 23% of respondents were in the lowest income category, whereas 50% of respondents fell in the second lowest income category. Additionally, 44% of the sample did not have non-equity wealth, while 24% were in the lowest non-equity wealth category. Regarding the class rank, 26% of respondents were freshmen, 30% were sophomore, 23% and 16% were junior and senior respectively, and 6% were graduates. Table 2A-4 of the Appendix 2F reports summary

statistics and Table 2A-5 of Appendix 2G reports the correlation between variables in the model.

2.4.2 The Measurement of Financial Literacy

To measure financial literacy, this study used two modules developed by Van Rooij et al. (2011), which included the "Big Three" questions introduced by Lusardi and Mitchell (2008) on numeracy, inflation, and risk diversification, which have become a regular component of international tests on financial literacy (Hastings, 2013; Lusardi, 2019). All of the information relating to financial literacy resulting from two sets of questions is split into two groups, and a factor analysis on the two sets was separately performed. In this way, two types of literacy indices can be constructed: first, an index potentially related to basic financial knowledge; and, second, an index measuring more advanced financial knowledge.

The first set of questions measures the ability to perform simple calculations (in the first question), the understanding of how compound interest works (second question), the effect of inflation (third question), the knowledge of time discounting (fourth question), and to assess whether respondents suffer from money illusion (fifth question). The exact wording of these questions measuring basic financial literacy are reported in Appendix 2A.

Responses to the basic financial literacy questions are reported in Table 2.1 (Panel A). Most respondents answered the first question correctly – roughly 77%. However, the proportion of correct answers then decreased considerably to around 45% when considering questions on inflation and time value of money. Moreover, the proportion of correct answers when questioned on measuring interest compounding was about only 41%. It is important to note that while many respondents answered each individual question correctly, the proportion of respondents who answered all five questions correctly was only

9.5% (see Panel B of Table 2.1). Therefore, while many students displayed knowledge of a few financial concepts, basic financial literacy is not widespread.

Table 2.1. Basic Financial Literacy.
Panel A reports the proportion of students providing correct, incorrect and "do not know" answers to each of the five basic literacy questions. Panel B reports the distribution of the number of correct, incorrect, and "do not know" answers on the five basic literacy questions. The data are from the 2016 University students' survey.

Panel A: Basic financial literacy

Weighted percentages of correct, incorrect and do not know answers of total number of respondents (N = 952)

	Numeracy	Interest compounding	Inflation	Time value of money	Money illusion
Correct	77.1	40.7	44.9	45.4	62.1
Incorrect	12.9	48.4	31.8	40.3	27.8
Do not know	9.8	10.5	22.5	13.8	9.3

Note: correct, incorrect, and do not know responses do not sum up to 100% because of refusals.

Panel B: Summary of responses

Weighted percentages of total number of respondents (N = 952)

	Number of correct, incorrect and do not know answers (out of five questions)						
	None	1	2	3	4	All	Mean
Correct	5.6	14.1	23.4	26.4	21.0	9.5	2.69
Incorrect	17.3	31.4	30.0	14.7	5.9	0.7	1.61
Do not know	64.2	19.6	7.4	4.6	3.1	1.1	0.65

Note: mean is the average of correct, incorrect, and do not know answers of total respondents. The means do not sum up to 5 due to refusals.

To be able to classify respondents according to different levels of financial sophistication, this study makes use of the other set of questions to the module. Obviously, these are much more complex questions than the previous set. The purpose of these questions was to measure more advanced financial knowledge related to investment and portfolio choice. Specifically, these questions were devised to assess knowledge of financial assets, such as stocks, bonds, and mutual funds; the riskiness of different assets; and the workings of the stock market. Moreover, they attempt to measure whether respondents understand the concept of risk diversification and the workings of mutual funds. The exact wording of these advanced literacy questions are reported in Appendix 2B.

Responses to advanced financial literacy questions are reported in Table 2.2 (Panel A). The pattern of answers is very different than that from the previous set of questions. For example, the proportion of correct answers on each question is much lower: only 20% of respondents know how long-term bonds work, and less than 32% know that a stock mutual fund is safer than a company stock. Indeed, less than 37% of respondents know the characteristics of mutual funds.

Not only did a sizable proportion of respondents answer these questions incorrectly, but many respondents stated that they did not know the answers to these questions. For example, while nearly 30% of respondents answered incorrectly relating to how bonds work, an additional 50% did not know the answer to this question. Similarly, more than 31% answered incorrectly when questioned about the risk comparison between a stock mutual fund and a company stock, and 37% of respondents stated that they did not know the answer to that question. So, in summary, many either responded incorrectly, or stated that they simply did not know the answer to questions about stocks, bonds, and the workings of mutual funds.

Panel B of Table 2.2 shows that only a tiny fraction of respondents (2.5%) were able to answer all of the advanced literacy questions correctly, while the fraction of incorrect responses or “do not know” answers on several questions is considerable. These are important findings; most models of portfolio choice assume that investors are knowledgeable and well-informed. Instead, the findings in Tables 2.1 and 2.2 show that financial literacy should not be taken for granted.

Table 2.2. Advanced Financial Literacy.
Panel A reports the proportion of students providing correct, incorrect, and "do not know" answers to each of the nine advanced literacy questions. Panel B reports the distribution of the number of correct, incorrect, and "do not know" answers on the nine advanced literacy questions. The data are from the 2016 University students' survey.

Panel A: Advanced financial literacy

Weighted percentages of correct, incorrect and do not know answers of total number of respondents (N = 952)

	Correct	Incorrect	Do not know
Which of the following statements describes the main function of the stock market?[1)]	55.2	33.2	11.1
What happens if somebody buys the stock of firm B in the stock market?[1)]	70.4	19.4	9.7
Which statement about mutual funds is correct?[1)]	36.5	24.0	39.1
What happens if somebody buys a bond of firm B?[1)]	37.7	35.1	26.6
Normally, which asset described below displays the highest fluctuations over time: savings accounts, bonds, or stocks?	60.8	22.7	16.3
When an investor spreads his money among different assets, does the risk of losing money increase, decrease, or stay the same?	43.9	45.0	10.9
If you buy a 10-year bond, it means you cannot sell it after 5 years without incurring a major penalty. True or false?	20.3	29.6	49.9
Stocks are normally riskier than bonds. True or false?	59.9	16.2	23.7
Buying a company fund usually provides a safer return than a stock mutual fund. True or false?	31.7	31.1	37.0

[1)] See Appendix 2B for the exact wording of the questions
Note: correct, incorrect, and do not know responses do not sum up to 100% because of refusals.

Panel B: Summary of responses

Weighted percentages of total number of respondents (N = 952)

	Number of correct, incorrect and do not know answers (out of nine questions)										
	None	1	2	3	4	5	6	7	8	All	Mean
Correct	3.3	7.1	11.1	16.9	20.5	14.6	13.2	5.9	4.9	2.5	4.15
Incorrect	11.4	18.5	22.6	18.5	14.7	8.7	3.9	1.2	0.4	0.1	2.56
Do not know	25.8	20.4	15.1	14.8	8.4	6.9	2.5	3.1	1.4	1.6	2.24

Note: mean is the average of correct, incorrect, and do not know answers of total respondents. The means do not sum up to 9 due to refusals.

2.4.3 Indices of Financial Literacy

In order to summarise all of this information into financial literacy indices, we first construct dummy variables for each individual question indicating whether a respondent answers the questions correctly. We then perform a factor analysis on these binary variables. Principal component analysis is applied to the two sets of questions separately. It leads us to retain two main factors: a basic and a more advanced financial literacy. This is

consistent with the way Van Rooij et al. (2011) have devised the financial literacy questions. Based on this split, we obtain two financial literacy indices: a first index related to basic financial knowledge (the first five questions) and a second index measuring advanced financial literacy (the remaining nine questions). The summary statistics of two indices are reported in Table 2A-4 of the Appendix 2F. Details about factor analysis are reported in Appendix 2C.

It is important to note that in the set of basic financial literacy questions, there are no questions regarding the stock market function or about stocks, mutual funds, and bonds. Whereas, the other set of questions measuring a more advanced financial knowledge does include questions about stocks, the working of the stock market, and other financial instruments. When designing these two special modules, Van Rooij et al. (2011) pointed out that the basic literacy questions aim to test basic numerical skills and thus are more likely to proxy for cognitive abilities which typically depreciate at advanced ages. Therefore, we assess each financial literacy index to seek evidence as to whether it significantly affects stock market participation.

2.4.4 Methodology

We examine the effect of financial literacy on stock market participation in Section 2.5.2. The probit model used to assess the relationship:

$$y_i^* = x_i\beta_i + u_i \quad (1)$$

where y^* is an unobservable (or latent) magnitude, which can be considered the net benefit to individual i of participating in stock market. The y^* as a latent variable linearly related to a set of factors x (i.e. basic and advanced financial literacy indices and demographic

variables) and a disturbance process u. The net benefit cannot be observed, but we can observe the outcome of the individual having:

$$y_i = 0 \text{ if } y_i^* \leq 0 \tag{2}$$

$$y_i = 1 \text{ if } y_i^* > 0 \tag{3}$$

That is, we observe that the individual did ($y = 1$) or did not ($y = 0$) participate in stock market. The probability of an individual making each choice:

$$\Pr(y = 1|x) = \Psi(y^*) \tag{4}$$

where $\Psi(.)$ is a cumulative distribution function. The parameters of binary-choice models are estimated using maximum likelihood techniques. For each observation, the probability of observing y conditional on x:

$$\Pr(y|x) = \{\Psi(x_i\beta)\}^{y_i} \{1 - \Psi(x_i\beta)\}^{1-y_i}, \quad y_i = 0, 1 \tag{5}$$

The log likelihood for observation:

$$l_i(\beta) = y_i \log\{\Psi(x_i\beta)\} + (1 - y_i) \log\{1 - \Psi(x_i\beta\} \tag{6}$$

and the log likelihood of the sample is $L(\beta) = \sum_{i=1}^{N} l_i(\beta)$, to be numerically maximized with respect to the k elements of β.

In section 2.5.3, we further take into account the fact that financial literacy is endogenous characteristic which can be influenced by other's financial behaviour. We thus instrument financial literacy with parent's financial knowledge. The intuitive justification is that individual's decision to participate in stock market is exogenous with respect to their parent's financial knowledge, but individuals can learn from their parents and therefore, increase their own financial literacy. The instrumental variable (IV) probit model used to assess the effect of financial literacy that is instrumented with parent's financial knowledge on stock market participation:

$$y_{1i}^{*} = y_{2i}\beta + x_{1i}\gamma + u_i \quad (7)$$

$$y_{2i} = x_{1i}\pi_1 + x_{2i}\pi_2 + v_i \quad (8)$$

where x_1 is a set of exogenous demographic variables, and x_2 is parents' financial knowledge (IV) that affects financial literacy (y_2) but does not directly affect stock market participation (y_1^*). The exogenous demographic regressors x_1 in equation (7) can be used as instruments for themselves. The variable y_1^* is latent and therefore is not directly observed. Instead, the individual's decision to participate ($y_1 = 1$) or not participate ($y_1 = 0$) in stock market is observed with $y_1 = 1$ if $y_1^* > 0$ and $y_1 = 0$ if $y_1^* \leq 0$.

2.5. Empirical Results

Lusardi (2019) reviews that financial literacy is low across the world and even higher national income levels do not equate to a more financially literate population. Low financial literacy on average is exacerbated by patterns of vulnerability among specific population sub-groups. To find conclusions regarding which people most lack of financial knowledge, we first turn to a disaggregated assessment of our data in Section 2.5.1.

Another important question we aim to answer in our analysis is not only whether respondents possess financial literacy, but also whether financial literacy matters in stock market participation. We define stock market participation as owning stocks and/or mutual funds. To obtain information about the relationship between financial literacy and stock holding, we test whether stock market participation is dependent on the distribution of financial literacy. We then address the direction between financial literacy and participation and, furthermore, examine whether this causation holds true

even after accounting for many of the determinants of stock market participation. This analysis is reported in Section 2.5.2.

2.5.1. Who is Financially Illiterate?

To confirm the validity of these two indices and their features, we report the distribution of financial literacy indices across demographic variables, such as class rank, age, and gender, in Table 2.3. The basic literacy measure is grouped in four quartiles and subgroups for class rank, age, and gender are formed to represent the proportion of students in each literacy quartile, as well as the mean quartile number. The Pearson chi-square statistic is used to test the null hypothesis that the distribution of students over the four literacy quartiles is independent of class rank, age and gender. The same procedures are used for advanced literacy measurement.

Panel A of Table 2.3 shows that there is a significant correlation between basic literacy and years of study, age and gender. Those with the lowest level of basic financial literacy are concentrated in the lowest class rank, i.e. freshman. While junior and senior class rank fall in the highest quartiles of the basic literacy (the proportion is 28.5% and 27.9%, respectively). A similar pattern is shown with regard to age. Based on age groups, the students between 21 and 22, and above 23 years old, have the highest basic literacy (the proportion is 27.3% and 25%, respectively). Table 2.3 also shows there are gender differences in basic literacy: women display lower basic knowledge than men. More than 28% of females fall within the lowest quartile of the basic literacy index distribution.

Table 2.3. Basic and Advanced Financial Literacy across Demographics.

Panel A reports the distribution of the basic literacy measure across different years of study, across age groups and gender. The basic literacy measure are grouped in four quartiles and reported for each subgroup of years of study, age, and gender; the proportion of students in each literacy quartile as well as the mean quartile number. The table shows weighted percentages and the Pearson chi-square statistic to test the null hypothesis that the distribution of students over the four literacy quartiles is independent of years of study, age, and gender (p-values reported in parentheses). Panel B reports the same statistics for advanced literacy measure. The data are from 2016 University students' survey.

Panel A: Basic financial literacy across demographics

	Basic literacy quartiles					
Class Rank	1 (low)	2	3	4 (high)	Mean	N
Freshman	33.0	24.0	30.8	12.2	2.22	221
Sophomore	23.2	26.2	33.2	17.4	2.45	259
Junior	23.3	20.2	28.0	28.5	2.62	193
Senior	16.2	25.7	30.2	27.9	2.70	136
Graduate	18.0	30.0	26.0	26.0	2.60	50
	Pearson chi2 (12) = 34.355			(p=0.001)		

	Basic literacy quartiles					
Age	1 (low)	2	3	4 (high)	Mean	N
Age ≤ 19	25.8	28.8	35.4	10.0	2.30	271
20 ≤ age ≤ 20	26.8	21.0	30.0	22.2	2.48	243
21 ≤ age ≤ 22	19.6	24.9	28.2	27.3	2.63	209
Age ≥ 23	22.0	26.8	26.2	25.0	2.54	168
	Pearson chi2 (9) = 31.520			(p=0.000)		

	Basic literacy quartiles					
Gender	1 (low)	2	3	4 (high)	Mean	N
Male	20.0	26.7	31.8	21.5	2.55	446
Female	28.7	24.3	28.6	18.4	2.37	478
	Pearson chi2 (3) = 9.574			(p=0.023)		

Panel B: Advanced financial literacy across demographics

	Advanced literacy quartiles					
Class Rank	1 (low)	2	3	4 (high)	Mean	N
Freshman	27.1	30.3	29.0	13.6	2.29	221
Sophomore	25.6	29.4	23.3	21.7	2.41	262
Junior	24.1	18.5	23.6	33.8	2.67	195
Senior	23.5	19.9	23.5	33.1	2.66	136
Graduate	16.0	16.0	28.0	40.0	2.92	50
	Pearson chi2 (12) = 41.880			(p=0.000)		

	Advanced literacy quartiles					
Age	1 (low)	2	3	4 (high)	Mean	N
Age ≤ 19	30.9	31.6	25.4	12.1	2.19	272
20 ≤ age ≤ 20	21.4	24.7	27.2	26.7	2.59	243
21 ≤ age ≤ 22	24.8	20.0	27.1	28.1	2.58	210
Age ≥ 23	17.8	21.3	20.1	40.8	2.84	169
	Pearson chi2 (9) = 54.476			(p=0.000)		

	Advanced literacy quartiles					
Gender	1 (low)	2	3	4 (high)	Mean	N
Male	24.9	24.3	24.5	26.3	2.52	449
Female	24.4	25.9	25.9	23.8	2.49	479
	Pearson chi2 (3) = 1.013			(p=0.798)		

Considering more advanced financial knowledge in Table 2.3 (Panel B), a relationship is found again with years of study. A large fraction of respondents in the highest quartile of advanced literacy are students in their third year (33.8%), final year (33.1%), and graduates (40%), while the 27.1% in the lowest quartile of advanced literacy are freshmen. Advanced literacy is the lowest among those who are 19 years old and younger, but is the highest among 23 year olds and above. These findings are similar to what is reported in Sjam (2015), in which senior college Indonesian students were more knowledgeable than freshmen. Mandell (2008) also found similar results that U.S. college students are far more financially literate than high school students, and literacy increases with each year of college. Some of the difference is probably due to the fact that senior or graduates are several years older than freshmen and thus, have had a great deal more experience with the use of financial instruments. The fact that financial literacy increases with the years of age is an indication that financial literacy is really a measure of problem-solving ability rather than possession of a body of time-limited financial facts as Van Rooij et al. (2011) suggest that people may be learning as they age.

The 24.9% of men are in the first (lowest) quartile of the literacy distribution while 26.3% are at the fourth quartile; the corresponding figures for women are 24.4% and 23.8%. Although females have a lower mean quartile (2.49) compared to males (2.52), the correlation between gender and advanced literacy is not significant. Consequently, there is now no fairly robust evidence confirming that women significantly have lower financial

knowledge compared to men. One explanation might be that most females in our sample have preferences in studying accounting compared to males. Because accounting deals with financial reporting, it requires that the students first become familiar with certain asset characteristics, and therefore, females who were studying accounting have some grasp of financial assets.

2.5.2. Does Financial Literacy Matter in Stock Market Participation?

An important question we aim to answer in our analysis is not only whether respondents possess financial literacy but also whether financial literacy matters in the decision to participate in the stock market. We first assess whether stock market ownership relates to financial literacy and demographics. We then examine whether financial literacy affects participation in the stock market.

Table 2.4 shows the weighted percentage of stock ownership across demographics and different levels of financial literacy. It also reports the Pearson chi-square statistic to test the null hypothesis that stock ownership does not correlate with demographics and financial literacy. The findings show that stock ownership increases with years of education. In line with class rank, it is shown that those who own stocks and/or mutual funds are concentrated among respondents who are above 23 years old. The fact that stock market participation increase with years of study and age is probably due to the fact that as individuals are getting older, they have had a chance to gain more experience with financial instruments and therefore increase the likelihood of participating in the stock market.

Interestingly, Table 2.4 demonstrates that gender is not associated with stock market participation. Stock market ownership is lower among women than men, although the gender gap is not as large as reported in other studies (Haliassos & Bertaut, 1995; Lusardi

& Mitchell, 2008; Van Rooij et al., 2011). As gender is independent from stock market ownership, so it does with saving rates. The saving rate is the amount of money that individuals save as a share of income. The profile of stock ownership has a hump shape with regard to savings, and its correlation is not significant.

Stock market participation increases strongly with both income and wealth levels. Income refers to total employment monthly income, i.e. the sum of salary, wages, benefits, investment income, and other income. If individuals were not employed yet, the income is the amount of money they receive from parents or other sources and investment income. Non-equity wealth is the sum of savings accounts, deposits accounts, gold, home ownership, and bonds. Because the dependent variable in this empirical work is stock market participation (including participation in mutual funds), thus, the definition of wealth in this study does not include stocks and mutual funds, which are clearly correlated with stock market participation. Our findings are similar to those reported in many other papers that income and wealth are associated with stock participation (Campbell, 2006; Van Rooij et al., 2011).

At the bottom of Table 2.4, stock ownership is reported across different levels of financial literacy. It is found that stock holding increases with advanced literacy. Participation in the stock market is concentrated among those with high literacy (fourth quartile), while only roughly 12% of respondents each in the first and second quartile of advanced literacy participate in the stock market. When considering basic literacy, we find that basic numeracy is not significantly correlated with stock participation. At this point, we might want to take into consideration that the basic literacy index is constructed based on simple knowledge and the ability to do calculations, moreover, there are no questions in this set about the stock market or about stocks and mutual funds. As Van Rooij et al. (2011)

point out, the basic literacy questions in the special module devised for testing basic numerical skills and are thus more likely to proxy for cognitive abilities.

Table 2.4. Stock Market Participation across Subgroups.
This table shows stock ownership across different levels of class rank, across gender and age groups, and across different levels of income, saving rate, wealth (excluding equity wealth), and basic as well as advanced literacy. Basic and advanced literacy are grouped in four quartiles. The table reports weighted percentages and stock ownership is defined as owning individual stocks and/or mutual funds. Pearson chi-square statistic is presented to test the null hypothesis that the distribution of stock market participation is independent of financial literacy, years of study, age, gender, income, saving rate, and wealth (p-values reported in parentheses). The data are from the 2016 University students' survey.

Class rank		**Income**	
Freshman	12.7	< IDR 1,000,000	8.7
Sophomore	12.3	IDR 1,000,000 – 3,000,000	16.2
Junior	15.9	IDR 3,000,001 – 5,000,000	15.7
Senior	24.6	> IDR 5,000,000	37.2
Graduate	27.1	Pearson χ^2 (3) = 33.640	(p=0.000)
Pearson χ^2 (4) = 14.653	(p=0.005)		
		Saving rate	
Age		0% ≤ savings ≤ 30%	14.4
Age ≤ 19	13.6	31% ≤ savings ≤ 65%	20.5
20 ≤ age ≤ 20	12.8	66% ≤ savings ≤ 100%	16.2
21 ≤ age ≤ 22	17.9	Pearson χ^2 (2) = 3.778	(p=0.151)
Age ≥ 23	25.4		
Pearson χ^2 (3) = 11.165	(p=0.011)	**Non-equity wealth**	
		None	8.7
Gender		< IDR 3,000,000	18.9
Male	17.5	IDR 3,000,000 – 6,000,000	23.2
Female	15.5	IDR 6,000,001 – 9,000,000	27.9
Pearson χ^2 (1) = 0.539	(p=0.463)	> IDR 9,000,000	30.4
		Pearson χ^2 (4) = 36.322	(p=0.000)
Basic literacy quartiles			
1 (low)	21.7	**Advanced literacy quartiles**	
2	15.7	1 (low)	11.9
3	14.2	2	12.0
4 (high)	16.1	3	20.1
Pearson χ^2 (3) = 4.346	(p=0.226)	4 (high)	22.6
		Pearson χ^2 (3) = 12.452	(p=0.006)

Although advanced literacy is correlated with stock participation as shown above, the correlation does not imply causation. Therefore, we will address the direction of causality between advanced literacy and stock participation and examine whether this

causation holds true, even after accounting for many of the determinants of stock market participation, such as age, gender, years of education, saving rate, income, and wealth.

Our empirical specification recognises that there are many determinants of stock participation. As in previous studies, we include demographics such as age, gender and years of study (Haliassos & Bertaut, 1995; Campbell, 2006). We also added dummies for income and wealth (Van Rooij, 2011). Additionally, we included dummies for saving rate to account for those who have more available resources and may therefore be more likely to hold stocks. Most importantly, we added measures of financial literacy. One of the main hypotheses in this paper is that respondents who are not financially knowledgeable will avoid the stock market. We use the basic and advanced financial literacy indices to account for different levels of literacy.

According to the basic specification in Column 1 of Table 2.5, income and wealth are important predictors of participation in stock market. Both variables show a significantly positive effect to the probability of investing in the stock market. Having income more than IDR 5,000,000 increases stock market participation by about 20 percentage points. Compared to those who do not have non-equity wealth, having wealth with values up to IDR 3,000,000 and up to IDR 6,000,000 rises stock participation by 12 percentage points. Having wealth above IDR 9,000,000 increases participation by about 13 percentage points.

Our results are in line with literature, finding that income and wealth are important predictors of stock market participation (Campbell, 2006; van Rooij et al., 2011). The fact that wealthier people are more willing to take risks might come from the fact that they are able to cushion on the impact of bad realizations (Dohmen et al., 2011) and, therefore, the likelihood of them participating in risky assets, such as stocks, is higher. Another explanation might be that wealthier individuals have more incentive to acquire financial literacy because

the expected returns are higher than the fixed and learning costs, which subsequently encourages these people to participate in stock market (Calvet et al., 2007; Jappeli and Padula, 2015).

Table 2.5. Basic Financial Literacy and Stock Market Participation: Probit Results.
This table reports marginal effects of probit regressions. Column 1 shows the effects of demographics on stock market participation. Column 2 reports the effects of basic financial literacy index and demographic control variables on stock market participation. Stock market participation is defined as owning stocks and/or mutual funds. The data are from the 2016 University students' survey. Robust standard errors are reported in parentheses. ***p<0.01; **p<0.05; *p<0.1

	(1)		(2)	
Basic literacy index			– 0.014	(0.014)
Class rank dummies (Base group: freshman)				
Sophomore	– 0.003	(0.038)	– 0.001	(0.037)
Junior	0.036	(0.052)	0.040	(0.051)
Senior	0.077	(0.057)	0.091	(0.058)
Graduate	0.105	(0.080)	0.123	(0.082)
Age dummies (Base group: age ≤ 19)				
20 ≤ age ≤ 20	– 0.025	(0.043)	– 0.024	(0.043)
21 ≤ age ≤ 22	– 0.017	(0.052)	– 0.023	(0.051)
age ≥ 23	0.013	(0.057)	0.005	(0.057)
Male	0.031	(0.027)	0.031	(0.027)
Income dummies (Base group: <IDR 1,000,000)				
IDR 1,000,000 – 3,000,000	0.058 *	(0.032)	0.055 *	(0.032)
IDR 3,000,001 – 5,000,000	0.003	(0.039)	– 0.002	(0.038)
> IDR 5,000,000	0.196 ***	(0.065)	0.207 ***	(0.066)
Saving rate dummies (Base group: 0% ≤ savings ≤ 30%)				
31% ≤ savings ≤ 65%	0.034	(0.031)	0.034	(0.031)
66% ≤ savings ≤ 100%	0.004	(0.049)	– 0.013	(0.046)
Non-equity wealth dummies (Base group: none)				
< IDR 3,000,000	0.123 ***	(0.038)	0.123 ***	(0.038)
IDR 3,000,000 – 6,000,000	0.123 **	(0.051)	0.126 **	(0.052)
IDR 6,000,001 – 9,000,000	0.106	(0.069)	0.112	(0.071)
> IDR 9,000,000	0.130 ***	(0.046)	0.112 **	(0.044)
No. of observations	639		634	
Pseudo R^2	0.092		0.094	
Log-likelihood	– 254.858		– 250.408	
Wald χ^2	49.31		50.44	
df	17		18	
p > chi2	0.000		0.000	

Column 2 of Table 2.5 includes a measure of basic financial literacy and shows that basic literacy is insignificant in explaining stock ownership. These results imply that simple knowledge and the ability to do calculations are not significant determinants for stock market participation. As Van Rooij et al. (2011) state, these basic numerical skills are more likely to proxy for cognitive abilities rather than financial literacy. We present the

distribution of basic literacy across different type of assets in Appendix 2E. We show that the asset ownership of those with a higher basic literacy is significantly tilted toward deposits accounts and gold. We next assess whether a higher level of financial literacy, namely advanced financial knowledge, can explain stock participation.

Table 2.6 presents the estimates of advanced financial literacy using two different specifications: a specification in which our measure of advanced financial literacy is included along with a set of demographic controls (Column 1); and a second specification in which we add a set of dummies for whether respondents have some economics education, and for the understanding of economics required in their daily activities (Column 2).

The inclusion of economics education in the second specification is based on a contribution from the previous study by Christiansen et al. (2008), who demonstrated that it is more important to control for an economics education than for the level of schooling as an economics education is more closely related to financial literacy than the level of education. They also show that an economics education is an important predictor of stock ownership. Furthermore, we incorporate information about how much understanding of economics respondents need during their daily activities (job, hobbies, etc.), to account for the fact that respondents can learn by doing and that current or past literacy can proxy for "interest in economics". Those who are not interested in economics are unlikely to choose a job that requires a lot of economics knowledge. The exact wording of economics education and daily use of economics are reported in Appendix 2D.

Column 1 of Table 2.6 shows that advanced financial literacy significantly affects stock market participation, even after controlling for demographic characteristics. The results suggest that advanced literacy is associated with 3 percentage point increases in stock holding, suggesting that individuals who display higher financial literacy are more likely

to participate in the stock market. Income and wealth are both significantly correlated with stock ownership.

Table 2.6. Advanced Financial Literacy and Stock Market Participation: Probit Results.
This table reports marginal effects of probit regressions. Column 1 shows the effects of advanced financial literacy index and demographics on stock market participation. Column 2 reports the effects of advanced financial literacy index, demographics, and additional controls, i.e. economics education and the need of economic understanding in daily activities. Stock market participation is defined as owning stocks and/or mutual funds. The data are from the 2016 University students' survey. Robust standard errors are reported in parentheses. ***p<0.01; **p<0.05; *p<0.1

	(1)		(2)	
Advanced literacy index	0.033 **	(0.016)	0.032 **	(0.016)
Class rank dummies (Base group: freshman)				
Sophomore	– 0.001	(0.037)	0.001	(0.037)
Junior	0.024	(0.050)	0.025	(0.051)
Senior	0.076	(0.057)	0.077	(0.057)
Graduate	0.099	(0.078)	0.109	(0.082)
Age dummies (Base group: age ≤ 19)				
20 ≤ age ≤ 20	– 0.026	(0.043)	– 0.026	(0.043)
21 ≤ age ≤ 22	– 0.019	(0.051)	– 0.018	(0.051)
age ≥ 23	0.004	(0.056)	0.005	(0.056)
Male	0.029	(0.027)	0.030	(0.027)
Income dummies (Base group: <IDR 1,000,000)				
IDR 1,000,000 – 3,000,000	0.052	(0.033)	0.054 *	(0.032)
IDR 3,000,001 – 5,000,000	– 0.007	(0.037)	– 0.006	(0.037)
> IDR 5,000,000	0.191 ***	(0.067)	0.190 ***	(0.066)
Saving rate dummies (Base group: 0% ≤ savings ≤ 30%)				
31% ≤ savings ≤ 65%	0.033	(0.031)	0.034	(0.031)
66% ≤ savings ≤ 100%	– 0.011	(0.046)	– 0.009	(0.046)
Non-equity wealth dummies (Base group: none)				
< IDR 3,000,000	0.117 ***	(0.037)	0.118 ***	(0.037)
IDR 3,000,000 – 6,000,000	0.114 **	(0.050)	0.114 **	(0.050)
IDR 6,000,001 – 9,000,000	0.098	(0.067)	0.092	(0.065)
> IDR 9,000,000	0.112 **	(0.045)	0.115 **	(0.045)
Economics education dummies (Base group: A lot)				
Some			– 0.012	(0.031)
Little			0.013	(0.045)
Daily use of economics dummies (Base group: A lot)				
Some			– 0.024	(0.030)
Little			– 0.030	(0.047)
No. of observations	637		637	
Pseudo R^2	0.101		0.103	
Log-likelihood	– 250.539		– 249.948	
Wald χ^2	56.00		57.05	
df	18		22	
p > chi2	0.000		0.000	

Notably, after accounting for an economics education and the need for understanding economics in daily activities (Column 2), the estimated advanced financial literacy is still significant. Other notable findings are that an economics education and the need for an understanding of economics in daily activities are not statistically significant.

One possible interpretation is that once advanced financial knowledge is taken into account, knowledge on economics become less relevant, as economics training is an important but not an exclusive tool through which one can accumulate knowledge about stock market. The absence of knowledge about stock market instruments and how the stock market works may hinder individuals from stock market participation.

To further analyse the effect of advanced literacy, the advanced literacy index is grouped into four quartiles and related with stock holding. The marginal effects of advanced literacy quartiles on stock market participation are reported in Table 2.7. Column 1 of Table 2.7 shows that students in the third quartile of literacy are 11% more likely to participate in the stock market, while those who are in the highest quartile are 8% more likely to hold stocks. The third and fourth quartiles of advanced literacy are still significant after including an economics education and the need for understanding economics in daily activities (Column 2).

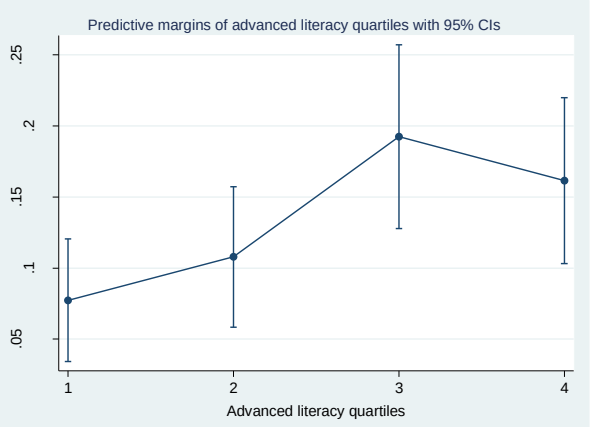
Table 2.7. Advanced Financial Literacy Quartiles and Stock Market Participation: Probit Results.
This table reports marginal effects of probit regressions. Column 1 shows the effects of advanced financial literacy quartiles and demographics on stock market participation. Column 2 reports the effects of advanced financial literacy quartiles, demographics, and additional controls, i.e. economics education and the need of economic understanding in daily activities. Stock market participation is defined as owning stocks and/or mutual funds. The data are from the 2016 University students' survey. Robust standard errors are reported in parentheses. ***p<0.01; **p<0.05; *p<0.1

	(1)		(2)	
Advanced literacy quartiles (Base group: 1 [low])				
2	0.029	(0.033)	0.030	(0.033)
3	0.113 ***	(0.039)	0.115 ***	(0.038)
4 (high)	0.086 **	(0.037)	0.084 **	(0.037)
Class rank dummies (Base group: freshman)				
Sophomore	0.003	(0.037)	0.006	(0.037)
Junior	0.028	(0.050)	0.030	(0.050)
Senior	0.075	(0.056)	0.076	(0.056)
Graduate	0.101	(0.077)	0.112	(0.081)
Age dummies (Base group: age ≤ 19)				
20 ≤ age ≤ 20	– 0.029	(0.042)	– 0.028	(0.042)
21 ≤ age ≤ 22	– 0.019	(0.051)	– 0.018	(0.051)
age ≥ 23	0.007	(0.056)	0.010	(0.056)
Male	0.029	(0.027)	0.030	(0.027)
Income dummies (Base group: <IDR 1,000,000)				
IDR 1,000,000 – 3,000,000	0.052	(0.032)	0.054 *	(0.032)
IDR 3,000,001 – 5,000,000	– 0.007	(0.037)	– 0.005	(0.037)

> IDR 5,000,000	0.195 ***	(0.066)	0.191 ***	(0.066)
Saving rate dummies (Base group: 0% ≤ savings ≤ 30%)				
31% ≤ savings ≤ 65%	0.035	(0.031)	0.034	(0.031)
66% ≤ savings ≤ 100%	– 0.008	(0.046)	– 0.006	(0.046)
Non-equity wealth dummies (Base group: none)				
< IDR 3,000,000	0.121 ***	(0.037)	0.122 ***	(0.037)
IDR 3,000,000 – 6,000,000	0.109 **	(0.049)	0.109 **	(0.049)
IDR 6,000,001 – 9,000,000	0.097	(0.066)	0.090	(0.064)
> IDR 9,000,000	0.113 **	(0.045)	0.117 ***	(0.045)
Economics education dummies (Base group: A lot)				
Some			– 0.014	(0.031)
Little			0.015	(0.045)
Daily use of economics dummies (Base group: A lot)				
Some			– 0.026	(0.029)
Little			– 0.026	(0.048)
No. of observations	637		637	
Pseudo R^2	0.110		0.113	
Log-likelihood	– 247.889		– 247.198	
Wald χ^2	61.70		63.77	
df	20		24	
p > chi2	0.000		0.000	

Figure 2.1 shows the probability of stock market participation for the advanced literacy quartile. Individuals who are in the third and fourth literacy quartiles have a probability of 19% and 16% of participating in the stock market, respectively; while those in the lowest literacy quartile have a probability of participation of 8%.

Figure 2.1. The Relationship between Advanced Financial Literacy and Stock Market Participation
This figure shows the probability of stock market participation by advanced financial literacy quartiles, controlling for other covariates. The first quartile is the lowest advanced financial literacy category while the fourth quartile is the highest advanced financial literacy category. Students in the third and fourth quartiles of literacy significantly more likely to participate in the stock market than those who are in the first quartile. Individuals who are in the third and fourth literacy quartiles have a probability of 19% and 16% of participating in the stock market, respectively; while those in the lowest literacy quartile have a probability of participation of 8%.



All in all, the estimates in Table 2.6 and Table 2.7 indicate that advanced financial literacy affects stock market participation, even after accounting for economics knowledge or the need for economic knowledge. Our findings support previous studies that risky investments require fixed learning and set-up costs, which may be smaller for more financially sophisticated individuals, which can therefore increase stock market participation (Haliassos & Bertaut, 1995; Campbell, 2006; Calvet et al., 2007; Jappelli and Padula, 2015).

2.5.3. Robustness

Van Rooij et al. (2011) state that financial literacy is not an exogenous characteristic; in fact, literacy can itself be affected by other's financial behaviour, for example if individuals learn via experience. Previous work has shown that individuals learn via interaction with others, in particular, with family and friends (Lusardi et al., 2010). Varcoe et al. (2005) present the data of the *Youth and Money Survey* administered by the American Savings and Education Council, in which 90% of the students reported that they were getting their financial education from family and friends, rather than from school.

To improve our analysis, our survey collects additional information beyond economics knowledge and interest in economics that can serve as an instrument for advanced literacy. To be able to rely on measures of literacy that are exogenous with respect to stock market participation, we asked respondents about their parent's understanding of financial matters. This piece of information is used as an instrument for the advanced literacy of the respondent, as also used in a previous study by Van Rooij et al. (2011). The intuitive justification is that individual's financial decision is exogenous with respect to their parent's financial knowledge, but individuals can learn from those around them and,

therefore, increase their own financial literacy. For the precise wording of this question, see Appendix 2D.

While parents' understanding of financial matters could proxy for family fixed effects such as talent and ability, the first-stage regression in Table 2.8 shows that respondents learn from the negative experience of parents. Those who have parents with a low understanding of financial matters are more likely to have a high literacy. This finding is consistent with the evidence of Lusardi (2003) who uses this instrument to assess the impact of retirement planning on saving. She finds that people whose parents experience negative shocks are more likely to plan for retirement. Van Rooij et al. (2011) consistently find that low levels of parent's financial knowledge is associated with higher levels of financial knowledge of the respondents.

Table 2.8. **First-stage Regression.**
This table shows the first-stage estimates of advanced financial literacy index on the set of controls and dummy variables indicating parents' understanding of financial matters. The reference group consists of those respondents whose parents have low understanding of financial matters. The data are from the 2016 University students' survey. Robust standard errors are reported in parentheses. ***p<0.01; **p<0.05; *p<0.1.

Class rank dummies (Base group: freshman)		
Sophomore	– 0.044	(0.103)
Junior	0.226 *	(0.130)
Senior	0.123	(0.135)
Graduate	0.324 *	(0.191)
Age dummies (Base group: age ≤ 19)		
20 ≤ age ≤ 20	0.094	(0.103)
21 ≤ age ≤ 22	– 0.048	(0.120)
age ≥ 23	0.194 *	(0.151)
Male	0.009	(0.075)
Income dummies (Base group: <IDR 1,000,000)		
IDR 1,000,000 – 3,000,000	0.228 ***	(0.087)
IDR 3,000,001 – 5,000,000	0.173	(0.128)
> IDR 5,000,000	0.293 **	(0.139)
Saving rate dummies (Base group: 0% ≤ savings ≤ 30%)		
31% ≤ savings ≤ 65%	0.058	(0.081)
66% ≤ savings ≤ 100%	– 0.003	(0.124)
Non-equity wealth dummies (Base group: none)		
< IDR 3,000,000	0.104	(0.086)
IDR 3,000,000 – 6,000,000	0.249 **	(0.125)
IDR 6,000,001 – 9,000,000	0.221	(0.152)
> IDR 9,000,000	0.219 *	(0.124)

Economics education dummies (Base group: A lot)		
Some	– 0.317 ***	(0.076)
Little	– 0.673 ***	(0.111)
Daily use of economics dummies (Base group: A lot)		
Some	– 0.101	(0.074)
Little	– 0.175	(0.120)
Parent's understanding of financial matters (Base group: low)		
Intermediate	– 0.170 **	(0.077)
High	– 0.275 **	(0.126)
No. of observations	637	
Wald χ^2	296.23	
df	22	
p > chi2	0.000	

The estimates in the second stage as reported in Table 2.9 show that that the relationship between advanced literacy and stock market participation remains statistically significant in the instrumental variable (IV) probit regression, even after controlling for demographics, such as gender, age, income, wealth, as well as the economics education and the need of economic understanding in daily activities. The exogeneity test rejects the null hypothesis that advanced financial literacy is exogenous. The p-value of the exogeneity test at the bottom of Table 2.9 is 0.041, so the null hypothesis is rejected at the 0.05 level. This implies that advanced financial literacy is endogenous and, therefore, it is needed to instrument advanced financial literacy. Overall, our estimates indicate that advanced financial literacy is an important determinant of stock market participation: those who have low advanced financial knowledge are less likely to hold stocks.

Table 2.9. Advanced Financial Literacy and Stock Market Participation: IV Probit Results.
This table reports marginal effects of instrumental variable probit regression. It shows the effects of advanced financial literacy index, demographics, economics education and the need of economic understanding in daily activities. The advanced literacy index has been instrumented using two dummy variables measuring parents' understanding of financial matters. The reference group is the respondents whose parents have the lowest understanding of financial matters. The data are from the 2016 University students' survey. Robust standard errors are reported in parentheses. ***p<0.01; **p<0.05; *p<0.1.

Advanced literacy index	1.011 ***	(0.172)
Class rank dummies (Base group: freshman)		
Sophomore	0.065	(0.142)
Junior	– 0.119	(0.198)
Senior	0.108	(0.218)

Graduate	– 0.040	(0.318)
Age dummies (Base group: age ≤ 19)		
20 ≤ age ≤ 20	– 0.153	(0.147)
21 ≤ age ≤ 22	– 0.034	(0.173)
age ≥ 23	– 0.194	(0.202)
Male	0.066	(0.106)
Income dummies (Base group: <IDR 1,000,000)		
IDR 1,000,000 – 3,000,000	– 0.052	(0.157)
IDR 3,000,001 – 5,000,000	– 0.161	(0.163)
> IDR 5,000,000	0.137	(0.315)
Saving rate dummies (Base group: 0% ≤ savings ≤ 30%)		
31% ≤ savings ≤ 65%	0.039	(0.114)
66% ≤ savings ≤ 100%	– 0.000	(0.168)
Non-equity wealth dummies (Base group: none)		
< IDR 3,000,000	0.203	(0.211)
IDR 3,000,000 – 6,000,000	0.082	(0.255)
IDR 6,000,001 – 9,000,000	0.053	(0.257)
> IDR 9,000,000	0.089	(0.269)
Economics education dummies (Base group: A lot)		
Some	0.246 *	(0.136)
Little	0.624 ***	(0.198)
Daily use of economics dummies (Base group: A lot)		
Some	0.030	(0.120)
Little	0.071	(0.191)
No. of observations	637	
Wald χ^2	296.23	
df	22	
p > chi2	0.000	
p-value exogeneity test	0.041	

2.6. Conclusions

There is a large literature from developed countries trying to explain the fact that many individuals do not hold stocks – a feature which is known as the stockholding puzzle. However, this puzzle is less investigated in emerging markets such as Indonesia. A recent survey from IFSA (2017) shows that majority of Indonesians have portfolios that tilted to banking products, while few Indonesians participate in the stock market. Given that it is a lower-middle-income country, and a relatively low capital market literacy compared to other financial institutions' literacy, we consider that financial literacy might be one of the most important barriers to accessing the stock market. Investigating what people know and how this drives their portfolio choices is of paramount importance, especially for young adults who

are at early stages of the life cycle, and are becoming increasingly responsible for saving and investing for their own future wealth.

Our study makes several contributions to the existing literature. First, we distinguish levesl of financial literacy: basic and advanced literacy, in which each conveys different financial content. The basic financial literacy covers topics ranging from the workings of interest rates and interest compounding to the effect of inflation, discounting, and nominal versus real values. The advanced financial knowledge covers topics such as the difference between stocks and bonds, the function of the stock market, and the workings of risk diversification. Incorporating this information can elevate the studies on portfolio choice and can offer the suggestion of specific financial education. Second, we provide a contribution towards explaining the stockholding puzzle. Third, we contribute to the existing literature by conducting a new survey of University students in Indonesia, which is considered as a section of the Indonesian population who are educated. Fourth, we incorporate additional control variables beyond basic demographics, namely an economics education and the need for economics in one's daily activities. Furthermore, we address the endogeneity characteristics of financial literacy by considering the experiences of an individual's family which can affect their financial knowledge.

We conduct a novel survey of University students in Indonesia, making use of special module devised by van Rooij et al. (2011) which differentiates between levels of financial literacy. We find that students have a much lower advanced literacy than basic literacy. While the majority of students are good at basic numeracy, many of them displayed low financial knowledge about stocks and mutual funds, the work of bonds, and characteristics of mutual funds. Freshmen and younger students were the groups displaying the lowest financial literacy, but we do not find evidence of a gender gap in financial knowledge. Most

importantly, individuals who display advanced financial literacy are more likely to participate in stock market. Financial literacy might decrease the participation costs and psychological fixed costs and, therefore, increase the likelihood of stock holding. On the other hand, basic financial literacy does not significantly affect stock market participation. This implies that basic numeracy skills are not adequate driver for people to invest in the stock market.

We consider the possibility that financial sophistication is endogenous, which can be influenced by interaction with other people around them. Hence, we instrument advanced financial literacy with parent's financial knowledge and find that students learn from negative experience of their parents. We find robust evidence that advanced financial literacy matters for stock participation, even after it is instrumented by parent's understanding of financial matters.

Our findings should be of interest to policy makers and educators who are aimed at encouraging young adults to plan and invest in the stock market. First, we show that financial literacy should not be taken for granted. A majority of youths possess limited financial literacy. Previous studies show that the level of financial literacy before individuals enter the labour market affects their financial literacy throughout life. Therefore, policies aimed at improving the level of financial literacy by providing financial education early in the life cycle are likely to have a long-term impact on portfolio allocations (Jappelli & Padula, 2015). Moreover, by conducting a study of University students, we consider a setting in which the students are a representative of educated Indonesians. Given the fact that these educated people are lacking knowledge of stock market and investments, the overall population might have an even lower financial literacy. This may suggest that policy actions to enhance financial literacy should target not only young people, but also on the general population.

Second, financial literacy differs significantly depending on age and years of education. This suggests that financial education programmes are likely to be more effective when targeted to specific groups of young people (Lusardi & Mitchell, 2014). Third, our findings suggest that policies aiming to increase basic financial literacy might not be effective in achieving higher levels of access to financial markets for the youth population. Nonetheless, the access to financial markets could be achieved by developing education programmes which foster advanced financial literacy.

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Appendix

Appendix 2A. Basic Literacy Questions

1. *Numeracy*: Suppose you had $100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow?
   A. More than $102
   B. Exactly $102
   C. Less than $102
   D. Do not know

2. *Interest compounding*: Suppose you had $100 in a savings account and the interest rate is 20% per year and you never withdraw money or interest payments. After 5 years, how much would you have on this account in total?
   A. More than $200
   B. Exactly $200
   C. Less than $200
   D. Do not know

3. *Inflation*: Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account?
   A. More than today
   B. Exactly the same
   C. Less than today
   D. Do not know

4. *Time value of money*: Assume a friend inherits $10,000 today and his sibling inherits $10,000 three years from now. Who is richer because of the inheritance?
   A. My friend
   B. His sibling
   C. They are equally rich
   D. Do not know

5. *Money illusion*: Suppose that in the year 2020, your income has doubled and prices of all goods have doubled too. In 2020, how much will you be able to buy with your income?
   A. More than today
   B. The same
   C. Less than today
   D. Do not know

Appendix 2B. Advanced Literacy Questions

1. Which of the following statements describes the main function of the stock market?
   A. The stock market helps to predict stock earnings
   B. The stock market results in an increase in the price of stocks
   C. The stock market brings people who want to buy stocks together with those who want to sell stocks
   D. None of the above
   E. Do not know

2. Which of the following statements is correct? If somebody buys the stock of firm B in the stock market:
   A. He owns a part of firm B
   B. He has lent money to firm B
   C. He is liable for firm B's debts
   D. None of the above
   E. Do not know

3. Which of the following statements is correct?
   A. Once one invests in a mutual fund, one cannot withdraw the money in the first year
   B. Mutual funds can invest in several assets, for example invest in both stock and bonds
   C. Mutual funds pay a guaranteed rate of return which depends on their past performance
   D. None of the above
   E. Do not know

4. Which of the following statements is correct? If somebody buys a bond of firm B:
   A. He owns a part of firm B
   B. He has lent money to firm B
   C. He is liable for firm B's debts
   D. None of the above
   E. Do not know

5. Normally, which asset displays the highest fluctuations over time?
   A. Savings accounts
   B. Bonds
   C. Stocks
   D. Do not know

6. When an investor spreads his money among different assets, does the risk of losing money:
   A. Increase

B. Decrease
C. Stay the same
D. Do not know

7. If you buy 10-year bond, it means you cannot sell it after 5 years without incurring a major penalty. True or false?
   A. True
   B. False
   C. Do not know

8. Stocks are normally riskier than bond. True or false?
   A. True
   B. False
   C. Do not know

9. Buying a company stock usually provides a safer return than a stock mutual fund. True or false?
   A. True
   B. False
   C. Do not know

Appendix 2C. Constructing Indices for Basic and Advanced Financial Literacy

The index for basic literacy is based on a set of five questions reported in Appendix 2A. For each basic literacy question, a dummy variable has been constructed for respondents who answered the question correctly. Then, the principle component analysis is performed on these binary variables. The factor analysis indicates that the first factor is very strong: it explains 31.97% of the variance in the set of five questions, implying that all questions are tapping a single dimension, namely basic financial literacy. This is consistent with the way Van Rooij et al. (2011) designed these questions for measuring basic financial literacy. The correlation between how respondents respond to each question and the underlying dimension (i.e. basic financial literacy) is represented by factor loadings. The loadings corresponding to the five basic financial literacy questions are presented in Table 2A-1.

All the loadings of the five basic literacy questions are substantial, varying from 0.476 to 0.639. This range is good when referring to a loading of at least 0.300 as the minimum

criterion for an item (Costello & Osborne, 2005). Because the loadings represent the correlation between how people respond to each question and basic financial literacy, the substantial loadings imply that the five questions are good indicators of basic financial literacy. Given these factor loadings, factor scores for each individuals were obtained weighting each questions according to how salient it is to the basic financial literacy. Essentially, factor scores allow us to not treat all questions as equally important for measuring basic financial literacy. The question with the larger loading should be given a greater weight when generating the scale score.

Table 2A-1. Factor Loadings Corresponding to the Five Basic Literacy Questions.
The data are from 2016 University students' survey.

Basic literacy questions	Factor loadings
Q1: Numeracy	0.629
Q2: Interest compounding	0.476
Q3: Inflation	0.639
Q4: Time value of money	0.544
Q5: Money illusion	0.522

The advanced financial literacy index has been constructed using the second set of questions, presented in Appendix 2B. Contrary to the answers to the basic literacy questions, the responses to the advanced literacy questions included many "do not know" answers. To take this response behaviour into account, two dummy variables for each of the nine questions were constructed. The first dummy variable indicates whether the question was answered correctly, while the other one refers to the "do not know" answers. In other words, the factor analysis was performed on 18 variables. The factor analysis shows the first factor explains 25.17% of the variance over all nine questions, suggesting one meaningful interpretation: this factor describes advanced financial literacy. The factor loadings corresponding to the nine advanced literacy questions are presented in Table 2A-2.

It is shown that all loadings are above the minimum criterion of 0.300. The sizeable loadings indicate that our nine indicators load on the concept being measured, i.e. advanced financial literacy. We then generate advanced literacy factor scores for each individual based on the weights of each questions to latent advanced financial literacy.

Table 2A-2. Factor Loadings Corresponding to the Nine Advanced Literacy Questions.
DK refers to "do not know". The data are from 2016 University students' survey.

Advanced literacy questions		Factor loadings
Q1: Which of the following statements describes the main function of the stock market?[1)]	Correct	0.320
	DK	– 0.510
Q2: What happens if somebody buys the stock of firm B in the stock market?[1)]	Correct	0.340
	DK	– 0.518
Q3: Which statement about mutual funds is correct?[1)]	Correct	0.498
	DK	– 0.596
Q4: What happens if somebody buys a bond of firm B?[1)]	Correct	0.421
	DK	– 0.569
Q5: Normally, which asset described below displays the highest fluctuations over time: savings accounts, bonds, or stocks?	Correct	0.466
	DK	– 0.588
Q6: When an investor spreads his money among different assets, does the risk of losing money increase, decrease, or stay the same?	Correct	0.369
	DK	– 0.510
Q7: If you buy a 10-year bond, it means you cannot sell it after 5 years without incurring a major penalty. True or false?	Correct	0.376
	DK	– 0.548
Q8: Stocks are normally riskier than bonds. True or false?	Correct	0.526
	DK	– 0.654
Q9: Buying a company fund usually provides a safer return than a stock mutual fund. True or false?	Correct	0.496
	DK	– 0.579

[1)] See Appendix 2B for the exact wording of the questions

Appendix 2D. Exact Wording of Survey Questions and Construction of Variables Used in the Empirical Analysis.

1. *Parent's financial knowledge*
   How would you assess the understanding of financial matters of your parents? Please take the parent that is or was mostly responsible for the major financial decisions (on a 7-point scale; 1 means very low and 7 means very high)?
   Very low Very high
   [ ] 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5 [ ] 6 [ ] 7
   [ ] Do not know
   The instrument variable *parent's financial knowledge* used in the regression analysis is constructed by grouping together the three lowest categories as "low", the fourth and fifth categories as "intermediate", and the two highest categories as "high".

2. *Economics education*

How much of your education was devoted to economics?
[ ] A lot
[ ] Some
[ ] Little
[ ] Hardly at all
[ ] Do not know
The variable *economics education* is used in the regression analysis by including two dummy variables for the response categories "some" and "little". The "hardly at all" and "do not knows" are grouped together with the "little" answers. The reference group consists of those respondents whose education is devoted "a lot" to economics.

3. *Daily use of economics*
How much of an understanding of economics do you need during your daily activities?
[ ] A lot
[ ] Some
[ ] Little
[ ] Hardly at all
[ ] Do not know
The variable *daily use of economics* is used in the regression analysis by including two dummy variables for the response categories "some" and "little". The "hardly at all" and "do not knows" are grouped together with the "little" answers. The reference group consists of those respondents who need "a lot" of understanding of economics during daily activities.

Appendix 2E. Basic Financial Literacy across Assets

Table 2A-3 reports the distribution of the basic literacy measure across different type of assets owned by University students. The basic literacy measures are grouped into four quartiles and reported for each type of asset. This table shows weighted percentages and the Pearson chi-square statistic to test the null hypothesis that the distribution of each asset holding is independent of the four basic literacy quartiles (p-values reported in parentheses).

In our sample of total 952 students, 78.5% of students own a savings account, whereas a much smaller percentage hold bonds (0.5%). Our findings are corroborated with Friedline and Elliot (2013) who found that savings accounts are the most commonly owned assets amongst young adults and only a smaller fraction owns bonds. However, although the large fraction of students own savings account, its ownership does not relate to their basic financial

knowledge. Instead, basic literacy is significantly associated with holding deposits account and gold. The majority of students who own deposits accounts and gold are in the third and fourth (highest) quartiles of basic literacy.

Table 2A-3. Basic Financial Literacy across Assets

This table shows basic financial literacy across different type of assets. Basic financial literacy are grouped in four quartiles. The table reports weighted percentages and asset ownership is defined as owning savings account, deposits account, gold, home, stocks, or bonds. Pearson chi-square statistic is presented to test the null hypothesis that the distribution of basic financial literacy is independent of savings account, deposits account, gold, home, stocks, and bonds ownership (p-values reported in parentheses). The data are from the 2016 University students' survey (N=952). The number of observations do not sum up to 952 because a respondent could have more than one asset.

	Basic Literacy Quartiles				p-value		
Asset Types	1 (low)	2	3	4 (high)	Pearson chi2	Mean	N
Savings account	23.6	24.5	30.5	21.4	(p=0.105)	2.50	747
Deposits account	14.3	20.9	36.2	28.6	(p=0.034)	2.79	91
Gold	24.0	19.0	27.3	29.7	(p=0.089)	2.62	121
Home	27.9	20.2	30.2	21.7	(p=0.866)	2.46	129
Stocks	30.2	22.2	26.2	21.4	(p=0.226)	2.39	126
Bonds	20.0	40.0	0.0	0.0	(p=0.410)	2.60	5

Appendix 2F. Summary Statistics

Table 2A-4. Summary Statistics

This table reports summary statistics for the basic and advanced financial literacy indices, outcome and demographic variables, and an instrumental variable used in this study. The data are from the 2016 University students' survey.

	Mean	**SD**	**Min**	**Max**	**N**
Financial literacy indices					
Basic literacy index	0	1	–2.070	1.635	942
Advanced literacy index	0	1	–3.002	1.624	946
Outcome					
Stock market participation	0.168	0.374	0	1	761
Demographics					
Age	20.727	2.209	16	30	886
Male	0.483	0.500	0	1	934
Class rank					
Freshmen	0.255	0.436	0	1	867
Sophomore	0.303	0.460	0	1	867
Junior	0.227	0.419	0	1	867
Senior	0.157	0.364	0	1	867
Graduate	0.058	0.233	0	1	867
Saving rate					

0% ≤ savings ≤ 30%	0.599	0.490	0	1	772
31% ≤ savings ≤ 65%	0.301	0.459	0	1	772
66% ≤ savings ≤ 100%	0.100	0.300	0	1	772
Income					
< IDR 1,000,000	0.227	0.419	0	1	843
IDR 1,000,000 – 3,000,000	0.505	0.500	0	1	843
IDR 3,000,001 – 5,000,000	0.151	0.357	0	1	843
> IDR 5,000,000	0.117	0.322	0	1	843
Non-equity wealth					
None	0.438	0.496	0	1	800
< IDR 3,000,000	0.244	0.430	0	1	800
IDR 3,000,000 – 6,000,000	0.114	0.318	0	1	800
IDR 6,000,001 – 9,000,000	0.062	0.242	0	1	800
> IDR 9,000,000	0.142	0.350	0	1	800
Economics education					
A lot	0.309	0.462	0	1	952
Some	0.494	0.500	0	1	952
Little	0.197	0.398	0	1	952
Daily use of economics					
A lot	0.546	0.498	0	1	952
Some	0.355	0.479	0	1	952
Little	0.099	0.298	0	1	952
Instrumental Variable					
Parent's understanding of financial matters					
Low	0.127	0.333	0	1	952
Intermediate	0.354	0.478	0	1	952
High	0.519	0.500	0	1	952

Appendix 2G. Correlation Table

Table 2A-5. Correlation between Variables in the Model

This table reports correlation coefficients between variables in the model. Significance level of each correlation coefficient is in parentheses.

	Stock participation	Basic Financial Literacy	Advanced Financial Literacy	Class Rank	Age
Stock participation	-	-	-	-	-
Basic financial literacy	– 0.057	-	-	-	-
	(0.120)				
Advanced financial literacy	0.092	0.361	-	-	-
	(0.011)	(0.000)			
Class rank	0.127	0.158	0.163	-	-
	(0.001)	(0.000)	(0.000)		
Age	0.111	0.112	0.202	0.640	-
	(0.003)	(0.001)	(0.000)	(0.000)	
Male	0.027	0.086	0.023	0.033	0.086
	(0.464)	(0.009)	(0.477)	(0.332)	(0.010)
Income	0.187	0.023	0.102	0.163	0.234
	(0.000)	(0.500)	(0.003)	(0.000)	(0.000)
Saving rate	0.048	– 0.049	0.021	– 0.009	– 0.004
	(0.206)	(0.172)	(0.561)	(0.799)	(0.920)
Non-equity wealth	0.213	0.105	0.137	0.092	0.177
	(0.000)	(0.003)	(0.988)	(0.010)	(0.000)

Economics education	– 0.040	– 0.076	– 0.216	– 0.030	– 0.032
	(0.267)	(0.020)	(0.000)	(0.372)	(0.332)
Daily use of economics	– 0.014	0.025	– 0.065	0.070	0.011
	(0.702)	(0.451)	(0.047)	(0.039)	(0.733)

Table 2A-5. Correlation between Variables in the Model - continued

	Male	Income	Saving Rate	Non-equity Wealth	Economics Education
Stock participation	-	-	-	-	-
Basic financial literacy	-	-	-	-	-
Advanced financial literacy	-	-	-	-	-
Class rank	-	-	-	-	
Age	-	-	-	-	-
Male	-	-	-	-	-
Income	0.021	-	-	-	-
	(0.552)				
Saving rate	0.032	0.040	-	-	-
	(0.376)	(0.270)			
Non-equity wealth	– 0.006	0.313	0.067	-	-
	(0.858)	(0.000)	(0.070)		
Economics education	0.051	– 0.112	0.026	– 0.053	-
	(0.121)	(0.736)	(0.474)	(0.135)	
Daily use of economics	0.080	0.008	0.003	0.027	0.270
	(0.015)	(0.820)	(0.936)	(0.435)	(0.000)

Chapter 3
Exponential Growth Bias and Financial Retirement Decisions

Abstract

Exponential growth bias refers to individuals' underestimation of the effects of exponential growth (i.e. tendency to neglect the effects of compound interest) and has been shown to affect important financial decisions such as financial retirement decisions. Using a novel survey of Indonesian employees from different sectors, the results show that exponential growth bias can explain the tendency to underestimate the future value of retirement savings. Bias empirically matters for portfolio allocation of retirement savings: employees with future value bias favour short-term over long-term assets in their portfolio and have propensity to acquire illiquid asset. This implies that bias can have a significant consequences on employees' retirement welfare due to poor portfolio allocation.

3.1. Introduction

Saving for retirement has become an issue of growing importance throughout developing Asia. In developed countries, most workers depend on government-based Social Security systems and private company-based pensions to smooth their consumption. In the developing world, the mechanisms are quite different. In the absence of significant formal institutional support, older individuals rely on their own labour income and support from their family (McKee, 2006). This is especially true for Indonesians who have traditionally relied upon their children to take care of their material needs in their old age. However, improvements in female education and better medical care have induced Indonesians to have fewer children and enabled them to live longer. The fertility rate in Indonesia was 2.2 in 2010 and it is predicted that this will have decreased to

1.9 by 2045, whereas the life expectancy was 71 in 2010 and is predicted to increase to 79 by 2045 (Park & Estrada, 2012).

In addition to changes in social factors, most Asian countries do not yet have mature, well-functioning pension systems. As a result, they are ill-prepared to provide economic security for the large number of retirees. Indonesians do not have adequate retirement savings from pension Social Security as is evident by poor key performance indicators, namely the replacement rate or the ratio of retirement income to pre-retirement income. The replacement rate is a widely used measure of the adequacy of pension benefit as a source of postretirement income. A higher replacement rate enables retirees to achieve a higher standard of living. Pension experts generally recommend a replacement rate of 60%-75%, adjusted for longevity and inflation risks. A pension modelling study completed in 2008 by the Asian Development Bank shows that Indonesia has a replacement rate of 19% which is the lowest among any other Asian country, including China, Korea, Malaysia, Singapore, Thailand, Vietnam, and the Philippines which has the highest replacement rate of 77% (Park & Estrada, 2012). Indonesia's replacement rate from mandatory Social Security pension schemes was 55.3% in 2018 (OECD, 2019), but this is still below the suggested rate for retirement welfare. The combination of decreasing dependency on family, increasing retirement costs as people live longer lives, rising health care costs, and inadequate pension benefit from government Social Security is therefore of serious concern.

Optimal retirement saving behaviour in this current situation requires an understanding of the relationship between current savings and income in retirement, which requires a level of financial sophistication that many individuals may lack. To remedy financial illiteracy, there exists previous studies which advise to deliver and improve general education in personal finance and

financial literacy (e.g. Morton, 2005; Lusardi & Mitchell, 2007). However, Fernandes et al. (2014) state that this general financial education programmes cost billions of dollars annually, but only explain for 0.1% of the variance of the analyzed financial behaviours. Instead, Song (2020), in addition to Foltice and Langer (2017, 2018) suggest that one should first identify the barriers to, for example, optimal retirement saving behaviour, and then deliver a more specific financial education to remove the barriers so that this approach would be more cost-effective.

Accordingly, we focus on one specific definition of financial literacy: misunderstanding exponential growth, or more specifically, the effect of compound interest. Although compound-interest perception may be considered as a component of broader financial literacy, exponential growth bias conveys different information. The standard measure of financial literacy, which is the share of questions answered correctly, ignores information about the direction and magnitude of how responses deviate from accurate responses. On the contrary, our exponential growth measure delivers information about the direction and magnitude of how an individual's responses depart from the correct response. Moreover, knowledge of compound interest is especially important for retirement savings decisions due to the long investment horizons. Individuals who misunderstand compounding of exponential growth might be prone to under save and run the risk of insufficient retirement income because of poor financial decision-making. There is obvious policy interest in understanding whether exponential growth bias affects retirement saving behaviour, which might have a distinct effect from general financial literacy as treating exponential growth bias may be more cost-effective than treating broader financial literacy.

We use a new dataset by conducting a survey of Indonesian employees from different industries in 2019 to seek new evidence as to whether they misunderstand exponential growth and whether it matters in financial decision-making. The survey involves 386 employees from different sectors. The proportion of sample for each sector imitates the share of Indonesian employees worked in selected industries, i.e. social and personal services, manufacturing, wholesale and retail, and financial sectors. Note that due to a small sample, the survey we conducted is not a national representative survey of Indonesian employees and, therefore, our study can be considered as a pilot study. Nonetheless, our study provides a description of employees understanding about compound interest, how it affects their perception about future value, and most importantly, how it affects their financial retirement decisions.

In agreement with the literature, we find evidence that employees display *future value bias*: a tendency to underestimate a future value given a present value, time horizon, and rate of return. Based on our observations, only 2% of respondents correctly perceived future value, whereas 41% of the workers underestimate future value of retirement savings; of those who underestimate future value, 31% anchor on linear growth of the future value by adopting simple or add-on interest rates.

We next examine the critical question for personal finance: Does exponential growth bias matter in financial decision-making? To answer it, we construct a measure of compound interest bias and correlate it with savings and portfolio choice. The results suggest that bias matters: employees who overestimate the future value of savings are less likely to save; while those who underestimate the future value of savings are substituting short-term and low-return assets for long-term and high-return assets, and also have propensity to acquire illiquid asset. All of these

results are conditional on controls for demographic, available resources, preferences, financial sophistication, and other decision inputs.

The paper contributes to the personal finance and portfolio choice literature, especially in the context of a developing country. The findings show the importance of knowledge about exponential growth as misunderstanding compound interest can have a significant consequence on retirees' welfare due to poor financial decisions. Furthermore, the results suggest that exponential growth bias has its own specific effects which are distinct from broader financial literacy. This implies that future research should further consider of what the definition of financial literacy as treating exponential growth bias might be different from treating financial illiteracy.

The paper proceeds as follows. Section 3.2 shows that exponential growth bias can explain future value bias. Section 3.3 provides a review of the literature on exponential growth and financial decision-making. Section 3.4 provides our hypothesis. Section 3.5 describes our data set, introduces our measures of bias, and also reports summary data of outcomes and control variables. Section 3.6 presents our results. Section 3.7 concludes.

3.2. Background: Exponential Growth Bias and Future Value Bias in the Context of Retirement Decisions

Exponential growth bias is the tendency of individuals to underestimate the effect of exponential growth. It is intuitive that someone who underestimates exponential growth will exhibit future value bias. Consider an employee who saves a present value of retirement saving S

at a periodic interest rate i over time horizon t, with periodic compounding. The future value of his retirement savings R is:

$$R_t = S\,(1+i)^t \tag{1}$$

The term $f(i,t) = (1+i)^t$ is an exponential function. Because the future value is just a multiple of that term, there is a straightforward link between exponential growth bias and future value bias. We use the θ term of Stango and Zinman (2009) to parameterize bias. Unbiased individuals have $\theta = 0$ and correctly perceive exponential growth, while those with $0 < \theta < 1$ have exponential growth bias. Suppose that, instead of using the correct formula in (1) to infer the future value of retirement savings, an individual with exponential growth bias uses $f(i,t,\theta) = (1+i)^{(1-\theta)t}$.

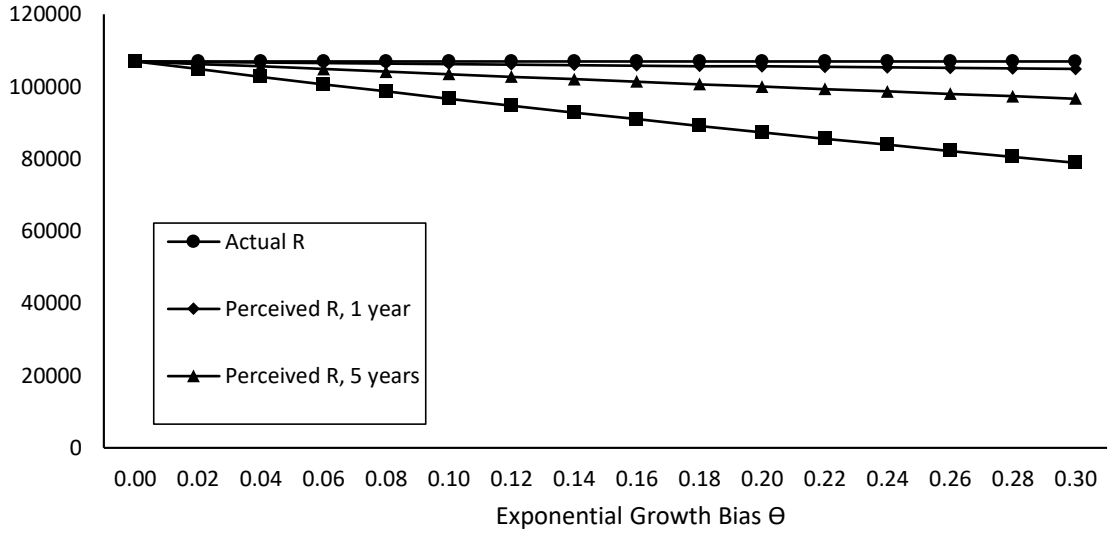
Figure 3.1 shows the numerical example of how exponential growth bias affects employees' perceptions of the future values of retirement savings R, over different time horizons $t = [1, 5, 15]$, with bias on the interval $\theta \in [0, 0.30]$.[1] Higher θ indicates greater exponential growth bias.

All calculations in Figure 3.1 uses an annual interest rate $i = 7\%$, as per the benchmark return of Social Security Old Age Saving Programme assumed by ESSAB.[2] Future values of retirement savings are calculated using:

$$R_t = S\,.\,f(i,t,\theta) \tag{2}$$

[1] The median θ implied by the hypothetical retirement saving questions is 0.315 and the range of θ is [0.003, 0.956].
[2] The Employment Social Security Administrative Body (ESSAB) is a non-profit public independent institution which manages the pension and old age savings programmes among other social securities, in Indonesia.

Figure 3.1. Perceptions of Future Values of Retirement Savings with Exponential Growth Bias
This figure shows the numerical example of perceptions of future values of retirement savings (R) which are effected by exponential growth bias (θ) over 1, 5, and 15 year time horizons, with bias on the interval between 0 and 0.30. Higher θ indicates greater exponential growth bias. This figure shows that exponential growth bias can lead to future value bias which becomes more pronounced as the time horizon lengthens.



Actual R uses an unbiased assessment of exponential growth:

$$f(i,t,0) = (1+i)^t \tag{3}$$

Perceived R uses the parameterized function:

$$f(i,t) = (1+i)^{(1-\theta)t} \tag{4}$$

The calculations use annual compounding and Ss that equalise the R when $\theta = 0$, to facilitate comparison of perceived Rs as exponential growth bias changes. For the 1-year time horizon, S = IDR 100,000. For the 5-year time horizon, S = IDR 76,290. For the 15-year time horizon, S = IDR 38,780. Figure 3.1 illustrates that exponential growth bias is essentially irrelevant over a 1-year horizon and has large effects over a retirement saving 15-year horizon.

It is also shown that even a mild degree of exponential growth bias can lead to future value bias which becomes more pronounced as the compounding horizon lengthens. Future value bias is less severe on short-term retirement savings, which comes from the fact that interest growing on both principal and interest multiplies less quickly as the time horizon decreases. As the accumulation period t on the retirement savings approaches zero, the exponential term in Equation (1) becomes insignificant for estimating the future value of retirement savings. Because the exponential term is insignificant, even someone with severe exponential growth bias will correctly infer the future value from a present value of retirement savings.

Exponential growth bias can produce biased perceptions of future value as described in Equation (4) when employees try to intuitively solve the problems. Exponential growth bias can also lead employees to adopt biased methods, such as linearizing returns over time horizon. Future value bias is a consequence of ignoring the returns provided by compounding. Previous studies have shown that the most common mistake in assessing future value is that respondents apply the simple or add-on interest rate, which represents the true rate of return only if a saver withdraws the return from his retirement account and does not reinvest it. However, the retirement savings programme requires the account holder to reinvest the return. An employee who does not think about returns from compounding or underestimates their impact on their retirement savings will have future value bias. Instead of using the correct form in Equation (3) to solve for the future value, an individual with linear bias uses:

$$f(i,t) = (1 + i.t) \tag{5}$$

3.3. Literature Review

Exponential growth bias is the tendency of individuals to underestimate the growth of exponential series or, more specifically, the effects of compound interest. Prior studies have shown that exponential growth bias is widespread. Lusardi and Mitchell (2007) examine financial literacy in Health and Retirement Study (HRS) that covers Americans over the age of 50 and found that only 18 percent correctly computed a compound interest question; of those who got that question wrong, 43 percent undertook a simple interest calculation, thereby ignoring the interest accruing on both principal and interest. These are surprising findings, especially considering that these respondents are only a few years from retirement and have handled numerous financial decisions during their lives.

Nonetheless, similar results are found in the work by Stango and Zinman (2009), Levy and Tasoff (2016), and Goda et al. (2019) which examine exponential growth bias in the general population. Findings of widely prevalent exponential growth bias are also reported in studies on undergraduate students (McKenzie & Liersch, 2011), smaller samples or specific groups of the population (Goda et al., 2014, 2020), and in a developing country context (Song, 2020).

Measures of exponential growth bias are usually obtained using survey questions (e.g. Stango & Zinman, 2009; Almenberg & Gerdes, 2012; Foltice & Langer, 2017, 2018; Goda et al., 2020) or experimental methods (e.g. Goda et al., 2014; Song, 2020). In the former studies, subjects are asked to estimate either the interest rate implied by a stream of payments or the final value of an investment that grows at a constant interest rate over several periods. In the latter type of studies, a random group of treated subjects usually receives some sort of information regarding compound interest which the control group does not obtain. Differences

in the observed behaviour of the two groups can be attributed to the exponential growth bias. Treated subjects typically show a higher likelihood to enroll in long-term savings plans and also contribute more to their plans. These studies demonstrate the existence of the exponential growth bias and relate the bias to disadvantageous financial decisions.

Empirically, a growing body of research has suggested that exponential growth bias is related to lower levels of savings (Stango & Zinman, 2009; Levy & Tasoff, 2016; Goda et al., 2019). Neglecting the effects of exponential growth can distort one's view of intertemporal budget constraints and could lead to suboptimal saving decisions. This occurs because biased individuals who underestimate compound interest believe that the expected return of savings is lower than it really is and, thus, shrinking motivation to save. Therefore, eliminating bias would encourage people to reduce their working period consumption and to save more for retirement because the marginal benefit of money saved is higher.

On the other hand, reducing exponential growth bias could conceivably decrease motivation to save. This idea is explained in prior study by McKenzie and Liersch (2011), who conducted an experimental study to increase retirement saving among undergraduate students by highlighting the effect of compound interest on retirement savings. They provided participants a graph that showed how saving for 40 years would result in future value more than twice as much money as saving for 20 years would because of the compound interest effect. They find that highlighting the exponential growth led to an increased motivation to save. However, highlighting compounding interest could also decrease motivation to save, because participants would realize that they will have more retirement savings than they otherwise expected. For a

given saving goal at retirement, individuals can learn that they can save less than they thought and still can achieve their goal.

Stango and Zinman (2009) further show that bias decreases long-horizon and high-yielding assets, but not short-term and low-yielding asset ownership. They proxy for long-term savings using the value of stock holdings, and for short-term savings using value of a certificate of deposit. Their findings demonstrate that bias induces large decreases in stock holding, but not in certificate of deposits holding. This suggests that biased households substitute short-term for long-term assets. One explanation is that the severity of bias depends on the time horizon. When the periodic return increases and the compounding horizon lengthens, the value of investment will multiply more quickly. Consumers who neglect how quickly a given yield compounds will underestimate the expected future value by making it appear a much lower return than the actual return, thus, making the long-term assets less attractive. On the other hand, the exponential effect becomes less significant in predicting future value in the short-term horizon, thus, even someone with severe exponential growth bias should correctly infer the future value of short-term assets. Therefore, bias should exert stronger effects over long-term assets, but not short-term assets.

Another possibility of why bias decreases the likelihood of stock participation is that bias is correlated with a lack of financial sophistication defined more broadly. The negative correlation between exponential growth bias and standard measures of financial literacy is proven empirically by Almenberg and Gerdes (2012). Previous studies confirming that financial literacy increases the likelihood of investing in the stock market and that these financially literate

individuals take advantage of the equity premium on stock investment and, thus, accumulate more wealth than financially illiterate individuals (van Rooij, et al., 2011, 2012).

Financial sophistication is often defined as input that reduces participation, learning, and setup costs (Campbell, 2006; Calvet et al., 2007; Christelis et al., 2010). Investing in risky high-yielding assets requires learning and participation costs, capturing both time and money that must be spent to gather and process information, which may be smaller for financially literate individuals. Therefore, financially sophisticated individuals are more likely to have a higher level of stocks and mutual fund participation due to smaller fixed learning and setup costs.

A related long-term asset to consider when assessing employees' retirement assets is property ownership. Lusardi and Mitchell (2007) conduct a study that relates workers' financial literacy to their success at retirement planning and their accumulation of retirement wealth in Health and Retirement Study (HRS). They find that the knowledge of interest compounding has an impact on retirement planning, and those who plan for their retirement accumulate more wealth in home equity. This suggests that knowledge of interest compounding can influence planning patterns, which in turn, affects individuals' wealth outcomes. The fact that interest compounding knowledge affects home equity ownership makes sense in as much as it is critical for long-term saving plans.

On the other hand, there is also a possibility that people acquire a house merely to meet their current basic necessities instead of a long-term asset for retirement. There is some evidence that many elderly individuals opt to not use their homes to finance retirement. Venti and Wise (1990, 1991) find retirees have not downsized their homes at retirement, nor have they taken up reverse mortgages. Lusardi and Mitchell (2007) discover 60% homeowners aged 50 and over

affirmed that they did not plan to sell their homes to finance retirement and almost 70% of respondents felt there was a minimal chance they would sell their homes to pay for retirement. If this is the case, then biased individuals may have housing equity, although we do not know yet whether they will draw down on this home equity in retirement.

3.4. Hypothesis

Future value bias is a tendency to underestimate a future value given a present value, time horizon, and rate of return. Individuals who display future value bias believe that the expected return of savings is lower than the actual return and, therefore, decreases the likelihood of saving (Stango & Zinman, 2009; Levy & Tasoff, 2016; Goda et al., 2019). Eliminating or reducing bias would increase retirement savings (McKenzie and Liersch, 2011; Goda et al., 2014, 2019; Song, 2020). The intervention increases individual's awareness of the exponential growth of savings over time and, therefore, makes the decision to save more look appealing. Therefore, our first hypothesis:

Hypothesis 1. Individuals who display future value bias are less likely to save than those who do not display future value bias.

Stango and Zinman (2009) show that bias decreases long-horizon and high-return asset holding by making it appear a relatively lower return, but not short-term and low-return asset ownership, because even consumers with severe bias should accurately assess short-term interest rates. Furthermore, exponential growth bias might be correlated with a lack of financial literacy defined more broadly (Almenberg & Gerdes, 2012). If this is true, then exponential growth bias should decrease risky long-term asset holding since the learning and setup costs to

participate in sophisticated assets may be higher for financially illiterate individuals (Campbell, 2006; Calvet et al., 2007; Christelis et al., 2010). These lead to our second and third hypotheses:

Hypothesis 2. Individuals who display future value bias are more likely to hold short-term and low-yielding assets than those who do not display future value bias.

Hypothesis 3. Individuals who display future value bias are less likely to hold long-term and high-yielding assets than those who do not display future value bias.

Knowledge of interest compounding is a significant predictor for retirement planning, and individuals who plan for their retirement accumulate more wealth in home equity (Lusardi & Mitchell, 2007). Nonetheless, it is possible that people acquire a house solely to meet their current basic necessities instead of a long-term asset to finance their retirement (Venti & Wise, 1990, 1991; Lusardi & Mitchell, 2007). If this is true, then biased individuals might own property, although we have not known whether they would use it to finance their retirement. Our fourth hypothesis:

Hypothesis 4. If property is a useful proxy for long-term assets, then Individuals who display future value bias are less likely to hold property than those who do not display future value bias.

3.5. Data and Methodology

3.5.1. Data

Indonesia has experienced a rapid economic and social transformation that has affected the supply and demand of labor force. During the "New Order" era between 1996 and 1998, the country's economy has been one of the fastest growing economies in Asia with an average real growth more than six percent annually. This performance has delivered the country from the position of one of the low-income countries to being one of the middle-income countries

(Hasoloan, 2006). However, this remarkable performance was interrupted by an economic and banking crisis that occurred on 1997-1998.

After experiencing recession and stagnation that caused the slowdown of economy in 1998 with the growth rate of economy being –13%, the country has undergone a profound transformation in economic, social, and political areas, as we describe in greater detail in Section 1.2. However, with such a transformation, employment creation, particularly in the formal sector, is limited and is not considerably enough to accommodate the increasing amount of labor supply. Those who cannot be employed in the formal sector have to continue either being unemployed or employed in the informal sector which acts as the last resort (Hasoloan, 2006).

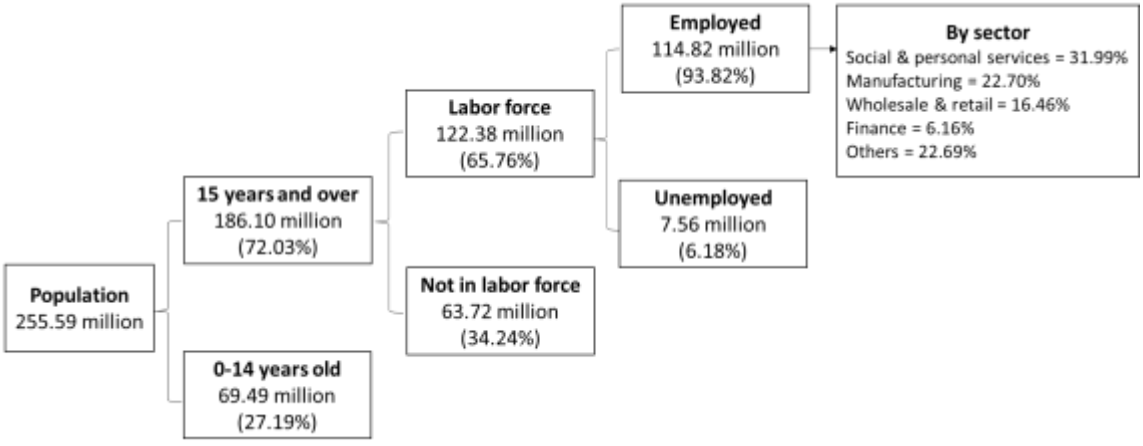
According to the 2015 population census published by Indonesia Central Bureau of Statistics (2016), the population of Indonesia was about 255 million in which 72.03% were 15 years old and over, while the remaining were under 15 years old. For about 65.76% of Indonesian were in labor force, i.e. those who were above 15 years old and either employed or unemployed, and 34.24% of population were not in labor force, i.e. attending school, doing housekeeping or others. Of those who were in labor force, 93.82% of them were employed while about 6.18% were unemployed. For about 32% employees worked in social and personal service sectors, 22.70% worked in manufacturing sector, 16.46% were in wholesale and retail industries, and 6.16% were in financial sector. Figure 3.2 shows the human resource profile in Indonesia.

The survey were conducted in Jakarta, the capital city of Indonesia, and Bandung. Bandung is the fourth largest city in Indonesia as well as the capital city of West Java, which is the most populous province in Indonesia where about 47 million people (18.31%) live in this province. Although the sample in this study is a small sample, it attempts to represent the

proportion of employees in each industry as closely as possible and, therefore, it provides a basis for a larger sample. 39.90% of the sample were employees in social and personal service sectors, including those who worked in education, health, and social services sectors. 36.53% were workers in manufacturing sector, 12.44% were in wholesale and retail industries, and 11.14% were in banking and insurance sectors. The survey participants were asked to fill in a written questionnaires distributed from June until November 2019. The exact wording of survey questions are reported in Appendix 3B.

Figure 3.2. Human Resources Profile in Indonesia

This figure shows Indonesia's labor markets according to 2015 population census by Indonesia Central Bureau of Statistics (2016). Labor force are Indonesian who were above 15 years old, either employed or unemployed. Those who are not in labor force were people attending school, doing housekeeping or others.



More than 53% of employees in the Universities spend less than income in the previous year. Almost all employees in Universities (90%), wholesale (93%), and banking industries (80%) were found to hold short-term assets, while all employees from service companies and hospitals owned short-term assets. 76% of employees in the wholesale sector and 67% of employees in

banking hold long-term assets, whereas all employees that work in hospitals own long-term assets. Our sample showed that the majority of employees own property. All employees in service companies and hospitals own property. For about 90% of University and wholesale company employees hold property, and 74% of the banking sector also own property. More than 65% of employees in the wholesale and service industries also possess property. Table 3A-1 of the Appendix 3A reports the correlation between variables in the analysis.

3.5.2. The Measurement of Bias

To capture future value bias, our survey asked employees to estimate a future value given a present value, time horizon, and self-supplied interest rate. We then calculate the difference between self-supplied interest rate and the actual interest rate and use this difference as our bias measure. We use the term *compound interest bias* for the rest of the paper to refer to our bias measure. We measure compound interest bias using two hypothetical questions which were given to survey participants in 2019. The first question is:

> *"Suppose you are saving IDR 100,000 at the beginning of the year into your retirement savings account. How much do you think your savings will be after three years, in total – including the principal and its interest?"*

The response to this first question is a lump sum *total savings* (e.g. IDR 133,100). Given the pre-defined principal amount and accumulation period, the total savings yields i^*, the *implied interest rate* per the respondent's self-supplied total savings. The computation uses annual compounding formula as described in (1). Figure 3.3 shows the distribution of the implied interest rate across all respondents. The mean is 38.822%, which corresponds to a total savings over three

years totaling roughly IDR 267,532. The 25th percentile is 3.145% (IDR 109,735) and the 75th percentile is 35.860% (IDR 250,767). The next question in the survey is:

"What percent rate of interest do you think those accumulated three years savings imply?"

This response is i^P, the *perceived interest rate*. Figure 3.4 shows the distribution of perceived interest rates. The perceived rate distribution has a lower variance than the implied rate distribution, but the implied rate and the perceived rate is still correlated in which the correlation is 0.050 among those with implied interest rates below the 75th percentile.

Figure 3.3. Implied Interest Rate on a Hypothetical Savings across All Respondents.
"Implied rate" is the saving interest rate calculated using the employee's self-supplied total savings on a hypothetical IDR 100,000, 3-years accumulation period.

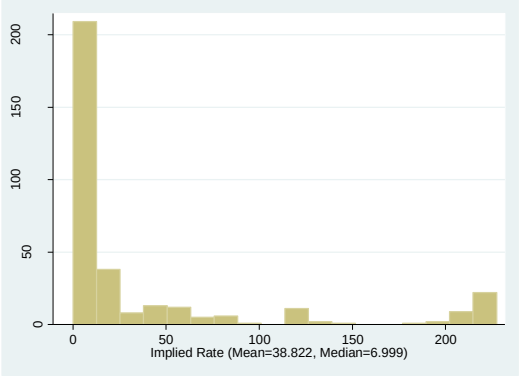
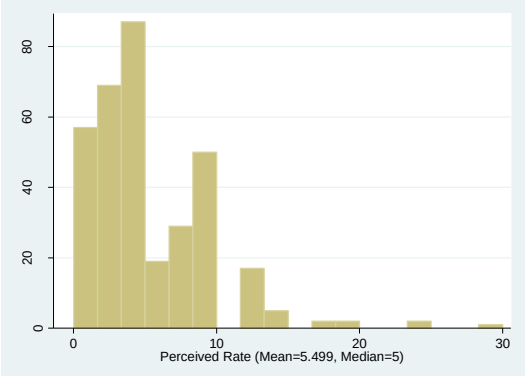


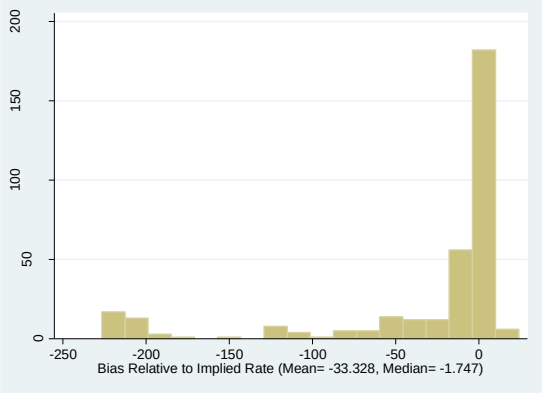
Figure 3.4. Perceived Interest Rate on a Hypothetical Savings across All Respondents.
"Perceived rate" is the saving rate inferred by the employees given their self-supplied total savings on a hypothetical IDR 100,000, 3-years accumulation period.



Compound interest bias is the difference between the perceived and implied interest rates. Figure 3.5 shows the distribution of bias relative to implied interest rate of all employees. About 41% of respondents underestimated the future value by reporting a perceived rate which was greater than the implied rate; of those who underestimated the future value, 31% gave the "simple" or "add-on" rate (e.g. a saving total of IDR 130,000 yields a perceived rate of 10%). Around 57% of respondents overestimated the future value by perceiving the interest rate as less than the implied rate. Whereas only 2% of respondents correctly perceived future value. The median bias is –1.747% and the mean bias is –33.328%.

Figure 3.5. Bias Relative to Implied Interest Rate.

Bias is the difference between the perceived and implied interest rates on the hypothetical saving across all respondents.



We classified our bias measure into negative and positive bias categories. Table 3.1 shows tabular data on compound interest bias on hypothetical retirement savings. The negative bias category includes employees who overestimated the future value by reporting the perceived rate as less than the implied rate. This category also includes 2% of employees with zero bias (perceived rate equals implied rate), i.e. those who correctly perceive the future value. The other

category is the positive bias category which includes workers who underestimated the future value by providing a perceived rate greater than the implied rate. We then stratify positive bias into low and high positive bias categories to distinguish different levels of bias. We use our bias measures for our analysis of whether individuals who underestimate future value behave differently from their counterpart who overestimate future value in financial decision-making.

Table 3.1. Compound Interest Bias on Hypothetical Retirement Savings.
Rates and bias are in percentage points. Total savings, interest rate, and bias measures are means by bias category. Bias are classified into negative, low and high positive bias categories. Negative bias category includes employees who overestimate future value and those who correctly perceive future value. Positive bias category includes employees who underestimate future value. The data are from the 2019 employees' survey.

	Bias Category		
	Bias ≤ 0	Low bias (Bias > 0)	High bias (Bias > 0)
Stated total savings (P + I)	781,685	112,246	111,690
Implied interest rate	98.462	3.926	3.754
Perceived interest rate	5.023	4.317	7.830
Compound interest bias = Perceived – Implied interest rate	–93.439	0.391	4.076
Range of bias in category	[–226.607, 0.000]	[0.010, 1.174]	[1.175, 24.000]
Number of employees	201	65	74

3.5.3. Outcomes and Control Variables

Our empirical models estimate whether employees' differences in bias explain outcomes in financial decision-making. We use specifications of the form:

$$Outcome_e = f(Bias_e, X_e) \quad (6)$$

The dependent variable $Outcome$ varies in each model. The outcomes are discussed in greater detail below, but to summarise, they are saving rate, short-term assets, stocks, and

property ownership. The vector $Bias$ contains compound interest bias category indicators in which the zero and negative biased group serves as the omitted category. We focus on compound interest bias as the key explanatory variable. The null hypothesis in each case is that the coefficients on $Bias$ is zero. The vector X contains all of the controls that might be correlated with both outcomes and our measure of compound interest bias. Note that the controls might be suppressed to conserve space, but each empirical model includes *all* of the control variables described below. Table 3.2 shows descriptive statistics on some key variables by bias category.

It is shown that employees who are in both low and high positive bias categories hold less stocks and/or non-money market mutual funds than those in the negative bias category. Those in the negative bias category own more short-term assets than those who are in low and high positive bias categories. The proportion of employees under the high positive bias category who hold property is the biggest (95%), compared to employees in low positive bias and negative bias. Roughly 52% of employees in low positive bias had less spending than income in the previous year.

Table 3.2. Compound Interest Bias and Employee Characteristics: Descriptive Statistics.

		Bias Category		
		Bias ≤ 0	Low bias (Bias > 0)	High bias (Bias > 0)
Financial outcomes				
(1) Stock and/or non-money market mutual funds holding	Mean	0.74	0.53	0.70
	N	120	49	48
(2) Short-term assets holding	Mean	0.89	0.65	0.87
	N	145	55	55
(3) Property holding	Mean	0.85	0.78	0.95
	N	133	59	55
(4) Saving rate (consumption < income)		0.34	0.52	0.48
	N	198	64	65
Demographics				
(5) Age	Mean	34	32	35
(6) Male		0.46	0.44	0.51

(7) High school graduate or less	0.24	0.20	0.29
(8) College degree	0.18	0.12	0.16
(9) Bachelor degree	0.40	0.48	0.35
(10) Master degree	0.14	0.17	0.19
(11) Doctorate degree	0.04	0.03	0.01
(12) Income: less than IDR 4,000,000	0.29	0.08	0.16
(13) Income: IDR 4,000,000 – 8,000,000	0.34	0.45	0.47
(14) Income: IDR 8,000,001 – 12,000,000	0.19	0.20	0.26
(15) Income: IDR 12,000,001 – 16,000,000	0.10	0.17	0.10
(16) Income: more than IDR 16,000,000	0.08	0.10	0.01
Preferences			
Risk			
(17) Takes substantial financial risk	0.10	0.33	0.24
(18) Takes > average financial risks	0.24	0.19	0.33
(19) Takes average financial risks	0.25	0.34	0.24
(20) Not willing to take any financial risks	0.41	0.14	0.19
Patience			
(21) Will tie up money long-run to earn substantial returns	0.25	0.37	0.33
(22) Will tie up money medium-run to earn > average returns	0.32	0.36	0.38
(23) Will tie up money short-run to earn average returns	0.18	0.16	0.17
(24) Will not tie up money at all	0.25	0.11	0.12
Financial advice			
(25) Uses professional financial advice	0.10	0.23	0.05
(26) Uses advice from friends/family	0.43	0.50	0.54
(27) Uses advice from other sources	0.16	0.11	0.17
(28) Uses no financial advice	0.31	0.16	0.24
Pension simulator			
(29) Uses pension calculator on ESSAB online account	0.09	0.19	0.13
(30) Uses pension calculator on ESSAB mobile application	0.17	0.25	0.23
(31) Uses pension calculator available free online	0.11	0.12	0.10
(32) Uses no pension calculator	0.63	0.44	0.54
Financial sophistication			
(33) Uses mobile application to make financial transactions.	0.80	0.86	0.61
Number of observations, unconditional outcomes	201	65	74

Controls for available resources and claim on resources include salary/wage income category, number of children, gender, education, age, marital status, years with current employer, and industry. The average age of the respondents was 33 years old. More than 50% of males are fell into the high positive bias category. Table 3.2 shows that employees educated to high school graduate level or less, are concentrated in the high positive bias category (29%), while those with a Bachelor degree are concentrated in the low positive bias category (48%). Employees who are in the lower income category (i.e., who have income between IDR 4,000,000 and 12,000,000) are distributed both in the low and high positive bias categories.

Controls for preferences include measures of risk preference and time preference. Königsheim et al. (2018) has demonstrated the importance of simultaneously estimating risk and time preferences when analysing the role of the exponential growth bias in intertemporal decisions. When these preferences are ignored, evaluations of the magnitude of the exponential growth bias could be compromised.

Risk preference is measured with the question: “Which of the following statements comes closest to the amount of financial risk you are willing to take when you save or make investments?” Answers fell into four categories, ranging from “willing to take substantial financial risks to earn substantial returns" to “not willing to take any financial risks.” Time preference or patience is measured with the question: “Which of the following statements comes closest to how you feel about tying up your money in investments for long period of time?” Answers range from “will tie up money in the long-run to earn substantial returns” to “will not tie up money at all.” Table 3.2 shows that employees who are not willing to take any financial risk are concentrated in the negative bias category, while only 14% and 19% are in the low and high

positive bias category, respectively. Workers who are in the low positive bias category are more willing to tie up money in the long- or medium-term to earn greater financial return than to tie-up money in the short-term and earn average returns, or to not tie up money at all.

Controls for financial advice are categorical variables measuring whether employees use external advice, and whether advice is from a professional, from friends and family, or from other sources. Controls for the use of a pension simulation calculator asks respondents whether they use the pension calculator on the Social Security (ESSAB) online account, Social Security (ESSAB) mobile application, another free online simulator, or do not use any pension simulator.[3] Table 3.2 demonstrates that the majority of employees in any bias categories seek financial advice from friends and family. The usage of pension simulators shows a similar pattern. A large fraction of employees from each bias category do not use pension calculator.

Almenberg and Gerdes (2012) find a negative correlation between exponential growth bias and standard measures of financial literacy. Since financial literacy might also link to financial decision-making, their study indicates that examining the relationship between exponential growth bias and individuals' financial behaviour, without adequate controls for financial literacy, may generate biased results. We use two proxies to control overall financial literacy. They are the use of mobile applications to make financial transactions and, of course, the level of education. Table 3.2 shows that about 80% and 86% of employees in negative bias and low

[3] The Employment Social Security Administrative Body (ESSAB) provides pension calculator for each Indonesian employee who has account in Social Security Old Age Savings Programme. The pension calculator can be accessed via either online account or mobile application. Given the amount of current balance, contributions, and accumulation period, the simulator calculates the predicted future value of retirement savings.

positive bias categories, respectively, uses mobile applications to complete financial transactions, in contrast to only 61% of employees in the high positive bias category.

3.6. Empirical Results

Decisions to make savings whilst still working is crucial as it will determine the future value of retirement savings. Individuals who misunderstand exponential growth might be prone to under saving and thus run the risk of insufficient retirement income because of inadequate savings during their working life period. We examine the effect of compound interest bias on savings in Section 3.6.1.

Savings is important for retirement preparedness. However, the portfolio choice is also vital in determining retirement income because different types of assets provide different returns. Section 3.6.2 assesses the effect of compound interest bias on portfolio choice, namely short-term assets, long-term assets, and property holding. Section 3.6.1 and 3.6.2 report results of our primary empirical tests from the multivariate model (6). Each multivariate specification conditions on the full set of control variables is listed in Section 3.5.3. The tables suppress most of the control variable coefficients to save space.

3.6.1. Does Bias Affect Saving?

We use compound interest bias, as bias measures described in Section 3.5.2, to assess whether bias affects savings. If our bias measure is generated by exponential growth bias, individuals with future value bias will neglect compounding and expect saving balances to grow linearly over time, and therefore underestimate the future value. Thus, compound interest bias

should decrease savings because they believe the expected return of their savings to be less than it really is, making the decision to save less attractive.

Table 3.3 shows results for the specification of correlating bias with savings rates. We estimate an ordered probit where the categories are ranked (1: dissaved, 2: even, 3: saved) based on a question regarding employee spending versus income in the previous year. Savings refer to the excess of income over consumption. On the other hand, dissaving refers to spending that exceeds income. Another possibility is where consumption equals to income, which implies employees spend all of their income. Column 1 shows that the coefficient on each of the positive bias category is positive and employees in the low positive bias categories are significantly more likely than employees in the negative bias (in the omitted category) to save (i.e. consumption less than income). Our findings imply that workers who overestimate the future value of savings (in the negative bias category) are 14% less likely to save than workers who underestimate the future value (in the low positive bias category). The predicted probability of having consumption less than their income last year is 36% for employees who overestimated the future value, and 50% for those who underestimated the future value.

Considering that saving behaviour residual is likely to be correlated for people working in the same industry, we cluster standard errors by industry in Column 2. The results are still robust in that employees who are in the negative bias category are significantly less likely to save than those who are in low and high positive bias categories. Figure 3.6 shows the probability of spending less than their income in the previous year by bias category. Employees who are in negative bias have a 36% probability of saving, while those in the low and high positive bias have a 50% and 45% probability of saving, respectively.

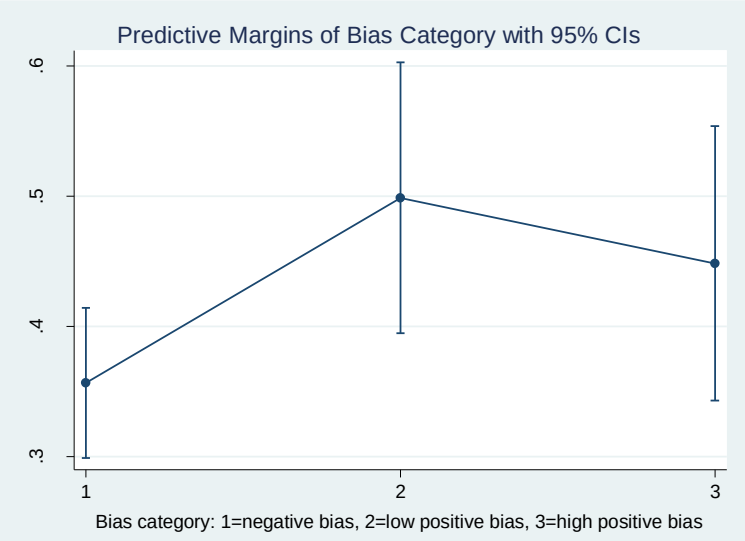
Table 3.3. Saving Rate and Compound Interest Bias.

This table reports marginal effects of Ordered Probit regression. Column 1 shows the effects of bias on the probability of consumption is less than income in the previous year; Huber-White standard errors are shown in parentheses. Column 2 shows the effects of bias on the probability of consumption is less than income in the previous year; cluster standard errors at sector level are shown in parentheses. The specification includes controls for the full set of covariates in addition to those reported in the table: years in current job, marital status, number of children, industry, use of financial advice on financial decisions, use of pension simulator, use of mobile application to make financial transactions. *, **, *** indicate 10%, 5%, and 1% level of significance, respectively.

Dependent variable:	Saving Rate: 1 : consumption > income 2 : consumption = income 3 : consumption < income			
Estimator:	(Ordered Probit)			
Mean dependent variable:	2.134			
	Column (1)		Column (2)	
Compound interest bias				
(base group: negative bias)				
Low positive bias	0.142 **	(0.060)	0.142 **	(0.060)
High positive bias	0.092	(0.060)	0.092 **	(0.045)
Age	0.005	(0.005)	0.005	(0.005)
Male	0.007	(0.045)	0.007	(0.032)
Education				
(base group: doctorate degree)				
high school graduate or less	– 0.356 *	(0.191)	– 0.356 ***	(0.085)
College degree	– 0.181	(0.183)	– 0.181 **	(0.076)
Bachelor degree	– 0.132	(0.180)	– 0.132 **	(0.056)
Master degree	– 0.085	(0.172)	– 0.085	(0.067)
Income				
(base group: more than IDR 16,000,000)				
less than IDR 4,000,000	– 0.063	(0.132)	– 0.063	(0.073)
IDR 4,000,000 – 8,000,000	– 0.112	(0.105)	– 0.112	(0.074)
IDR 8,000,001 – 12,000,000	– 0.031	(0.102)	– 0.031	(0.067)
IDR 12,000,001 – 16,000,000	– 0.036	(0.108)	– 0.036	(0.064)
Risk preference				
(base group: take substantial financial risk)				
Takes > average financial risks	0.066	(0.079)	0.066	(0.126)
Takes average financial risks	0.147 *	(0.079)	0.147 **	(0.058)
Not willing to take any financial risks	– 0.026	(0.075)	– 0.026	(0.101)
Patience				
(base group: will tie up money long-run to earn substantial returns)				
Will tie up money medium-run to earn > average returns	– 0.019	(0.057)	– 0.019	(0.082)
Will tie up money short-run to earn average returns	– 0.114	(0.071)	– 0.114 **	(0.058)
Will not tie up money at all	– 0.026	(0.076)	– 0.026	(0.070)
Full set of controls?	Yes		Yes	
Pseudo R^2	0.190		0.190	
Number of observations	298		298	

Figure 3.6. The Relationship between Bias and Saving Rate

This figure shows the probability of spending less than income in the previous year by bias category. The first category includes employees with negative bias, i.e. those who overestimate the future value of savings. The second and third categories include employees with low and high positive bias, i.e. those who underestimate the future value of savings. Employees in low positive bias are 14% more likely to save than those who are in negative bias category. Employees who are in low positive bias and negative bias have a probability of 50% and 36% to save, respectively; while those in high positive bias have a probability of 45% to save.



The explanation is embedded in the previous experimental studies by McKenzie and Liersch (2011) and Krijnen et al. (2020). They design intervention by providing subjects with future outcomes of their retirement savings and find that focusing people's attention on the attractiveness of potential retirement savings growth increases motivation to start saving as early as possible. However, the opposite effect can also possibly occur. Highlighting exponential growth conceivably could decrease motivation to save because people would realise that they will have more retirement savings than they otherwise expected. Hence, for a given savings goal at retirement, individuals can learn that they can save less than they thought and still can achieve their goal. Accordingly, our respondents who overestimate their future value of savings might perceive that they would have greater retirement savings than they expected and, thus, decrease

their motivation to save because they thought that they can still attain their retirement income whilst saving less.

3.6.2. Does Bias Affect Portfolio Choice?

Savings made by employees during the working period is important as it will determine the future value of wealth available at the time of retirement to finance their consumption during their pension. However, savings are not the only factor which determine retirement wealth. Portfolio choice is also crucial in determining retirement wealth as various forms of assets provide different returns over time periods. In this section, we examine whether bias affects short-term and long-term asset holding. If compound interest bias is driven by exponential growth bias, we would expect that workers who underestimated the future value of savings (in positive bias categories) are less likely to hold long-term and high-return assets (by making it appear relatively low returns), but are more likely to hold short-term and low-return assets (since even individuals with severe bias should accurately assess short-term returns).

Table 3.4 tests whether bias is correlated with short-term asset ownership, for example, certificate of deposits. Column 1 shows that individuals in the positive bias categories are more likely to hold short-term assets. The coefficient of each of the positive bias categories is positive, and employees in high positive bias category are approximately 16% significantly more likely than the employees in the negative bias category (in the omitted category) to hold short-term assets. The predicted probability of holding short-term assets is 91% for individuals who underestimated the future value, and 75% for those who overestimated the future value.

The controls also enter the empirical relationship in meaningful ways. Lower education and lower income are both associated with lower propensity to own short-term assets. Our measure of time preference is negatively correlated with short-term asset holding. This is in line with Goda et al. (2019) who show that present-biased people overweigh present consumption relative to future consumption, and present-biased agents may procrastinate over completing the often tedious process of enrolling in tax-deferred savings plans, and also have lower savings than unbiased agents given the same exponential growth bias.

Table 3.4. Short-term Assets and Compound Interest Bias.

This table reports marginal effects of Probit regression. Column 1 shows the effects of bias on the probability of holding short-term assets; Huber-White standard errors are shown in parentheses. Column 2 shows the effects of bias on the probability of holding short-term assets; cluster standard errors at sector level are shown in parentheses. All specifications include controls for the full set of covariates in addition to those reported in the table: years in current job, marital status, number of children, industry, use of financial advice on financial decisions, use of pension simulator, use of mobile application to make financial transactions. *, **, *** indicate 10%, 5%, and 1% level of significance, respectively.

Dependent variable:	Short-term Asset Holding			
Estimator:	(Probit)			
Mean dependent variable:	0.832			
	Column (1)		Column (2)	
Compound interest bias				
(base group: negative bias)				
Low positive bias	0.040	(0.044)	0.040	(0.457)
High positive bias	0.156 ***	(0.042)	0.156 ***	(0.047)
Age	0.002	(0.004)	0.002	(0.002)
Male	– 0.053	(0.037)	– 0.053	(0.060)
Education				
(base group: doctorate degree)				
high school graduate or less	– 0.076	(0.167)	– 0.076	(0.138)
College degree	– 0.044	(0.169)	– 0.044	(0.185)
Bachelor degree	– 0.177	(0.154)	– 0.177	(0.154)
Master degree	– 0.335 **	(0.153)	– 0.335 **	(0.152)
Income				
(base group: more than IDR 16,000,000)				
less than IDR 4,000,000	– 0.981 ***	(0.157)	– 0.981 ***	(0.153)
IDR 4,000,000 – 8,000,000	– 0.707 ***	(0.125)	– 0.707 ***	(0.107)
IDR 8,000,001 – 12,000,000	– 0.703 ***	(0.135)	– 0.703 ***	(0.135)
IDR 12,000,001 – 16,000,000	– 0.553 ***	(0.124)	– 0.553 ***	(0.127)

Risk preference				
(base group: take substantial financial risk)				
Takes > average financial risks	0.086	(0.074)	0.086	(0.084)
Takes average financial risks	0.070	(0.062)	0.070	(0.151)
Not willing to take any financial risks	0.024	(0.083)	0.024	(0.107)
Patience				
(base group: will tie up money long-run to earn substantial returns)	– 0.020	(0.042)	– 0.020	(0.023)
Will tie up money medium-run to earn > average returns	– 0.128 ***	(0.049)	– 0.128 **	(0.054)
Will tie up money short-run to earn average returns	– 0.077	(0.071)	– 0.077	(0.073)
Will not tie up money at all				
Full set of controls?	Yes		Yes	
Pseudo R^2	0.596		0.596	
Number of observations	192		192	

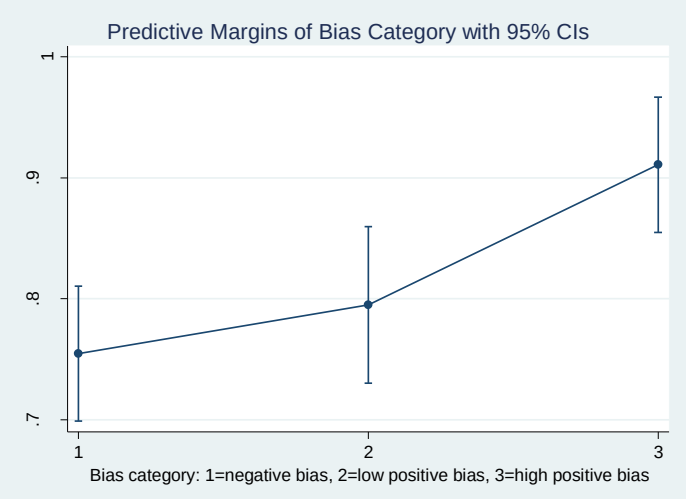
Column 2 uses cluster standard errors by sector and shows that the results still hold that employees who are in the high positive bias category are significantly more likely to hold short-term assets than those who are in the negative bias category. Figure 3.7 shows the probability of holding short-term assets by bias category. Employees who are in negative bias have a 75% probability of short-term asset participation, while those in the low and high positive bias have a 79% and 91% probability of participation, respectively. Overall, the results on short-term asset holding are consistent with exponential growth bias affecting decisions through future value bias.

Not all types of assets require the same degree of sophistication. Some assets are relatively simple in the way in which they operate while others are more complex. Dealing with risky and more intensive-information assets typically requires a higher degree of skills than other type of assets. Previous studies show that financial literacy is a key of risky high-yielding stock participation as learning and setup costs may be smaller for financially literate individuals (Campbell, 2006; Calvet et al., 2007; Stango & Zinman, 2009; Christelis et al., 2010). If compound interest bias captures low financial literacy defined more broadly, then it should be negatively

related to high-return sophisticated asset ownership. Moreover, if our bias measure is driven by exponential growth bias, individuals who underestimated the future value (in the positive bias category) would be less likely to hold long-term and high-yielding assets.

Figure 3.7. The Relationship between Bias and Short-term Asset Holding

This figure shows the probability of holding short-term assets by bias category. The first category includes employees with negative bias, i.e. those who overestimate the future value of savings. The second and third categories include employees with low and high positive bias, i.e. those who underestimate the future value of savings. Employees in high positive bias are 16% more likely to hold short-term assets than those who are in negative bias category. Employees who are in high positive bias and negative bias have a probability of 91% and 75% to hold short-term assets, respectively; while those in low positive bias have a probability of 79% to own short-term assets.



We proxy for long-term assets using stock and/or non-money market mutual fund ownership. Column 1 of Table 3.5 presents the marginal effects from a model where the dependent variable equals one if a respondent own stock and/or non-money market mutual funds. All of the coefficients of the positive bias categories are negative and the coefficient of the low positive bias category is significant. Employees in the low positive bias category are about 23% less likely to hold stocks than those in the negative bias category. The predicted probability

of stock holding is 51% for people who are in the low positive bias category and 74% for those who are in the negative bias category. This implies that individuals who underestimated the future value are less likely to hold stocks than their counterpart. Males have lower propensity to hold stock than females. We also find that impatient people are less likely to own long-term and high-return assets. Column 2 demonstrates that the results are robust when standard errors are clustered at sector level.

Table 3.5. Stocks and Compound Interest Bias.

This table reports marginal effects of Probit regression. Column 1 shows the effects of bias on the probability of holding stocks and/or non-money market mutual funds; Huber-White standard errors are shown in parentheses. Column 2 shows the effects of bias on the probability of holding stocks and/or non-money market mutual funds; cluster standard errors at sector level are shown in parentheses. All specifications include controls for the full set of covariates in addition to those reported in the table: years in current job, marital status, number of children, use of financial advice on financial decisions, use of pension simulator, use of mobile application to make financial transactions. *, **, *** indicate 10%, 5%, and 1% level of significance, respectively.

Dependent variable:	Stock Holding			
Estimator:	(Probit)			
Mean dependent variable:	0.660			
	Column (1)		Column (2)	
Compound interest bias				
(base group: negative bias)				
Low positive bias	– 0.230 ***	(0.072)	– 0.230 *	(0.122)
High positive bias	– 0.006	(0.073)	– 0.006	(0.083)
Age	– 0.004	(0.007)	– 0.004	(0.007)
Male	– 0.140 **	(0.060)	– 0.140 *	(0.081)
Education				
(base group: doctorate degree)				
high school graduate or less	– 0.093	(0.186)	– 0.093	(0.139)
College degree	0.146	(0.191)	0.146	(0.123)
Bachelor degree	– 0.083	(0.170)	– 0.083	(0.090)
Master degree	– 0.211	(0.162)	– 0.211 ***	(0.063)
Income				
(base group: more than IDR 16,000,000)				
less than IDR 4,000,000	– 0.075	(0.144)	– 0.075	(0.145)
IDR 4,000,000 – 8,000,000	– 0.137	(0.122)	– 0.137	(0.150)
IDR 8,000,001 – 12,000,000	0.009	(0.116)	0.009	(0.161)
IDR 12,000,001 – 16,000,000	– 0.135	(0.115)	– 0.135	(0.140)
Risk preference				
(base group: take substantial financial risk)				

Takes > average financial risks	0.054	(0.095)	0.054	(0.119)
Takes average financial risks	0.069	(0.093)	0.069	(0.176)
Not willing to take any financial risks	− 0.151	(0.107)	− 0.151	(0.141)
Patience (base group: will tie up money long-run to earn substantial returns)				
Will tie up money medium-run to earn > average returns	0.005	(0.070)	0.005	(0.071)
Will tie up money short-run to earn average returns	− 0.136	(0.096)	− 0.136	(0.118)
Will not tie up money at all	− 0.282 **	(0.119)	− 0.282 ***	(0.075)
Full set of controls?	Yes		Yes	
Pseudo R^2	0.270		0.270	
Number of observations	196		196	

Figure 3.8 shows the probability of holding long-term assets by bias category. Employees who are in the low positive bias category have a 51% probability of long-term asset ownership, while those in the negative and high positive bias categories have a 74% probability of holding long-term assets.

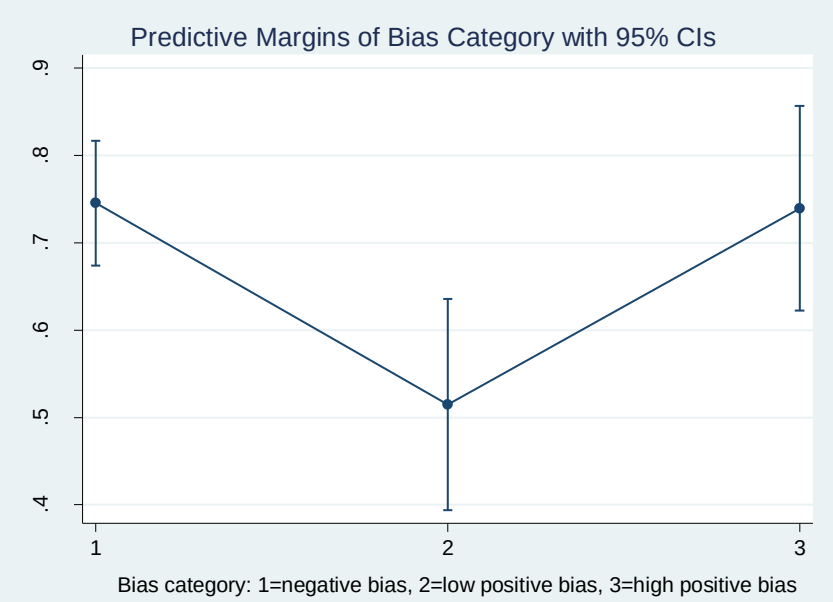
Our results in Table 3.4 and Table 3.5 suggest that individuals with future value bias substitute short-term for long-term assets. These findings are consistent with exponential growth bias affecting asset composition via future value bias. Nonetheless, Table 3.5 shows that the magnitude of the coefficient of the high positive bias category is small and insignificant. Therefore, we find only partial support for the hypothesis that our measure of bias captures broader financial sophistication that decreases the cost of financial products.

Our findings are corroborated with a previous study by Stango and Zinman (2009) which suggests that biased consumers substitute short-term and low-return assets for long-term and high-return assets. They also found little evidence that their bias measure is strongly correlated with broader financial sophistication. A more recent paper by Königsheim et al. (2018) show similar results that there is no significant relationship between exponential growth bias and

financial literacy as well as cognitive ability. Overall, their results and ours suggest that exponential growth bias has a specific and distinct effect from financial sophistication defined more broadly.

Figure 3.8. The Relationship between Bias and Long-term Asset Holding

This figure shows the probability of holding long-term assets by bias category. The first category includes employees with negative bias, i.e. those who overestimate the future value of savings. The second and third categories include employees with low and high positive bias, i.e. those who underestimate the future value of savings. Employees in low positive bias are 23% less likely to hold long-term assets than those who are in negative bias category. Employees who are in low positive bias and negative bias have a probability of 51% and 74% to hold long-term assets, respectively; while those in high positive bias have a probability of 74% to own long-term assets.



Another asset worth considering when assessing employees' retirement assets is property ownership as pensioners could use their homes to finance their retirement. Table 3.6 examines whether compound interest bias relates to property holding: property ownership equals one if employees have property. If property is a useful proxy for long-term retirement assets, then people with future value bias would be less likely to own property. The results show

that the high positive bias category has a significant positive coefficient. The probability of property ownership is 97% for individuals who are in the high positive bias category and 85% for those who are in the negative bias category. Thus, employees who are in the high positive bias category are approximately 12% more likely to own property than those in the negative bias category. This implies that workers who underestimated the future value are more likely to own property than those who overestimate future value. When clustered standard errors at industry level are applied in Column 2, the findings still holds that workers in the high positive bias category are more likely to hold property than those who are in the negative bias category. Additionally, we find that lower education and lower income are negatively correlated with property ownership.

Table 3.6. Property and Compound Interest Bias.

This table reports marginal effects of Probit regression. Column 1 shows the effects of bias on the probability of holding property; Huber-White standard errors are shown in parentheses. Column 2 shows the effects of bias on the probability of holding property; cluster standard errors at sector level are shown in parentheses. All specifications include controls for the full set of covariates in addition to those reported in the table: years in current job, marital status, number of children, use of financial advice on financial decisions, use of pension simulator, use of mobile application to make financial transactions. *, **, *** indicate 10%, 5%, and 1% level of significance, respectively.

Dependent variable:	Property Holding			
Estimator:	(Probit)			
Mean dependent variable:	0.849			
	Column (1)		Column (2)	
Compound interest bias				
(base group: negative bias)				
Low positive bias	– 0.050	(0.057)	– 0.050	(0.064)
High positive bias	0.119 ***	(0.039)	0.119 ***	(0.041)
Age	0.003	(0.005)	0.003	(0.004)
Male	– 0.046	(0.043)	– 0.046	(0.061)
Education				
(base group: doctorate degree)				
high school graduate or less	– 0.773 ***	(0.123)	– 0.773 ***	(0.090)
College degree	– 0.553 ***	(0.118)	– 0.553 ***	(0.153)
Bachelor degree	– 0.702 ***	(0.120)	– 0.702 ***	(0.121)
Master degree	– 0.613 ***	(0.123)	– 0.613 ***	(0.078)

Income				
(base group: more than IDR 16,000,000)				
less than IDR 4,000,000	– 0.739 ***	(0.137)	– 0.739 ***	(0.217)
IDR 4,000,000 – 8,000,000	– 0.837 ***	(0.136)	– 0.837 ***	(0.186)
IDR 8,000,001 – 12,000,000	– 0.862 ***	(0.123)	– 0.862 ***	(0.156)
IDR 12,000,001 – 16,000,000	– 0.734 ***	(0.148)	– 0.734 ***	(0.111)
Risk preference				
(base group: take substantial financial risk)				
Takes > average financial risks	0.162 ***	(0.062)	0.162 **	(0.082)
Takes average financial risks	0.051	(0.073)	0.051	(0.137)
Not willing to take any financial risks	0.045	(0.079)	0.045	(0.118)
Patience				
(base group: will tie up money long-run to earn substantial returns)				
Will tie up money medium-run to earn > average returns	0.019	(0.055)	0.019	(0.051)
Will tie up money short-run to earn average returns	0.119 ***	(0.046)	0.119 ***	(0.027)
Will not tie up money at all	0.038	(0.074)	0.038	(0.087)
Full set of controls?	Yes		Yes	
Pseudo R^2	0.289		0.289	
Number of observations	226		226	

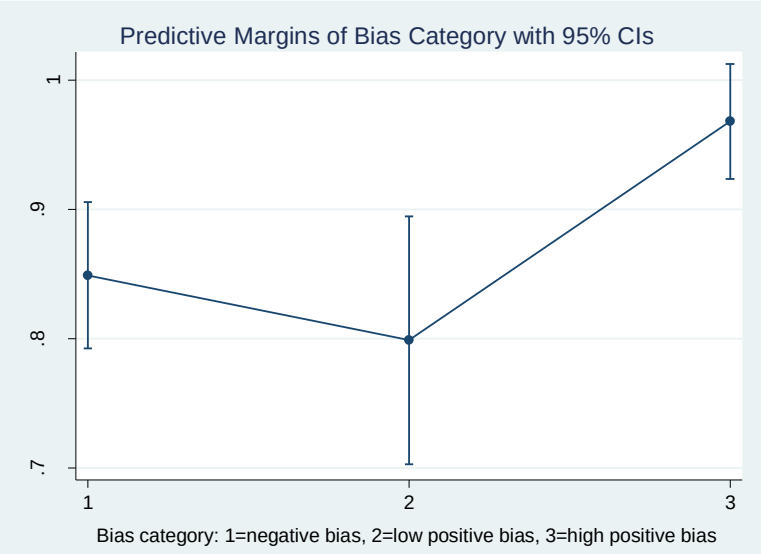
Figure 3.9 shows the probability of property holding by bias category. Employees who are in the low positive bias category have an 80% probability of owning property, while those in the negative and high positive bias categories have an 85% and 97% probability of holding property, respectively.

If property is a long-term asset for retirement, workers who underestimated the future value are less likely to own property. However, our results show the opposite effect: future value bias increases the likelihood of property ownership. A possible explanation is that employees acquire a house merely to meet their current basic necessities instead of as a long-term retirement assets. There is some evidence that the elderly, however, do not use their homes to finance retirement. Venti and Wise (1990, 1991) find that retirees have not downsized their homes at retirement, nor have they taken up reverse mortgages. Lusardi and Mitchell (2007)

discover that 60% of homeowners aged 50 and over affirmed that they did not plan to sell their homes to finance retirement and almost 70% of respondents felt there was a minimal chance that they would sell their homes to pay for retirement. Therefore, biased individuals may have housing equity although we do not know yet whether they will draw down home equity in retirement.

Figure 3.9. The Relationship between Bias and Property Holding

This figure shows the probability of holding property by bias category. The first category includes employees with negative bias, i.e. those who overestimate the future value of savings. The second and third categories include employees with low and high positive bias, i.e. those who underestimate the future value of savings. Employees in high positive bias are 12% more likely to hold property than those who are in negative bias category. Employees who are in high positive bias and negative bias have a probability of 97% and 85% to hold property, respectively; while those in low positive bias have a probability of 80% to own property.



Our risk and time preference measures give support to the assumption of property possession as a basic necessity. Risk aversion and impatience have a positive relationship with property ownership. This evidence is consistent with Laibson (1997) who proposes that present-

biased individuals, i.e. people who overweigh the importance of immediate consumption relative to future consumption, will invest in less liquid assets. A more recent study by Goda et al. (2019) find empirical support for impatient individuals investing a greater fraction of their assets in illiquid vehicles, specifically housing equity, as a vehicle of saving.

In the previous specification in Table 3.5, we see that impatience is negatively correlated with stocks, which is a proxy for long-term and high-return assets. The intuitive explanation is rooted in previous studies (Carroll et al., 2009; Goda et al., 2020) which posit the existence of present bias when people consider the cost and benefit to acquire an asset. When considering whether to acquire a long-term asset for retirement, such as stocks, they perceive that the cost of acquiring stocks is immediate, but the benefits of asset to finance retirement is delayed and therefore, the impatient people would be less likely to hold long-term assets such as stocks. On the contrary, when considering housing acquisition to meet their current basic needs, they perceive that they will benefit from the asset immediately, while the cost to acquire asset might be delayed through mortgage financing. Hence, even impatient individuals would not procrastinate to acquire property to meet their current need. Laibson (1997) and Goda et al. (2019) emphasise that the failure to invest in relatively liquid asset classes, such as stocks instead of housing, could lead to lower returns and lower total retirement savings.

3.7. Conclusions

Indonesians now make more savings and investment decisions for themselves due to decreasing support from nuclear family members, increasing life expectancy that leads to increasing health and retirement costs, and inadequacy pension benefit from government Social

Security. A key requirement for optimal retirement saving decisions is an understanding of the relationship between current savings and assets at retirement, which many individuals may lack. Policy makers and educators face challenges to provide effective financial education that can eliminate financial illiteracy. The effort to examine broader financial literacy often results in difficulties to provide specific financial education that is cost-effective.

Accordingly, we focus on a well-defined component of financial literacy: misunderstanding compound interest. Misunderstanding exponential growth can lead people to underestimate the magnitude of compound interest which can have significant consequences on the standard of living for the retirees due to poor financial decisions. Knowledge of compound interest is especially important due to long-horizon retirement savings. Moreover, our bias measure conveys information about the direction and magnitude of how an individual's responses depart from the correct response which the standard measure of general financial literacy does not.

We conducted a new survey of Indonesian employees from various sectors in 2019. The survey involves 386 employees with the share of employees in each industry imitates the share of Indonesian employees in selected industries. However, we acknowledge that due to a small sample which is not a national representative sample of whole population, our study is considered as a pilot study which provides a description of to what extend employees understanding of exponential growth, how it influences future value perception, and how it affects their financial decision-making in the real world.

We presented evidence that employees display future value bias. Around 41% of employees underestimated the future value; of those who underestimated the future value, 31%

linearized compound growth by adopting simple or add-on interest rates. On the other hand, only 2% of respondents correctly perceived the future value. More importantly, we find that bias matters empirically. Employees who overestimate the future value of savings are less likely to save; whereas workers who underestimate the future value of savings prefer short-term and low-yielding assets to long-term and high-yielding assets, and these individuals seems to acquire illiquid assets to meet their current basic necessity.

Our results suggest that exponential growth bias has its own specific effects which are distinct from financial sophistication defined more broadly. It is corroborated with previous studies emphasizing that exponential growth bias is conceptually distinct from broader financial literacy, i.e. the ability to perform basic calculations as well as familiarity with financial products and concepts (Stango & Zinman, 2009; Almenberg & Gerdes, 2012). This highlights further consideration for future research on the definition of financial sophistication, and how it affects financial decision-making.

Distinguishing exponential growth bias from broader financial sophistication should be of interest to policy makers and educators since the treatment prescriptions are different. Delivering specific financial education to debias individuals with exponential growth bias might be more cost-effective than extensive financial education for financially unsophisticated individuals. This is a similar suggestion provided in previous studies, such as those by Foltice and Langer (2017, 2018). Furthermore, specific education about exponential compounding eliminates a major “training the trainer” challenge of implementing general financial literacy and personal finance training programmes on a large scale, as most teachers do not feel adequately prepared to teach such courses (Way & Holden, 2009).

Another promising future research is how to debias individuals. There are some evidences that simple interventions can debias individuals. Mailing printed retirement income projections along with enrollment information affects University employees' contributions to retirement accounts (Goda et al., 2014). Teaching a formula to calculate compound growth to subjects might help to develop a grasp of exponential effects (Foltice & Langer, 2017, 2018). Providing graphical or projected account balances of retirement savings motivates both college students and employees to save more for retirement (McKenzie & Liersch, 2011; Krijnen et al., 2020). A more labour-intensive treatment is face-to-face financial education that informs subjects about compound interest, and the treatment results in increasing pension contributions in rural areas (Song, 2020).

Our study finds that most Indonesian in our sample display bias about future outcomes. Nonetheless, other cultural traits and values in Indonesia are also worth being explored as evident from literature that culture is an important determinant of future-oriented behaviours. For example, Chen's (2013) cross-country study shows how linguistic differences correlate with future-oriented behaviours such as saving, retirement savings, exercising, abstaining from smoking, and long-term health. He distinguishes languages into two broad categories: weak and strong future-time reference. This criterion separates those languages which require future events to be grammatically marked when making predictions (i.e. strong future-time language, like English), from those which do not (i.e. weak future-time languages, like Indonesian).

He finds that speakers of weak future-time reference languages (with little to no grammatical distinction between the present and future) appear more future-oriented in numerous monetary and non-monetary behaviours. Weak future-time reference speakers are

more likely to have saved in any given year, have accumulated more wealth by retirement, are less likely to smoke, are more likely to be physically active, and are less likely to be medically obese. He claims that since strong future-time reference speakers are required to speak in a distinct way about future events, then this leads speakers to take fewer future-oriented actions. In other words, grammatically separating the future and the present leads speakers to disassociate the future from the past. This would make the future feel more distant, and since saving involves current costs for future rewards, would make saving harder. On the other hand, some languages, i.e. with weak future-time reference, grammatically equate the present and future. Those speakers would be more willing to save for a future which appears closer.

Furthermore, he also finds that “trust” has a large and marginally significant effect on the propensity of an individual to save. Individuals who think others are generally trustworthy are more likely to have saved. Moreover, people who put high value on family by reporting that family is important for them, save significantly more than those who do not. The finding also show that individuals, who report “thrift and saving money” is an important value to teach children, are more likely to save.

We also hope that future work collects more representative observations along with interviewer-administered survey to make the data more complete as non-response items can be mitigated with effective interviewer probing. In addition to making the data more complete, probing enhances the validity of conclusions as they are based on a more representative sample of individuals. Interviewer-administered surveys also allow interviewers to capture any item that requires consistent probing to see if modifications are needed to simplify or shorten the question, which would ease interviewer and respondent burdens during the survey. We have relatively few

missing observations for the demographics information. It seems that respondents do not have difficulty or objection to providing information about the highest level of education attended, marital status, number of children, job tenure, or other demographic characteristics. However, we have more missing values on questions about hypothetical retirement savings and financial outcomes. This indicates that some survey questions, for instance knowledge-based questions, requires further probing to alleviate non-response questions.

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Appendix 3A. Correlation Table

Table 3A-1. Correlation between Variables in the Analysis

This table reports correlation coefficients between variables in the analysis. Significance level of each correlation coefficient is in parentheses.

	Stock holding	Short-term asset holding	Property holding	Saving rate	Bias ≤ 0
Stock holding					
Short-term asset holding	0.655				
	(0.000)				
Property holding	0.436	0.651			
	(0.000)	(0.000)			
Saving rate	0.049	0.120	0.053		
	(0.457)	(0.049)	(0.396)		
Bias ≤ 0	0.132	0.168	-0.004	-0.196	
	(0.052)	(0.007)	(0.955)	(0.000)	
Low bias (Bias > 0)	-0.182	-0.256	-0.126	0.155	-0.585
	(0.007)	(0.000)	(0.047)	(0.005)	(0.000)
High bias (Bias > 0)	0.025	0.053	0.134	0.086	-0.634
	(0.715)	(0.400)	(0.036)	(0.121)	(0.000)
Age	0.074	0.135	0.160	0.037)	0.030
	(0.256)	(0.026)	(0.009)	(0.479)	(0.584)
Male	-0.182	-0.156	-0.088	-0.025	-0.019
	(0.005)	(0.010)	(0.153)	(0.638)	(0.727)
Education	0.016	0.145	0.146	0.327	-0.014
	(0.806)	(0.016)	(0.017)	(0.000)	(0.791)
Income	0.106	0.126	0.165	0.309	-0.075
	(0.109)	(0.038)	(0.008)	(0.000)	(0.169)
Risk preference	-0.093	0.050	0.074	-0.157	0.288
	(0.160)	(0.414)	(0.233)	(0.003)	(0.000)
Time preference	-0.225	-0.062	0.069	-0.158	0.179
	(0.000)	(0.309)	(0.271)	(0.003)	(0.001)
Use of financial advice	0.020	0.058	0.037	-0.122	0.133
	(0.760)	(0.342)	(0.557)	(0.020)	(0.015)
Use of pension simulator	0.104	0.203	0.135	0.075	0.160
	(0.117)	(0.001)	(0.030)	(0.160)	(0.004)
Financial sophistication	-0.886	-0.117	-0.097	0.078	0.088
	(0.182)	(0.055)	(0.117)	(0.140)	(0.108)
Job tenure	0.056	0.098	0.144	0.053	-0.036
	(0.402)	(0.111)	(0.021)	(0.313)	(0.508)
Married	-0.007	0.070	0.019	-0.028	-0.032
	(0.922)	(0.253)	(0.756)	(0.601)	(0.566)
Number of children	-0.031	0.015	0.033	-0.253	0.020
	(0.646)	(0.808)	(0.600)	(0.00)	(0.719)
Industry	0.051	-0.119	-0.028	-0.067	0.070
	(0.434)	(0.049)	(0.655)	(0.203)	(0.198)

Table 3A-1. Correlation between Variables in the Analysis - continued

	Low Bias (Bias > 0)	High Bias (Bias > 0)	Age	Male	Education
Stock holding					
Short-term asset holding					
Property holding					
Saving rate					
Bias ≤ 0					
Low bias (Bias > 0)					
High bias (Bias > 0)	-0.256				
	(0.000)				
Age	-0.108	0.067			
	(0.047)	(0.217)			
Male	-0.024	0.045	0.155		
	(0.662)	(0.404)	(0.002)		
Education	0.060	-0.040	0.249	-0.033	
	(0.271)	(0.464)	(0.000)	(0.522)	
Income	0.139	-0.042	0.502	0.004	0.549
	(0.011)	(0.434)	(0.000)	(0.932)	(0.000)
Risk preference	-0.191	-0.161	0.089	-0.119	-0.064
	(0.000)	(0.003)	(0.085)	(0.020)	0.213
Time preference	-0.125	-0.094	-0.065	-0.042	-0.161
	(0.022)	(0.085)	(0.205)	(0.410)	(0.002)
Use of financial advice	-0.179	0.013	0.082	-0.001	-0.061
	(0.001)	(0.812)	(0.110)	(0.978)	(0.234)
Use of pension simulator	-0.149	-0.048	0.177	-0.070	0.128
	(0.007)	(0.385)	(0.000)	(0.176)	(0.013)
Financial sophistication	0.101	-0.202	-0.167	-0.099	0.120
	(0.065)	(0.000)	(0.001)	(0.052)	(0.020)
Job tenure	-0.012	0.057	0.776	0.081	0.154
	(0.824)	(0.312)	(0.000)	(0.115)	(0.003)
Married	-0.001	0.046	0.452	0.094	0.099
	(0.884)	(0.408)	(0.000)	(0.069)	(0.054)
Number of children	-0.033	0.008	0.539	0.160	0.050
	(0.552)	(0.891)	(0.000)	(0.002)	(0.328)
Industry	0.062	-0.143	-0.180	-0.041	-0.208
	(0.253)	(0.009)	(0.000)	(0.421)	(0.000)

Table 3A-1. Correlation between Variables in the Analysis - continued

	Income	Risk preference	Time preference	Use of financial advice	Use of pension simulator
Stock holding					
Short-term asset holding					
Property holding					
Saving rate					
Bias ≤ 0					
Low bias (Bias > 0)					
High bias (Bias > 0)					
Age					
Male					
Education					
Income					
Risk preference	-0.021				
	(0.690)				
Time preference	-0.164	0.473			
	(0.001)	(0.000)			
Use of financial advice	-0.001	0.565	0.63		
	(0.859)	(0.000)	(0.000)		
Use of pension simulator	0.082	0.322	0.290	0.343	
	(0.116)	(0.000)	(0.000)	(0.000)	
Financial sophistication	0.061	0.012	-0.022	0.054	-0.075
	(0.238)	(0.812)	(0.666)	(0.293)	(0.148)
Job tenure	0.438	0.077	-0.123	0.003	0.104
	(0.000)	(0.140)	(0.018)	(0.959)	(0.047)
Married	0.169	0.014	0.011	0.027	0.156
	(0.001)	(0.784)	(0.831)	(0.605)	(0.003)
Number of children	0.095	0.066	-0.011	0.017	0.074
	(0.064)	(0.203)	(0.826)	(0.740)	(0.156)
Industry	-0.162	-0.140	-0.123	-0.129	-0.135
	(0.001)	(0.006)	(0.016)	(0.012)	(0.009)

Table 3A-1. Correlation between Variables in the Analysis - continued

	Financial sophistication	Job tenure	Married	Number of children	Industry
Stock holding					
Short-term asset holding					
Property holding					
Saving rate					
Bias ≤ 0					
Low bias (Bias > 0)					
High bias (Bias > 0)					
Age					
Male					
Education					
Income					
Risk preference					
Time preference					
Use of financial advice					
Use of pension simulator					
Financial sophistication					
Job tenure	-0.121				
	(0.020)				
Married	-0.121	0.328			
	(0.020)	(0.000)			
Number of children	-0.137	0.387	0.669		
	(0.008)	(0.000)	(0.000)		
Industry	-0.014	-0.173	-0.072	-0.063	
	(0.784)	(0.001)	(0.163)	(0.220)	

Appendix 3B. Exact Wording of Survey Questions.

Hypothetical Retirement Savings

1) Suppose you are saving IDR 100,000 at the beginning of the year into your retirement savings account. How much do you think your savings will be after three years, in total – including the principal and its interest? IDR …….
2) What percent rate of interest do you think those accumulated three years savings imply? ……. % p.a.

Financial Outcomes

1) How much is the value of stocks and/or non-money market mutual funds that you own as a share of total assets in your portfolio? ……. % from total assets.
2) How much is the value of short-term savings (e.g. Certificate of Deposits) that you hold as a share of total assets? ……. % from total assets.
3) How much is the value of your property as a share of total assets? ……. % from total assets.
4) How was your spending versus income by the end of 2018?
   ☐ Spending > income
   ☐ Spending = income
   ☐ Spending < income
5) How much are the average monthly savings as a share of income (including total salary and the value of all benefits)? ……. % from income.

Demographics

Job tenure with current employer : …… year(s)
Current age : ……. years
Gender : ☐ Male ☐ Female
Marital status : ☐ Single ☐ Married ☐ Other
Number of children:
☐ None
☐ One
☐ Two
☐ More than two

What industry is your company in?
☐ Education
☐ Bank
☐ Hospital
☐ Manufacturing
☐ Wholesale/ retail
☐ Insurance
☐ Service

Highest education completed:
☐ High school graduate
☐ College degree
☐ Bachelor degree
☐ Master degree
☐ Doctorate degree

Your salary last month (including the value of all benefits):
☐ Less than IDR 4,000,000
☐ IDR 4,000,000 – 8,000,000
☐ IDR 8,000,001 – 12,000,000
☐ IDR 12,000,001 – 16,000,000
☐ More than IDR 16,000,000

Which of the following statements comes closest to the amount of financial risk you are willing to take when you save or make investments?
☐ Willing to take substantial risks, expecting to earn substantial returns
☐ Willing to take higher than average risks, expecting to earn higher than average returns
☐ Willing to take average risks, expecting to earn average returns
☐ Not willing to take any financial risks

Which of the following statements comes closest to how you feel about tying up your money in investments for long period of time?
☐ I will tie up money in the long-run to earn substantial returns
☐ I will tie up money in the medium-run to earn higher than average returns
☐ I will tie up money in the short-run to earn average returns
☐ I will not tie up money at all.

Do you use a mobile application to make financial transactions?
☐ Yes ☐ No

What is your source of advice when you have to make important financial decisions? (Please check all that apply)
☐ Uses professional financial advice
☐ Uses advice from friends/family
☐ Uses advice from other sources
☐ Uses none financial advice

Which statement(s) best describe you? (Please check all that apply)
☐ Used the retirement simulation calculator on ESSAB online account
☐ Used the retirement simulation calculator on ESSAB mobile application
☐ Used the retirement simulation calculator free online available
☐ I do not use any retirement simulation calculator

Chapter 4
Cognitive Ability and Financial Asset Participation

Abstract

Cognitive ability is key information-processing that is relevant to financial decision-making. This study examines not only the relationship between cognitive ability and financial asset participation, but also further investigates two channels through which cognitive ability might facilitate financial asset participation. Using the Indonesian Family Life Survey (IFLS), which is representative of about 83% of the Indonesian population, this paper provides novel evidence that individuals with higher cognitive ability are more likely to hold financial assets than those with lower cognitive ability. The results are robust after including demographics, using alternative specifications and different time lags. The findings show some evidence that the relation between cognitive ability and financial asset holding is mediated by risk tolerance and patience traits. These results have important policy implications for drawing individuals into the formal financial market and improving individual welfare in Indonesia.

4.1 Introduction

One of the most important decisions many people face is the choice of a portfolio of assets for their future wealth accumulation. Data on the asset portfolios of Indonesian households reveals two facts. Firstly, a large fraction of households do not hold financial assets. The Indonesia Family Life Survey (IFLS) survey data from 1997 to 2014 (Frankenberg & Thomas, 2000; Strauss et al., 2004, 2009, 2016) confirmed that only 1.29% of households hold financial assets, i.e. savings, certificate of deposits and/or stocks. Second, it found that the majority of the population own non-financial assets: 24.59% of households own household furniture and utensils, 24.07% hold household appliances, 20.47% have vehicles, 16.40% own poultry, livestock

and fishponds, while a small fraction of households possess other assets, such as house and land occupied by the household, non-agricultural land, receivables and jewellery.

The large size of the informal sector is an important feature of emerging markets, such as Indonesia, and arguably, drawing these individuals into the formal financial market would be one of the fastest ways to foster financial development in emerging markets (Cole et al., 2011). From the individual perspective, participating in financial markets could offer many benefits. A bank savings account can be an efficient savings technology: secure from theft, and often paying interest, as well as acting as a means of sending and receiving payments. A savings account also allows customers to build a relationship with the bank, potentially facilitating access to credit and other financial services. This may in turn improve individuals' welfare (Cole et al., 2011). Stocks offer an opportunity to obtain equity premium; thus, people who hold stocks accumulate more wealth than those who do not own stocks (van Rooij et al. 2012). Welfare loss from no stockholding amounts to four percent of wealth (Cocco et al., 2005). Therefore, understanding the determinants that prevent large sectors of the Indonesian population from holding financial assets is a challenge for research in personal finance.

By conducting the study in Indonesia, we consider a setting in which cognitive ability may be one of the most important barriers to accessing financial markets. This may be explained in part by the low level of cognitive skills. Adults in Indonesia show low levels of proficiency in literacy and numeracy compared to adults in the 33 other countries and economies that participated in the OECD Programme for the International Assessment of Adults Competencies (PIAAC) in 2014-2015 (OECD, 2016). PIAAC provides a picture of adults' proficiency in two key information-processing skills, namely literacy and numeracy. Literacy assessment measures the

ability to understand and respond appropriately to written texts, while numeracy assessment measures the ability to use numerical and mathematical concepts. Proficiency is described on a scale of 500 points. Table 4.1 shows the comparison of mean literacy proficiency scores of the selected countries with the highest and the lowest average level of proficiency in literacy across 33 participating countries.

The average literacy score across the OECD countries that participated in the literacy assessment is 268 points. Japan had the highest average level of proficiency in literacy (296 points), followed by Finland (288 points) and the Netherlands (284 points). Turkey (227 points) and Chile (220 points) recorded the lowest average scores among countries. However, Indonesia had an even lower average score (200 points).

Table 4.1. Comparison of Average Literacy Proficiency.
This table shows mean literacy proficiency scores of 16-65 year-olds. Proficiency has a scale of 500 points maximum. The selected countries listed in this table are those which have the highest and the lowest average level of proficiency in literacy.

Country	Mean
Japan	296
Finland	288
Netherlands	284
OECD average	**268**
Turkey	227
Chile	220
Indonesia	200

Mean numeracy scores among adults in the selected countries participating in PIAAC are presented in Table 4.2. The average numeracy score across the OECD countries that participated in the numeracy assessment is 263 points. Japan had the highest average level of proficiency in numeracy (288 points), followed by Finland (282 points) and Belgium (280 points). Turkey (219

points), Indonesia (210 points), and Chile (206 points) recorded the lowest average scores. Overall, Indonesian show low levels of proficiency in literacy and numeracy compared to other participating countries in the Survey of Adults Skills. This is not surprising, given that most participating countries are more economically developed than Indonesia.

Table 4.2. Comparison of Average Numeracy Proficiency.
This table shows mean numeracy proficiency scores of 16-65 year-olds. Proficiency has a scale of 500 points maximum. The selected countries listed in this table are those which have the highest and the lowest average level of proficiency in numeracy.

Country	Mean
Japan	288
Finland	282
Belgium	280
OECD average	**263**
Turkey	219
Indonesia	210
Chile	206

Cognitive skills are key information-processing competencies that are relevant to people in many contexts, including a financial context. Financial decision-making may involve the ability to process information and make complex optimal decisions, as well as the ability to retrieve and use appropriate numerical principles and draw more precise decisions from numbers and numerical comparisons (Peters et al. 2006). Dealing with more intensive-information assets, such as financial assets, typically requires a higher degree of skills than other types of asset. Therefore, this study aims to examine cognitive ability, which may explain limited financial asset participation.

The data source for this analysis is the Indonesia Family Life Survey (IFLS) panel: a large-scale longitudinal survey which is a national representative survey of Indonesian. Using panel

data IFLS from 1997 to 2014, we find that individuals with higher cognitive ability are more likely to hold financial assets than those with lower cognitive ability. Our results are robust to alternative specifications, i.e. when we incorporate financial wealth as an alternative definition of financial asset participation, and when we use observed cognitive ability tests as alternative measures of cognitive ability. Furthermore, we examine the relationship between cognitive ability and financial participation which is potentially mediated by risk tolerance and patience channels. The findings show some evidence that the relation between cognitive ability and financial asset holding is mediated by risk tolerance and patience traits.

The importance of cognitive ability as a determinant of financial decision-making is confirmed empirically by previous studies (e.g. Benjamin et al., 2006; Banks & Oldfield, 2007; Christelis et al., 2010; Dohmen et al., 2011). There several channels through which cognitive ability might affect the decision to buy stocks and other financial assets. First, the cost of gathering and processing information is lower for skilled individuals, therefore, low ability can act as a barrier preventing stockholding. Second, the perception of risk is also likely to depend on cognitive abilities. Low cognitive abilities can make some investors overestimate the precision of the information that they possess. Overconfident investors trade more and take more financial risk than rational agents with unbiased perceptions, which implies a negative relation between cognitive skills and stockholding (Christelis et al. 2010).

In economic models and application, cognitive ability is typically assumed to be independent of both risk aversion and impatience and this assumption has received relatively little attention in the empirical literature. However, several studies in psychology show that higher cognitive ability is associated with greater patience (Kirby et al., 2005; Parker & Fischoff,

2005; Shamosh & Gray, 2008). A more recent paper in behavioural economics also provide evidence in this issue. Benjamin et al. (2013) show that higher standardized test scores (SAT) for Chilean high school students are associated with risk neutrality, as well as greater patience. Our findings complement the previous literature by providing psychological evidence that preference features, i.e. risk and time preferences, are important channels that partially mediate the effect of cognitive ability on financial decision-making.

The rest of the paper is organised as follows. Section 4.2 provides a framework to understand how cognitive ability might affect financial asset participation. Section 4.3 provides our hypothesis. Section 4.4 describes the data, the construction of latent variables that will be used in the empirical analysis, the meanings of direct and indirect effects, as well as the measurement model. Section 4.5 presents the empirical results for the probability of holding financial assets and performs robustness analysis. The results are summarised in Section 4.6.

4.2 Literature Review

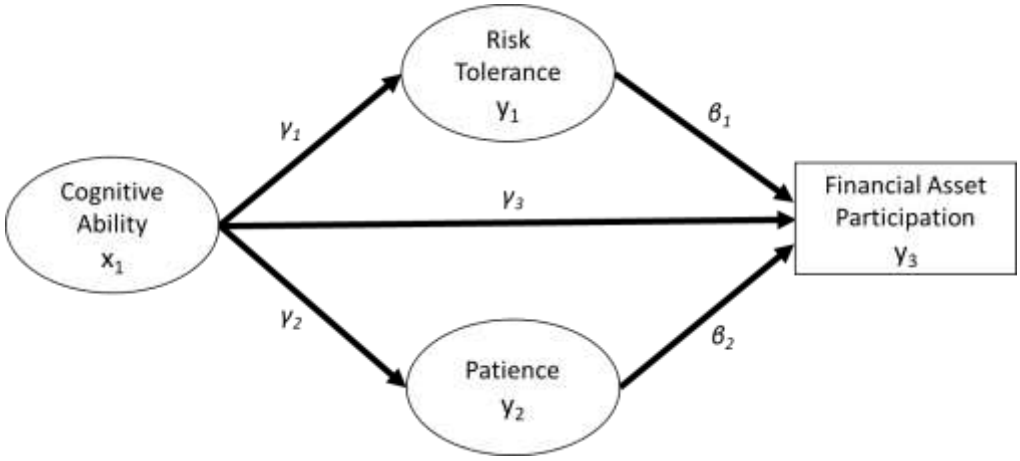
A large number of studies show that cognitive ability is correlated with various financial decisions. Cognitive ability affects stock market participation (Banks & Oldfield, 2007; Grinblatt et al., 2011; Benjamin et al., 2013), mutual funds ownership (Christelis et al., 2010; Grinblatt et al., 2011), and retirement account holding (Banks & Oldfield, 2007; Christelis et al., 2010). Nonetheless, the mechanisms by which cognitive ability influences financial choices is not quite fully understood yet. For example, why intelligent people are more willing to invest in riskier assets, such as financial assets, and therefore earn risk premium.

Christelis et al. (2010) suggest information barriers is a channel that may explain the strong correlation between cognitive abilities and the propensity to invest in both direct stock market participation and indirect participation through mutual funds and retirement accounts. Investing in more information-intensive assets, such as financial assets, requires gathering and processing information costs, in terms of time and effort to familiarise oneself with asset returns, volatility and transaction costs. Cognitive impairment which is manifested in a reduced ability to perform numerical calculations, to read and to recall, might further increase these costs. Campbell (2006) argues that another entry barrier to the stock market can also come from the psychological fixed cost of participation. Some people may fail to invest in stocks in part because they are aware that they lack the skills to invest efficiently, and therefore feel uncomfortable participating in an activity for which they are poorly prepared. Korniotis and Kumar (2011) point out that the perception of having limited abilities might also increase the cost of stock market participation. Therefore, the learning costs and the psychological fixed cost participation are higher for individuals with lower cognitive ability which can act as a barrier, thus preventing financial asset participation.

In theoretical and empirical research in economics, the relationship between cognitive ability and psychological traits, such as risk and time preferences, has received relatively little attention. Moreover, cognitive ability is typically assumed to be independent of both risk tolerance and patience traits (Dohmen et al., 2010). Although the evidence is mixed, psychology literature show the evidence of the relationship between intelligence and the ability to delay gratification (e.g. Funder & Block, 1989; Shoda et al., 1990; Kirby et al. 2005; Parker & Fischoff, 2005). These relationship have important implications for theoretical and empirical research. For

example, given a relationship between cognitive ability and these traits, it is important to take into account that cognitive ability conveys information about the crucial traits of risk tolerance and patience for understanding the mechanism of how cognitive ability affects financial decision-making. Therefore, in this paper, we explore two potential channels, namely risk tolerance and patience, through which cognitive ability might influence the decision to hold financial assets. Figure 4.1 shows a path diagram for the causal relationships between cognitive ability (x_1), risk tolerance (y_1) and patience (y_2) as mediators, and financial asset participation (y_3) as an outcome.

Figure 4.1. Pathway of a Mediation Process for Cognitive Ability on Financial Asset Participation.
This figure shows a path diagram for the direct effect of cognitive ability on financial asset participation without mediator, and the indirect effect of cognitive ability on financial asset participation mediated by risk tolerance and patience traits.



Firstly, we propose that an individual's willingness to bear risk as a channel which can explain the relationship between cognitive ability and financial asset participation. Even though this personality trait is not unambiguously good or bad, previous papers in behavioural economics provide evidence that aversion to loss is less pronounced among more educated

individuals (Guiso & Paiella, 2005; Johnson et al., 2006), and that precision in probabilistic thinking is associated with portfolio choice (Lillard & Willis, 2001). Benartzi and Thaler (1995) and Barberis et al. (2006) cite myopic loss aversion and narrow framing as potential explanations for limited participation in financial markets.

Secondly, we suggest patience as a channel which might clarify the association between cognitive ability and financial asset holding. Several psychology studies have shown that higher cognitive ability relates to greater patience (Kirby et al., 2005; Parker & Fischoff, 2005; Shamosh & Gray, 2008). Benjamin et al. (2013) demonstrate that higher standardized test scores (SAT) for Chilean high school students are associated with risk neutrality, as well as greater patience in small-stakes monetary choice. Furthermore, they show that those with higher scores are more likely to participate in the financial market.

Theories from behavioural economics provide reasons to expect that cognitive ability could be related to risk tolerance and patience. Theories of choice bracketing (Read et al., 1999) incorporate the tendency of some people who have difficulty bracketing choices broadly, i.e. they fail to take into account all the consequences of their actions which generally leads to choices that yield higher utility. Narrow bracketing can make people behave in a more risk averse manner due to failing to integrate individual risky decisions with future wealth, or myopically have difficulty incorporating current decisions and future goals.

In application of this idea, Benartzi and Thaler (1995) attributed the equity premium puzzle – i.e. the low rate of return for bonds relative to stock – to *myopic loss aversion*, which is their term for a combination of narrow bracketing and loss aversion shown by investors who invest in fixed income securities in preference to equities despite the much higher historical rate

of return to equities. They argue that investors dislike stocks because they look at their portfolios frequently – perhaps once a month – even though the average investor is saving for a distant retirement. Over brief periods, stock prices are almost as likely to fall as to rise. For loss averse investors, the falls will be extremely painful and the rises only mildly enjoyable, so the overall experience might not be worth undertaking. If people could resist looking at their portfolios for longer periods, i.e. they bracket their investment choices more broadly, the likelihood that they would see such losses would diminish, and the clear benefits of stocks would emerge.

Cognitive limitations – in perception (Miller, 1956), analytical processing (Simon, 1957), attention (Kahneman, 1973), memory (Baddeley, 1986) – are one important determinant of bracketing. Such limitations sharply constrain individuals' ability to simultaneously consider multiple decisions. As the number of choices increases, the cognitive cost of broad bracketing will multiply. This is proven by empirical evidences which find narrow bracketing is reduced when cognitive costs are lowered. Rabin and Weizsäcker (2009) show that narrow bracketing in risky choice is reduced when the maths is worked out for subjects. Abeler and Marklein (2007) found that narrow bracketing in consumption decisions is reduced for people with higher maths grades. Therefore, the tendency for lower cognitive ability to cause narrow bracketing, subsequently leading to risk aversion, could be one mechanism explaining how lower cognitive ability decreases financial asset participation.

Another theoretical framework which emphasises the interaction between cognitive ability and emotion in decision making is a two-system approach (Bernheim & Rangel, 2004; Fudenberg & Levine, 2006). The emotional system is assumed to have preferences that are risk averse and myopic, whereas the cognitive system is assumed to be more risk neutral and to take

a longer-term view in intertemporal problems. Lab experiments have demonstrated in various ways that a reduced influence of emotions or stronger influence of cognitive ability, tends to mitigate risk aversion and impatience. Benjamin et al. (2013) found that inducing a cognitive load to decrease working memory results in increased impatience and more risk-averse decisions. McClure et al. (2004) showed that emotional systems in the brain value immediate rewards, and that stronger activation in cognitive systems relative to emotional systems predicts increased patience. Therefore, a two-system decision process is another potential mechanism explaining how higher cognitive ability leads to higher risk tolerance and patience and, in turn, has a positive impact on financial asset participation.

Understanding individual decision-making under risk and over time are two foundations of economic analysis because risk and time are intertwined. In general, the literature on intertemporal choice distinguishes between two different components underlying time discounting. The first is related to the fact that delaying rewards implies delay of gratification. A reward of $100 in one year is worth less than a reward of $100 today because in the former case, one has to wait a year before actually using the money. The second component concerns the risk associated with delaying the reward. A reward of $100 in a year carries the risk that, due to unforeseen contingencies, in a year, the reward will not be received after all. This risk does not exist when the rewards is paid today. This is confirmed by an experimental study by Anderhub et al. (2001) which attempted directly to investigate the correlation between risk attitudes and time preferences. They found that risk-averse agents tend to discount the future more heavily than agents that are less risk averse or risk seeking. This suggests that the observation is problematic

of one intends to study time preference in isolation from risk. Therefore, we incorporated both risk and time preferences in our model.

4.3 Hypothesis

Participating in more information-intensive assets requires learning costs, requiring time and money, which must be spent to familiarise oneself with asset returns, volatility, and transaction costs. Low cognitive ability, which is manifested in a reduced ability to perform numerical calculations, to read and to recall, might increase these costs and can act as a barrier preventing financial asset holding (Christelis et al., 2010). Others may avoid the stock market because they simply feel uncomfortable participating in an activity for which they are incompetent, thus increasing the psychological fixed cost of participation (Campbell, 2006; Korniotis & Kumar, 2011). These lead to our first hypothesis:

Hypothesis 1. Cognitive ability affects financial asset participation.

Other theories from behavioural economics suggest that cognitive ability could be related to risk aversion. Cognitive limitations – in perception (Miller, 1956), analytical processing (Simon, 1957), attention (Kahneman, 1973), memory (Baddeley, 1986) – are one important determinant of narrow choice bracketing, i.e. failing to consider all the consequences of their actions (Read et al., 1999). Narrow bracketing can make individuals behave in a more risk averse manner due to fail integrating individual risky decisions with future wealth, and this myopic loss aversion explains limited participation in financial markets (Benartzi & Thaler, 1995; Barberis et al., 2006).

Hypothesis 1a. The effect of cognitive ability on financial asset participation is mediated by risk tolerance.

A two-system theory postulates that the emotional system is assumed to have preferences that are risk averse and myopic, whereas the cognitive system is assumed to be more risk neutral and to take a longer-term view in intertemporal problems (Bernheim & Rangel, 2004; Fudenberg & Levine, 2006). Stronger activation in cognitive systems relative to emotional systems results in increased patience (McClure et al., 2004; Kirby et al., 2005; Parker & Fischoff, 2005; Shamosh & Gray, 2008) and increased likelihood to participate in the financial market (Benjamin et al., 2013).

Hypothesis 1b. The effect of cognitive ability on financial asset participation is mediated by patience.

4.4 Data and Methodology

4.4.1 Indonesia Family Life Survey (IFLS) Overview

By the middle of the 1990s, Indonesia had enjoyed over three decades of remarkable social, economic, and demographic change. Per capita income had risen since the early 1960s, from around US$ 50 to more than US$ 1,000 in 1997. Massive improvements occurred in many dimensions of living standards of the Indonesian population. The poverty headcount measure as measured by the World Bank declined from over 40% in 1976 to just 18% in 1996. Primary school enrolments rose from 75% in 1970 to universal enrolment in 1995, and secondary schooling rates from 13% to 55% over the same period. Nonetheless, the economic outlook began to change as

Indonesia was gripped by the economic crisis that affected much of Asia in 1997-1998. At the beginning of 1998 the rupiah collapsed and gross domestic product (GDP) contracted by an estimated –13%. Afterwards, GDP was flat in 1999. Between 2003 and 2014, GDP growth fluctuated between 5% and 6% per year and recovery ensued (Strauss et al., 2016).

Many reforms have taken place in Indonesia following the Asian financial crisis of 1997-1998. Wide reforms have been carried out in all areas of governance, including in the financial sector, and a new development strategy has been adopted for inclusive economic development in order to increase economic growth and the welfare of the population. One way to achieve financial inclusion is through financial education which is an ongoing process to change the behaviour and culture of society and to increase familiarisation with the financial world. Another effort to promote financial inclusion is by initiating and implementing a number of regulations and policies in order to protect consumers and generate consumer trust and confidence, leading to more active and appropriate use of financial products and services by consumers. The financial education, regulations and policies, which have been initiated and implemented by Indonesian government after Asian financial crisis 1997-1998 to this date, are described in greater detail in Table 1.1.

Across Indonesia, there was considerable variation in the impacts of the crisis, as there had been of the earlier economic success. The different waves of the Indonesia Family Life Survey (IFLS) can be used to understand the impact of social, economic, and environmental change on the population. IFLS is an ongoing longitudinal survey which has been conducted by RAND Corporation, a non-profit institution that helps improve policy and decision-making through research and analysis. The first wave, IFLS1, was conducted in 1993-1994. The survey sample

represented about 83% of the population living in 13 of the country's 26 provinces. IFLS2 followed up with the same sample four years later, in 1997-1998. One year after IFLS2, a 25% subsample was surveyed to provide information about the impact of Indonesia's economic crisis. IFLS3 was fielded on the full sample in 2000, IFLS4 in 2007-2008, and IFLS5 in 2014-2015.

The IFLS complements and extends the existing survey data available for Indonesia, and for developing countries in general, in a number of ways. First, relatively few large-scale population-based longitudinal surveys are available for developing countries and very few are available for an extended period of time, i.e. 21 years since IFLS1 until IFLS5. IFLS is the only large-scale longitudinal survey available for Indonesia. Because data are available for the same individuals from multiple points in time, IFLS affords an opportunity to understand the dynamics of behaviour at individual, household and family, and community levels.

Second, IFLS has re-contact rates which are as high as or higher than most longitudinal surveys in the United States and Europe because they were committed to tracking and interviewing individuals who had moved or split off from the origin IFLS1 households. In IFLS1, 7,224 households were interviewed and detailed individual-level data were collected from over 22,000 individuals. In IFSL2, 94.4% of IFLS1 households were re-contacted. In IFLS3, the re-contact rate was 95.3% of IFLS1 dynasty households (any part of the original IFLS1 households). In IFLS4, the re-contact rate of original IFLS1 dynasties was 93.6%. In IFLS5, the dynasty re-contact rate was 92%. For the individual target households, the re-contact rate was 90.5%. Among IFLS1 dynasties, 86.9% are interviewed in all 5 waves. High re-interview rates contribute significantly to data quality in a longitudinal survey because they lessen the risk of bias due to non-random attrition in studies using the data (Strauss et al., 2016).

Third, IFLS collected both current and retrospective information on most topics. With data from multiple points of time on current status and an extensive array of retrospective information about the lives of respondents, researchers can relate dynamics to events that occurred in the past. For example, financial decision-making of adults can be related to their conditions several years earlier as teenagers.

Fourth, because the waves of IFLS span the period from several years before the 1997 financial crisis hit Indonesia (IFLS1), to one year (IFLS2), to three years (IFLS3), ten years (IFSL4), and seventeen years (IFLS5) after, extensive research can be carried out regarding the living conditions of Indonesian households during this very tumultuous period and its long-term aftermath. In sum, the breadth and depth of the longitudinal information over 21 years on individuals and households make IFLS data a unique resource for scholars and policy makers interested in the processes of economic development.

4.4.2 Description of the IFLS Data Set

The data source for this study is the IFLS (Indonesia Family Life Survey) panel, a representative survey of the Indonesian population. The sample in our study are household members who are randomly selected to provide detailed individual information. We use panel data from 1997 to 2014 which consists of four waves (Frankenberg & Thomas, 2000; Strauss et al., 2004, 2009, 2016). IFLS cover relevant survey content for our analysis, including cognitive ability tests, risk tolerance and time preference tests which are described in Table 4A-1, Table 4A-2, and Table 4A-3 of the appendix 4A, respectively. IFLS also has information on financial asset participation and demographics.

The surveys on demographics are fielded every wave. On the other hand, some of surveys on cognitive ability, risk tolerance, and patience have been fielded only once or twice. Most of these are new surveys that were added to the previous wave, while some were discarded from the following wave. Table 4A-4 of the appendix 4A reports in which years each variable is available and Table 4A-5 describes the variables. 41% of the sample of 59,139 individuals have exactly four waves of data, while 9% were in the sample for the first three waves. 30% of the sample were only available in one wave. There were about 15% of respondents over the first two waves or the last two waves.

We employ nine cognitive ability tests available in the IFLS. There is no variation over time for some cognitive ability tests, namely language, maths, pattern of number series, a series of subtraction of numbers, and date tests because they were only conducted once in a particular year (see Table 4A-4 of the appendix 4A). Nonetheless, numeracy, picture matching, immediate and delayed word recall tests vary between individuals, rather than vary over time. There is also more variation across individuals than over time for risk and time preferences, income, education, and financial asset participation.

76% of the 37,429 overall observations did not hold financial assets, while 24% held financial assets. The financial asset participation is close to time-invariant as 74% of people who had ever owned financial assets always owned these financial assets during the time period covered by the panel (1997 – 2014), and the 91% who did not hold financial assets had never held financial assets. In addition, 43% of the observations that had ever held financial assets for one period remained as holders of financial assets for the next period. And the 81% who did not hold financial assets for one period, still did not hold financial assets for the next period. 57% of

the observations that had ever held financial assets for one period did not hold financial assets for the next period.

4.4.3 Construction of the Latent Variables

Our model in Figure 4.1 consists of one latent exogenous cognitive ability (x_1), two latent endogenous preferences (i.e. risk tolerance, y_1 and patience, y_2), and one endogenous financial asset participation (y_3) variable. The constructs of cognitive ability, risk tolerance, and patience are abstract and cannot be readily observed in their abstract form. Therefore, they must be defined first through a set of observed measures, which are hypothesized to measure the unobserved constructs. Latent cognitive ability is constructed through nine observed cognitive ability test scores. The cognitive ability indicators are reported in Table 4A-1 of the appendix 4A. The latent cognitive ability is what the all tests share in common. An individual's response to these tests depends on their cognitive ability. The latent cognitive ability is specified in formal expression:

$$\begin{bmatrix}\alpha_1\\ \alpha_2\\ \alpha_3\\ \alpha_4\\ \alpha_5\\ \alpha_6\\ \alpha_7\\ \alpha_8\\ \alpha_9\end{bmatrix} = \begin{bmatrix}\lambda_1\\ \lambda_2\\ \lambda_3\\ \lambda_4\\ \lambda_5\\ \lambda_6\\ \lambda_7\\ \lambda_8\\ \lambda_9\end{bmatrix}[x_1] + \begin{bmatrix}\varepsilon_1\\ \varepsilon_2\\ \varepsilon_3\\ \varepsilon_4\\ \varepsilon_5\\ \varepsilon_6\\ \varepsilon_7\\ \varepsilon_8\\ \varepsilon_9\end{bmatrix} \quad (1)$$

where $\alpha_1 - \alpha_9$ are nine observed cognitive ability tests which are linked to the underlying latent cognitive ability,x_1, through the factor loadings, $\lambda_1 - \lambda_9$. Each observed cognitive ability test has a separate error term, $\varepsilon_1 - \varepsilon_9$.

We relate our risk tolerance and patience factors to conventional measured risk and time preferences in economics. We elicited willingness to take risks using the survey questions of hypothetical money and income lottery which are presented in Table 4A-2 of the appendix 4A. Subjects were shown a list of binary alternatives, a safe option, and a varying lottery. In each question the safe option was exactly the same, but the lottery were different whereas a respondent could earn some money with 50 percent probability. Subjects with monotonic preferences should choose the lottery with higher expected value for lower safe options. The subject's final choice in sequential questions is informative of their willingness to take risks. The earlier a subject switches to the safe option, the less willing they are to take risks. The risk preference questions separate the respondents into five distinct risk tolerance categories which can be ranked by the level of willingness to take risks. The endogenous latent risk tolerance can be represented in matrix form as:

$$\begin{bmatrix}\alpha_{10}\\ \alpha_{11}\end{bmatrix} = \begin{bmatrix}\lambda_{10}\\ \lambda_{11}\end{bmatrix}[y_1] + \begin{bmatrix}\varepsilon_{10}\\ \varepsilon_{11}\end{bmatrix} \quad (2)$$

where α_{10} and α_{11} are observed hypothetical money and income lottery tests, respectively. Both tests are related to unobserved latent risk tolerance, y_1, through factor loadings, λ_{10} and λ_{11}, respectively. The ε_{10} and ε_{11} are error terms for each test.

To measure how patient an individual is, we use the survey questions of time preference. In the discounting survey, the subjects were posed with choices between receiving the same amount of money immediately or adopting different payments at different times. The decision in the intertemporal choice survey was always between the same amount of money "today" and a different delayed amount of money that would be received 1 year later (short-term horizon)

and 5 years later (long-term horizon). The survey questions of patience over short-term and long-term horizon are presented in Table 4A-3 of the appendix 4A.

In observing individuals' choice between the same amount of instant payment and a different value of payment to induce individuals to wait 1 year or 5 years, we obtained the measurement of patience. The most impatient people always preferred immediate compensation, even when the delayed payment offered a more substantial amount of money. On the contrary, patient individuals were willing to give up a smaller early payment to receive a higher compensation in the future, even when the amount was not much different than the immediate offer. The time preference questions separate the respondents into five distinct time preference categories, which can be ranked by the level of patience. The endogenous latent patience can be specified:

$$\begin{bmatrix}\alpha_{12}\\ \alpha_{13}\end{bmatrix} = \begin{bmatrix}\lambda_{12}\\ \lambda_{13}\end{bmatrix}[y_2] + \begin{bmatrix}\varepsilon_{12}\\ \varepsilon_{13}\end{bmatrix} \quad (3)$$

where α_{12} and α_{13} are observed time preference questions over short-term and long-term horizon, respectively. Both tests are related to unobserved latent patience, y_2, through factor loadings, λ_{12} and λ_{13}, respectively. The ε_{12} and ε_{13} are error terms for each test.

4.4.4 Direct and Indirect Effects

The first purpose of this paper is to examine the relationship between cognitive ability and financial asset ownership. The second purpose is to investigate whether the effect of cognitive ability on financial asset participation can be mediated by a change in risk tolerance and patience. For these purposes, we decompose the influences of cognitive ability on financial asset

participation into direct and indirect effects. We draw on the work of Alwin and Hauser (1975) and MacKinnon et al. (2007) to describe the meanings and techniques for calculating them.

Our model in Figure 4.1 consists of one latent exogenous cognitive ability (x_1), two latent endogenous preferences (risk tolerance, y_1 and patience, y_2), and one endogenous financial asset participation (y_3) variable. The structural equation modelling for this mediation model is given by:

$$y_1 = \mu_1 + \gamma_1 x_1 + \varepsilon_{14} \tag{4}$$

$$y_2 = \mu_2 + \gamma_2 x_1 + \varepsilon_{15} \tag{5}$$

$$y_3 = \mu_3 + \gamma_3 x_1 + \beta_1 y_1 + \beta_2 y_2 + \varepsilon_{16} \tag{6}$$

where μ_1, μ_2, and μ_3 are intercepts; ε_{14}, ε_{15}, and ε_{16} are residuals. The *direct effect* is the pathway from cognitive ability to financial asset participation, while controlling for risk tolerance and patience. Therefore, in our path diagram, γ_3 is the direct effect.

The *indirect effect* describes the pathway from cognitive ability to financial asset participation through the mediators, i.e. risk tolerance and patience. To form the mediated or indirect effects, we perform the product of the coefficients method (Alwin & Hauser, 1975). The indirect effect of cognitive ability to financial asset participation mediated by risk tolerance is represented through the product of γ_1 and β_1 ($\gamma_1\beta_1$). Whereas the indirect effect of cognitive ability to financial asset participation mediated by patience is represented through the product of γ_2 and β_2 ($\gamma_2\beta_2$). The rationale behind this method is that mediation depends on the extent to which cognitive ability influences patience, γ_2, and the extent to which patience affects

financial asset participation, β_2. Finally, the *total effect* is the sum of the direct and indirect effects of cognitive ability on financial asset participation, $\gamma_3 + \gamma_1\beta_1 + \gamma_2\beta_2$.

4.4.5 Methodology

The surveys on demographics, such as gender, age, income and education, are fielded every wave. This implies that we have relatively few missing observations for these control variables. By contrast, the main surveys on cognitive ability, risk and time preferences have been fielded only once or twice, which means we have a relatively substantial number of missing values (see Table 4A-4 of the Appendix 4A). Another cause for incomplete data occurs when the respondents refuse to participate in answering the tests or are illiterate. Some of them have low ability and so are unable to finish the tests. Some participants had moved or could not be contacted. Table 4.3 reports summary statistics.

Each cognitive ability test used as indicator for latent cognitive ability has different scale (see Table 4A-1 of Appendix 4A). One test has larger ranges than another test. For example, language test score ranges from 0 to 40 points, in contrast to numeracy test score which only ranges from 0 to 5 points. If the variances of the indicators are markedly heterogeneous, the convergence problem may occur. In order to avoid this problem, the indicators submitted to the latent variable analysis are preferred to be kept on a similar scale (Brown, 2015). Therefore, the nine indicators of latent cognitive ability in Table 4.1 are rescaled into standardized scores, each with mean equals zero and standard deviation equals one.

Table 4.3. Summary Statistics
This table reports summary statistics for the cognitive ability indicators, risk tolerance indicators, patience indicators, outcome variables, and control variables used in this study. Table 4A-5 of the appendix defines the variables. The data cover from 1997 to 2014.

	Mean	SD	Min	Max	N
Cognitive ability indicators					
Language	0	1	-2.608	2.893	7,768
Math	0	1	-2.637	3.643	7,643
Numeracy	0	1	-2.537	2.527	73,197
Picture matching	0	1	-3.834	1.452	75,348
Pattern of number series	0	1	-2.934	1.765	31,409
Immediate word recall	0	1	-2.756	2.790	59,266
Delayed word recall	0	1	-2.184	3.086	58,063
A series of subtraction of numbers	0	1	-1.609	1.094	28,983
Today' date	0	1	-3.728	0.615	30,685
Risk tolerance indicators					
Hypothetical money lottery	2.473	1.489	1	5	60,330
Hypothetical income lottery	2.180	0.828	1	5	60,321
Patience indicators					
Patience over short-time horizon	2.532	0.990	1	5	60,596
Patience over long-time horizon	2.290	0.685	1	5	60,594
Outcome variables					
Financial asset participation	0.236	0.425	0	1	37,429
Financial wealth	13.939	2.030	6.215	20.723	8,835
Control variables					
Male	0.478	0.499	0	1	125,547
Age	39.112	15.497	18	90	115,697
Age squared	1769.876	1419.247	324	8100	115,697
Schooling choice	2.236	1.235	1	7	83,911
Income	12.963	1.406	2.197	27.631	56,450

We used the maximum likelihood (ML) with missing values method in STATA to handle missing data in the estimation of the structural equation model with latent variables. ML method assumes that the data is missing at random (MAR). The justification of MAR assumption and an overview of the ML method are reported in Appendix 4B and Appendix 4C, respectively.

4.4.6 Model Evaluation

The acceptability of the model is evaluated on basis of overall goodness of fit. The goodness-of-fit indices are examined to evaluate the acceptability of the model. If these indices

are consistent with good model fit, this provides support that the model has been properly specified. The chi squared, root mean square error of approximation (RMSEA), and comparative fit index (CFI) are employed to evaluate the model. Appendix 4D describes the goodness-of-fit indices. In the first modelling step the hypothesized model was fitted to the data for the whole waves. This model fit was not quite acceptable (χ^2 = 17197.651, df = 73, p<0.000, N = 115,319, RMSEA = 0.045, CFI = 0.862), which implies that our model failed to reproduce the data, i.e. to reproduce the entire information in the covariance matrix.

Acknowledging that our model is a weak fit to the data in the first modelling step, thus, we re-specified our model. A correlated measurement error was indicated between the immediate and delayed word recall tests in which we felt this covariance made theoretical sense as both tests require a retention phase which is influenced by memory. Ingham's study (1952) was designed to study the existence of a retention factor in the learning memory process. He conducted testing sessions which are similar to the immediate and delayed word recall tests we employed in this paper. He used an *immediate memory* score, being the number of items recalled correctly on the first attempt in the learning phase; and *a retained items* score, the number of items recalled correctly on the first trial of the relearning phase. He obtained a general "*m*" (memory) factor that he interpreted as a general "retentivity" factor. Therefore, we included error covariance between immediate and delayed word recall tests into our model. The covariance between the pair of error terms of immediate and delayed word recall tests is 0.676 (p<0.001) which shows a high significant correlation.

After re-specification, the fit was judged acceptable, even though the overall goodness-of-fit test was still highly significant (χ^2 = 2686.375, df = 72, p<0.000, N = 115,319). However, the

RMSEA value was 0.018, and CFI value was 0.979, which indicate good fit. The standardized loadings of the indicator variables on the latent variables are reported in Table 4.4.

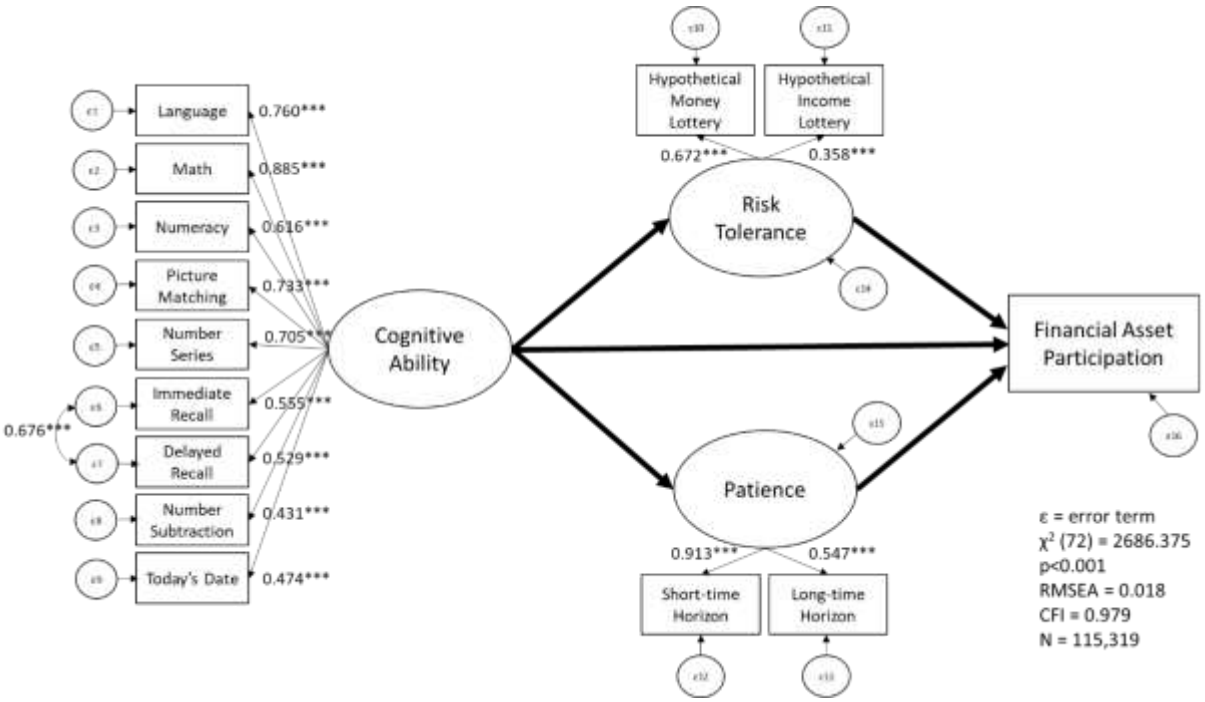
Table 4.4. Standardized Factor Loadings
This table reports standardized factor loadings for each indicator variables. The data cover from 1997 to 2014.
***p < 0.001

	Standardized factor loadings
Cognitive ability indicators	
Language	0.760 ***
Math	0.885 ***
Numeracy	0.616 ***
Picture matching	0.733 ***
Pattern of number series	0.705 ***
Immediate word recall	0.555 ***
Delayed word recall	0.529 ***
A series of subtraction of numbers	0.431 ***
Today's date	0.474 ***
Risk tolerance indicators	
Hypothetical money lottery	0.672 ***
Hypothetical income lottery	0.358 ***
Patience indicators	
Patience over short-time horizon	0.913 ***
Patience over long-time horizon	0.547 ***

The loadings are the correlation between how respondents respond to each test and the underlying, latent dimension. All the loadings of the indicator variables are substantial and significant at the $p<0.001$ level, varying from 0.358 to 0.913. This range is good as a loading of at least 0.30 is the minimum criterion for an indicator (Costello & Osborne, 2005). The sizeable and significant loadings indicate that our indicators load on their latent variables which is consistent with our model specification described in Section 4.4.3. The measurement model is presented in Figure 4.2 includes the key measures of goodness-of-fit along with factor loadings for each indicator of latent variables and covariance between error terms of the immediate and delayed word recall tests.

Figure 4.2. A Model of Cognitive Ability on Financial Asset Participation, Mediated by Risk Tolerance and Patience.

This figure shows a final confirmatory factor analysis (CFA) model which includes factor loadings for each indicator of latent variables, covariance between error terms of the immediate and delayed word recall tests, and goodness-of-fit indices.

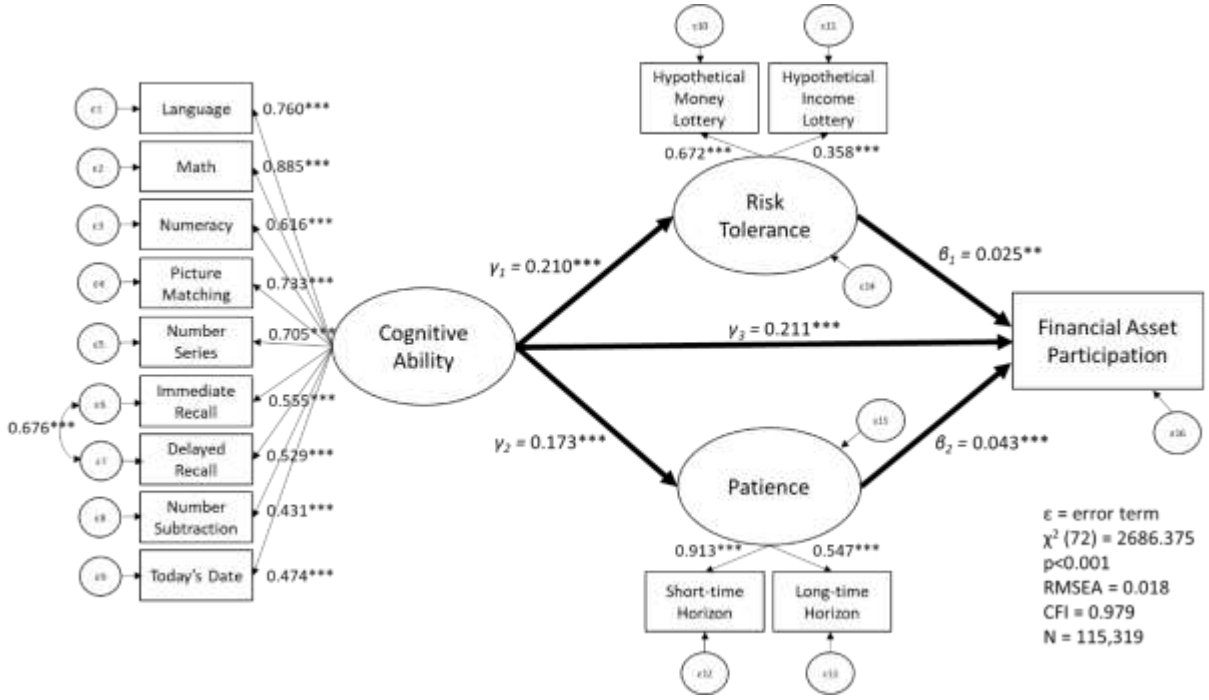


4.5 Empirical Results

4.5.1 The Effects of Cognitive Ability on Financial Asset Participation

We start by examining the direct effect of cognitive ability on financial asset participation. The direct effect is the influence of cognitive ability on financial asset ownership unmediated by any other variable in the model. Figure 4.3 presents the correlation of all variables on one another. In figure 4.3, γ_3 = 0.211 (p<0.010) is the direct effect which shows that cognitive ability significantly increases financial asset participation. Individuals with higher cognitive ability are more likely to hold financial assets than those with lower cognitive ability.

Figure 4.3. The Effects of Cognitive Ability on Financial Asset Participation
This figure shows the direct effect of cognitive ability on financial asset participation (γ_3), the indirect effect of cognitive ability on financial asset participation mediated by risk tolerance ($\gamma_1\beta_1$) and patience ($\gamma_2\beta_2$). It also shows factor loadings for each indicator of latent variables, covariance between error terms of the immediate and delayed word recall tests, and goodness-of-fit indices.



We then proceed to evaluate the effect of cognitive ability on the participation mediated by a change in the risk tolerance and patience. The indirect effect of cognitive ability on financial asset holding as mediated by risk tolerance is represented through the product of γ_1 and β_1 ($\gamma_1\beta_1$) yielding 0.005 (p<0.050). This implies that higher cognitive ability leads to higher risk tolerance which, in turn, leads to financial asset participation. The indirect effect of cognitive ability on participation through patience equals $\gamma_2\beta_2$ resulting 0.007 (p<0.010). The result suggests that individuals with higher cognitive ability have greater patience and these intelligent people have greater propensity to hold financial assets than those with lower cognitive ability.

Our findings support the theory of choice bracketing (Read et al., 1999), which posits a causal relationship between the cognitive skill and ability to broadly bracket available choices, thus, cause an individual to be more risk neutral (γ_1= 0.210; p<0.010), and these risk tolerant people are more likely to hold financial assets (β_1= 0.025; p<0.050). Furthermore, our results are in concordance with "two-system" theories which postulate a causal relationship between the application of cognitive system resources and the expression of behavioural biases. According to these theories, decision-making is a result of the interaction between a cognitive system, which is patient and risk neutral, and an emotional system, which is impulsive and risk averse (Bernheim & Rangel, 2004; Fudenberg & Levine, 2006). We show that cognitive ability significantly increases individuals' ability to delay gratification (γ_2= 0.173; p<0.010), and patient individuals have greater propensity to participate in financial assets (β_2= 0.043; p<0.010). Coefficients of direct and indirect effects of cognitive ability on participation are reported in Column 1 of Table 4.5. Furthermore, it is shown that the size of the direct effect of cognitive ability on participation is relatively larger than its indirect effect through risk tolerance and patience channels. Thus, this suggests that risk tolerance and patience only mediate part of the effect of the cognitive ability on financial assets participation.

Table 4.5. The Effects of Cognitive Ability on Financial Asset Participation

This table shows standardized coefficients of direct and indirect effects of cognitive ability on financial asset participation. The dependent variable is equal to 1 if the respondent owns savings, certificate of deposits and/or stocks. Column 2 includes demographics (male, age, age squared, the logarithm of income, and the level of highest education attended). Standard errors are reported in parentheses. The data cover from 1997 to 2014. *p<.10; **p < .05; ***p < .01.

	(1)	(2)
Direct effect	0.211 *** (0.009)	0.115 *** (0.015)
Indirect effects		
via risk tolerance	0.005 ** (0.002)	0.004 * (0.003)

via patience	0.007 *** (0.001)	0.008 *** (0.001)
Male		– 0.068 *** (0.006)
Age		0.231 *** (0.033)
Age squared		– 0.196 *** (0.036)
Income		0.057 *** (0.008)
Education		0.161 *** (0.009)
χ^2	2686.375	9367.146
df	72	135
p > chi2	0.000	0.000
RMSEA	0.018	0.021
CFI	0.979	0.942
R^2	0.899	0.907
Observations	115,319	149,429

The results in Column 1 of Table 4.5 show positive significant effects of cognitive ability on the probability of owning financial assets when no other covariates are included. However, a number of different covariates could explain the relation between cognitive ability and participation. In our specification reported in Column 2 of Table 4.5, we add control for demographics. We include gender and age as these characteristics have been found by previous studies to be related to stock market participation (Sunden & Surette, 1998; Barber & Odean, 2001; Dwyer et al., 2002; Agnew et al., 2003).

We incorporate the quadratic age controls for a potentially nonlinear relationship of willingness to hold financial assets. Ameriks and Zeldes (2004) present evidence that professionals and mutual fund companies recommend reducing stock exposure as one ages. For instance, a typical advice is that the asset shares invested in stocks should be 100 minus the investor's age. Therefore, even if there are no compelling theoretical reasons to reduce risk exposure with age, people might nevertheless do so following standard financial advice. We also

add controls for other important characteristics, including (logarithm) income and educational attainment. The details of the control variables are reported in Table 4A-5 of the appendix 4A.

The results in Column 2 of Table 4.5 show that the positive significant relationship between cognitive ability and participation still holds after controlling for these additional characteristics. The direct effect of cognitive ability on financial asset holding is 0.115 and is significant at the $p<0.010$. The indirect effect of cognitive ability on financial asset holding is 0.004 ($p<0.100$) when mediated by risk tolerance, and is 0.008 ($p<0.010$) mediated by patience. The direct effect of cognitive ability on participation is sizable compared to its influence mediated by risk tolerance and patience. This implies that risk tolerance and patience only partially mediate the effect of cognitive ability on financial asset participation. Overall, the results suggest that individuals with higher cognitive ability have a greater likelihood of holding financial assets, even after controlling for demographics.

4.5.2 Robustness: Alternative specifications

We assess the robustness of our findings by evaluating alternative specifications, including alternatives for dependent and independent variables. First, we use alternative definitions of the dependent variable to address concerns that the findings are driven by irregularities in the data, such as the limited number of individuals with financial assets paired with the sizable fraction of individuals with no financial assets. We use the logarithm of financial wealth rather than the indicator of financial asset holding. Financial wealth is defined as the amount of money that is put into savings, certificate of deposits and/or stocks. We report the results in Appendix 4E. Our main findings are robust to logged version of outcomes. Cognitive

ability has a significant direct effect on financial wealth, which implies that cognitive able individuals are more likely to have higher financial wealth.

Second, we consider alternative specifications of our cognitive ability measures. We employed nine observed cognitive ability tests available from the IFLS as main independent variables and we include risk and time preference tests, and demographics as control variables. We also consider multiple imputations as an alternative method to address missing values in our data set. Results are reported in Appendix 4F. Overall, these results point to a robust relationship between observed cognitive ability as parameters of interest and financial asset participation even after controlling for preferences and demographic characteristics. Individuals with higher numeracy, pattern of number series, and immediate word recall test scores have a greater propensity to participate in financial assets.

4.6 Conclusions

The Indonesia Family Life Survey (IFLS) documents that a large proportion of the Indonesian population do not hold financial assets which could hinder them from accumulating future wealth. Given the importance of cognitive ability as a determinant of financial decision-making, we examine the relation between cognitive ability and financial asset participation. We then further explore the mechanism behind this relationship by incorporating risk tolerance and patience in the mediation process. For these purposes, we decompose the effects of cognitive ability on financial asset participation into direct and indirect effects through risk tolerance and patience mediators.

Our findings show that cognitive ability has a positive and significant direct effect on financial asset participation unmediated by any variables in the model. This implies that individuals with higher cognitive ability are more likely to hold financial assets than those with lower ability. This is true even after controlling for gender, age, income, and educational attainment. Our results robust to an alternative definition of financial asset participation and alternative measures of cognitive ability. Nonetheless, we find little evidence that cognitive ability influences financial asset participation mediated by risk tolerance and patience traits, suggesting that cognitive ability can have an impact on financial asset holding without a change in preferences.

Understanding the role of cognitive ability and preferences is important from a policy perspective. Firstly, while it is difficult to alter cognitive ability after childhood, this suggests a recommendation for intervention designed to nurture this ability at an early stage of life with targeted school programmes; evidence portrays that early childhood environment has a strong impact on cognitive skills (Knudsen et al., 2006; Heckman et al., 2010; Chetty et al., 2011). Second, assessing cognitive ability could help identifying which individuals are more willing to take risks and are more patient – both of which are crucial traits but difficult to observe. Rothschild and Stiglitz (1976) suggest that contracts can be tailored based on observable cognitive ability which reflects this piece of information. This is beneficial to employers when screening their employees, and to insurance companies when designing contracts. For empirical research applications, it may be appropriate to allow for a positive correlation between cognitive ability and risk tolerance and patience when estimating structural models.

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Appendix 4A. Tables

Table 4A-1. Indicators of Latent Cognitive Ability.

Cognitive Ability Tests	***Survey Questions***
Language	35 – 40 multiple choice questions of Indonesian language test.
Math	35 – 40 multiple choice questions of math test.
Numeracy	5 multiple choice questions of numeracy test.
Picture matching	8 picture matching test. The subject was asked to choose one of the pictures that match with the pattern of the main picture.
Pattern of number series	6 adaptive number series test to measure fluid intelligence in which the respondent was asked to fill in the number that is missing in several series of numbers.
Immediate word recall	The respondent was asked to recall as many words as he can remember from a list consisting of 10 words.
Delayed word recall	After a postponement, the respondent was asked to recall as many words as he can remember from a list consisting of 10 words that has read to him in the previous immediate word recall.
A series of subtraction of numbers	The respondent was asked to calculate a series of subtraction of numbers.
Today's date	The respondent was asked to mention the date when he was interviewed according to Gregorian, Islamic, and local calendar.

Table 4A-2. Indicators of Latent Risk Tolerance

Risk Preference Tests	***Survey Questions***
Hypothetical money lottery	Participants were shown a list of binary alternatives, a safe option and a varying money lottery. The safe option was the same for each decision (i.e. 800 thousand). The expected value of the lottery are different (i.e. 900 thousand, 1 million, 1.1 million, and 1.2 million) whereas a respondent could earn some money with 50 percent probability.
Hypothetical income lottery	Participants were shown a list of binary alternatives, a safe option and a varying income lottery. The safe option was the same for each decision (i.e. 4 million). The expected value of the money lottery are different (i.e. 3 million, 5 million, 6 million, and 7 million) whereas a respondent could earn some income with 50 percent probability.

Table 4A-3. Indicators of Latent Patience

Time Preference Tests	*Survey Questions*
Patience over short-time horizon	Subjects were given two lists of choices between 1 million "today", which was the same in all choices, and an increasing amount of money received 1 year later (i.e. 1 million, 2 million, 3 million, and 6 million).
Patience over long-time horizon	Subjects were given two lists of choices between 1 million "today", which was the same in all choices, and a varying amount of money received 5 year later (i.e. 0.5 million, 2 million, 4 million, and 10 million).

Table 4A-4. Years Survey Variables are Available

This table reports the availability of each variable over time.

Variable	**1997**	**2000**	**2007**	**2014**
Cognitive ability indicators				
Language	x			
Math	x			
Numeracy		x	x	x
Picture matching		x	x	x
Pattern of number series				x
Immediate word recall			x	x
Delayed word recall			x	x
A series of subtraction of numbers				x
Today' date				x
Risk tolerance indicators				
Hypothetical money lottery			x	x
Hypothetical income lottery			x	x
Patience indicators				
Patience over short-time horizon			x	x
Patience over long-time horizon			x	x
Outcome variable				
Financial asset participation	x	x	x	x
Control variables				
Male	x	x	x	x
Age	x	x	x	x
Age squared	x	x	x	x
Income	x	x	x	x
Education	x	x	x	x

Table 4A-5. Variable Definition

Risk tolerance indicators	
Hypothetical money lottery	Five rating scale of willingness to take risks on hypothetical money lottery.
Hypothetical income lottery	Five rating scale of willingness to take risks on hypothetical income lottery.
Patience indicators	
Patience over short-time horizon	Five rating scale of patience over short-term horizon.
Patience over long-time horizon	Five rating scale of patience over long-term horizon.
Outcome variables	
Financial asset participation	Indicator equal to 1 if the respondent owns savings, certificate of deposits and/or stocks, whereas the alternative is having non-financial assets. Non-financial assets include house and land occupied by the household, other unoccupied house or building, non-farm land, poultry, livestock/fishpond, vehicles, household appliances, receivables, jewellery, household furniture and utensils.
Financial wealth	The logarithm of financial wealth which is defined as owning savings, certificate of deposits and/or stocks in Indonesian rupiah.
Control variables	
Male	Indicator for male
Age	Age in years
Age squared	The quadratic of age
Education	The level of highest education attended (elementary school, junior high school, senior high school, college degree, bachelor degree, master degree, and doctorate degree).
Income	The logarithm of the salary/wage (including the value of all benefits) if the respondent is a government/private/casual worker, or the logarithm of the net profit/loss if the respondent is a self-employed.

Appendix 4B. Justification of Missing Data Mechanism.

The ML method applied assumes that the data is missing at random (MAR) which implies that the propensity for missing data can be explained by other variables in the analysis. To justify the MAR assumption, we generated an indicator variable for each variable that has a missing value. The indicator dummy variable is 0 if the variable is observed and 1 if the variable has a missing value. We then correlate these missing value indicators with all variables in our model. The correlation between missing value indicators and all variables in the model are reported in

Table 4A-6. We found there are many variables in the model that are significantly correlated with missing value indicators. This implies that we can account for some of the missing values because of their relationship with other variables in the model. For instance, gender is significantly correlated with missing values because males skip more items than females in surveys; older people are more likely to skip some items; whereas individuals with higher education are less likely to skip questions.

Another example is the correlation between the immediate word recall test and the probability of the missing value of the delayed word recall test. The immediate word recall test asks respondents to recall as many words as they can remember from a list consisting of ten words in total. The interviewer then proceeds with other questions unrelated to the word recall test. Afterwards, the interviewer asks the respondent again to recall the words read to them previously. We show in Table 4A-6 of Appendix 4A that the correlation between the immediate word recall test and the missingness of delayed word recall test is –0.159 ($p<0.001$). This implies that respondents who have a lower score in the immediate word recall test do not have a score for the delayed word recall test. The respondents who can only recall a few words at the first attempt might have low memory capacity and also have difficulty to recall after postponement, therefore, they have a greater tendency to refuse to recall at the second attempt. Although we cannot guarantee that the assignment of tests to respondents yields data that completely satisfies the MAR assumption, the fact that there are many significant correlations of missingness with other variables in the model should allow for good possibilities to satisfy the MAR assumption.

Table 4A-6. Correlation between Missing Value Indicator and Variables in the Model

This table reports correlation coefficients between missing value indicators and all variables in the model. Missing value indicator is a dummy variable coded 0 if the variable is observed and 1 if the variables has a missing value. The missing value indicators are listed in columns and all variables in the model are listed in rows. Significance level of each correlation coefficient is in parentheses.

	Missing Value Indicators				
	Language	Math	Numeracy	Picture matching	Pattern of number series
Language	-	– 0.121 (0.000)	-	-	-
Math	– 0.068 (0.000)	-	-	-	-
Numeracy	-	-	-	– 0.126 (0.000)	– 0.125 (0.000)
Picture matching	-	-	– 0.109 (0.000)	-	– 0.213 (0.000)
Pattern of number series	-	-	0.006 (0.329)	0.006 (0.329)	-
Immediate word recall	-	-	– 0.153 (0.000)	– 0.154 (0.000)	– 0.004 (0.382)
Delayed word recall	-	-	– 0.142 (0.000)	– 0.144 (0.000)	– 0.003 (0.487)
A series of subtraction of numbers	-	-	0.007 (0.257)	0.007 (0.257)	0.000 (0.966)
Today's date	-	-	– 0.000 (0.988)	– 0.000 (0.988)	– 0.018 (0.001)
Hypothetical money lottery	-	-	– 0.112 (0.000)	– 0.104 (0.000)	– 0.136 (0.000)
Hypothetical income lottery	-	-	0.005 (0.261)	0.004 (0.307)	0.016 (0.000)
Patience over short-time horizon	-	-	– 0.068 (0.000)	– 0.064 (0.000)	– 0.055 (0.000)
Patience over long-term horizon	-	-	– 0.053 (0.000)	– 0.051 (0.000)	– 0.040 (0.000)
Financial asset participation	0.004 (0.439)	0.003 (0.531)	– 0.041 (0.000)	– 0.036 (0.000)	– 0.046 (0.000)
Male	– 0.005 (0.076)	– 0.005 (0.109)	0.007 (0.022)	0.010 (0.001)	0.012 (0.000)
Age	0.220 (0.000)	0.228 (0.000)	0.201 (0.000)	0.228 (0.000)	0.005 (0.070)
Education	-	-	– 0.206 (0.000)	– 0.191 (0.000)	– 0.119 (0.000)
Income	0.123 (0.000)	0.123 (0.000)	– 0.397 (0.000)	– 0.390 (0.000)	– 0.416 (0.000)

Table 4A-6. Correlation between Missing Value Indicator and Variables in the Model - continued

	Missing Value Indicators			
	Immediate word recall	Delayed word recall	A series of subtraction of numbers	Today's date
Language	-	-	-	-
Math	-	-	-	-
Numeracy	– 0.137	– 0.138	– 0.155	– 0.139
	(0.000)	(0.000)	(0.000)	(0.000)
Picture matching	– 0.230	– 0.232	– 0.235	– 0.226
	(0.000)	(0.000)	(0.000)	(0.000)
Pattern of number series	-	-	– 0.263	– 0.223
			(0.000)	(0.000)
Immediate word recall	-	– 0.159	– 0.076	– 0.036
		(0.000)	(0.000)	(0.000)
Delayed word recall	– 0.012	-	– 0.067	– 0.030
	(0.006)		(0.000)	(0.000)
A series of subtraction of numbers	-	-	-	– 0.068
				(0.000)
Today's date	-	-	– 0.210	-
			(0.000)	
Hypothetical money lottery	– 0.056	– 0.072	– 0.131	– 0.137
	(0.000)	(0.000)	(0.000)	(0.000)
Hypothetical income lottery	– 0.012	– 0.014	0.012	0.017
	(0.005)	(0.000)	(0.004)	(0.000)
Patience over short-time horizon	– 0.036	– 0.041	– 0.061	– 0.054
	(0.000)	(0.000)	(0.000)	(0.000)
Patience over long-term horizon	– 0.023	– 0.026	– 0.037	– 0.038
	(0.000)	(0.000)	(0.000)	(0.000)
Financial asset participation	– 0.009	– 0.015	– 0.061	– 0.051
	(0.093)	(0.005)	(0.000)	(0.000)
Male	0.008	0.006	0.003	0.009
	(0.007)	(0.042)	(0.323)	(0.002)
Age	0.052	0.065	0.024	0.021
	(0.000)	(0.000)	(0.000)	(0.000)
Education	– 0.134	– 0.147	– 0.141	– 0.137
	(0.000)	(0.000)	(0.000)	(0.000)
Income	– 0.475	– 0.479	– 0.041	– 0.418
	(0.000)	(0.000)	(0.000)	(0.000)

Table 4A-6. Correlation between Missing Value Indicator and Variables in the Model - continued

	Missing Value Indicators				
	Hypothetical money lottery	Hypothetical income lottery	Patience over short-time horizon	Patience over long-term horizon	Financial asset participation
Language	-	-	-	-	0.092
					(0.000)
Math	-	-	-	-	0.087
					(0.000)
Numeracy	– 0.136	– 0.136	– 0.133	– 0.133	– 0.028
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Picture matching	– 0.227	– 0.227	– 0.225	– 0.225	– 0.036
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Pattern of number series	– 0.062	– 0.068	– 0.010	– 0.010	0.063
	(0.000)	(0.000)	(0.077)	(0.077)	(0.000)
Immediate word recall	– 0.069	– 0.073	– 0.018	– 0.019	0.036
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Delayed word recall	– 0.060	– 0.061	– 0.017	– 0.018	0.032
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
A series of subtraction of numbers	0.000	– 0.010	0.004	0.004	0.039
	(0.967)	(0.088)	(0.455)	(0.455)	(0.000)
Today's date	– 0.060	– 0.064	– 0.021	– 0.021	– 0.013
	(0.000)	(0.000)	(0.000)	(0.000)	(0.021)
Hypothetical money lottery	-	– 0.008	0.004	0.002	0.051
		(0.047)	(0.362)	(0.582)	(0.000)
Hypothetical income lottery	– 0.007	-	– 0.004	– 0.005	0.038
	(0.106)		(0.264)	(0.249)	(0.000)
Patience over short-time horizon	– 0.013	– 0.014	-	0.001	0.020
	(0.002)	(0.001)		(0.814)	(0.000)
Patience over long-term horizon	– 0.008	– 0.008	– 0.002	-	0.019
	(0.056)	(0.041)	(0.671)		(0.000)
Financial asset participation	– 0.003	– 0.003	– 0.002	– 0.002	-
	(0.588)	(0.590)	(0.730)	(0.749)	
Male	0.011	0.011	0.012	0.012	0.336
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age	0.032	0.032	0.026	0.026	– 0.017
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Education	– 0.126	– 0.126	– 0.125	– 0.125	0.082
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Income	– 0.472	– 0.473	– 0.472	– 0.472	0.048
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Table 4A-6. Correlation between Missing Value Indicator and Variables in the Model - continued

	Missing Value Indicators			
	Male	Age	Education	Income
Language	– 0.004	0.001	-	0.059
	(0.718)	(0.936)		(0.000)
Math	– 0.011	– 0.009	-	0.070
	(0.320)	(0.458)		(0.000)
Numeracy	– 0.076	– 0.023	– 0.111	– 0.062
	(0.000)	(0.000)	(0.000)	(0.000)
Picture matching	– 0.138	– 0.079	– 0.174	– 0.113
	(0.000)	(0.000)	(0.000)	(0.000)
Pattern of number series	– 0.001	0.101	– 0.264	– 0.069
	(0.934)	(0.000)	(0.000)	(0.000)
Immediate word recall	0.000	0.142	– 0.226	– 0.020
	(0.957)	(0.000)	(0.000)	(0.000)
Delayed word recall	– 0.004	0.150	– 0.174	0.001
	(0.306)	(0.000)	(0.000)	(0.847)
A series of subtraction of numbers	– 0.006	0.033	– 0.098	– 0.032
	(0.348)	(0.000)	(0.000)	(0.000)
Today's date	0.009	0.077	– 0.202	– 0.012
	(0.132)	(0.000)	(0.000)	(0.033)
Hypothetical money lottery	0.012	– 0.005	– 0.040	– 0.063
	(0.003)	(0.218)	(0.000)	(0.000)
Hypothetical income lottery	0.001	0.008	– 0.013	– 0.023
	(0.725)	(0.041)	(0.001)	(0.000)
Patience over short-time horizon	– 0.005	0.048	– 0.039	– 0.004
	(0.265)	(0.265)	(0.000)	(0.348)
Patience over long-term horizon	– 0.010	0.047	– 0.017	– 0.011
	(0.753)	(0.000)	(0.000)	(0.006)
Financial asset participation	0.006	– 0.016	– 0.067	– 0.100
	(0.234)	(0.002)	(0.000)	(0.000)
Male	-	0.010	– 0.050	– 0.243
		(0.000)	(0.000)	(0.000)
Age	-	-	0.068	– 0.034
			(0.000)	(0.000)
Education	0.018	0.043	-	– 0.065
	(0.000)	(0.000)		(0.000)
Income	0.030	– 0.078	– 0.381	-
	(0.000)	(0.000)	(0.000)	

Appendix 4C. Maximum Likelihood Estimation

The ML estimates use all of the available data – complete and incomplete – to identify the population parameter values which have the highest probability of producing the sample data. The estimation process uses a log likelihood function to quantify the standardised distance between the observed data points and the parameter values, and the goal is to identify parameter estimates that minimize these distances. We draw on the work of Enders and Bandalos (2001), and Baraldi and Enders (2010) to provide a non-technical overview of the mathematics behind the estimation. Assuming multivariate normality, the casewise likelihood of the observed data is obtained by maximizing the function:

$$\log L_i = K_i - \frac{1}{2}\log|\Sigma_i| - \frac{1}{2}(x_i - \mu_i)^T\Sigma_i^{-1}(x_i - \mu_i) \quad (7)$$

where K_i is a constant that depends on the number of complete data points for case i, x_i is the observed data for case i, μ_i and Σ_i contain the parameter estimates of the mean vector and covariance matrix, respectively, for the variables that are complete for case i. The T symbol represents the matrix transpose (i.e. rows become columns, columns become rows), and -1 denotes the inverse (i.e. the matrix analog to division). The term $(x_i - \mu_i)^T\Sigma_i^{-1}(x_i - \mu_i)$ is a squared z-score that quantifies the standardized distance between a set of scores for a particular individual and the population means. Score values that are close to the mean produce a small z-score and a large log likelihood value, whereas scores that are far from the mean produce larger z-scores and smaller log likelihoods. The casewise likelihood functions are accumulated across the entire sample and maximized as follows:

$$\log L(\mu, \Sigma) = \sum_{i=1}^{N} \log L_i \quad (8)$$

ML aims to estimate the population parameter (i.e. the mean and the covariance matrix) which produces the highest sample log likelihood. An iterative algorithm repeatedly substitutes different sets of parameter values into the log likelihood function and computes the sample log likelihood until it identifies the estimates that best fits the data. That is, the estimates which minimize the distance to the data and therefore, produce the largest sample log likelihood, or the largest probability.

The log likelihood function (Equation (7)) does not require complete data. With missing data, an individual's squared z-score is computed using whatever data are available for that person. In this way, all available data are utilized during parameter estimation; a case i contributes to the estimation of all parameters for which there is complete data. However, the inclusion of partially complete cases also contributes to the estimation of parameters that involve the missing portion of the data.

When we justify the MAR assumption in Appendix 4B, we show an example in which the immediate word recall test correlates with the missingness of the delayed word recall test. Suppose we have bivariate data set where the delayed recall test score were missing for individuals who scored poorly on immediate recall test. Because the immediate and delayed recall tests are positively correlated ($r = 0.761$, $p<0.001$), the presence of a low-immediate recall score in the log likelihood computations (e.g., the squared z-score in Equation (7)) implies that the missing delayed recall test would have also been low had it been observed. Consequently,

including the partial data records in the estimation process results in a downward adjustment to the delayed recall test score mean.

The inclusion of partially complete data of the immediate recall test not only contributes to the estimation of its parameter, but it also contributes to the estimation of the delayed recall test parameter via the correlation between both tests. That is, probable values for the missing delayed recall test are implied by the observed immediate recall test values, and inclusion of the partially complete data increases the precision and accuracy of delayed recall test parameter estimates. Although the ML algorithm does not impute missing values, this borrowing of information from the observed portion of the data is conceptually analogous to replacing missing data points with the conditional expectation of missing data given the observed data.

Appendix 4D. Descriptive Goodness-of-Fit Indices

The chi-squared tests the *exact-fit hypothesis* that there are no discrepancies between the population covariances and those implied by the model. A significant chi-square test can be an indication of poor fit of the model to the data. However, the chi-square distribution is greatly affected by sample size (the larger the sample, the more likely the chi-square will be significant). Kline (2011) stated that in very large samples, such as N=5,000, it can happen that the chi-square test is failed, even though differences between observed and predicted covariances are slight. Similarly, Kenny (2015) claimed that for models with 400 or more cases, the chi square is almost always statistically significant. Thus, the proponents of the structural equation modelling approach have suggested that several different indices of fit are used to augment the evaluation of fit provided by the chi-square statistic.

The root-mean-square error of approximation (RMSEA) and the comparative fit index (CFI) were chosen to augment the evaluation of fit for the analysis included here. RMSEA is a type of parsimony correction index which incorporates a penalty function for poor model parsimony (i.e. number of freely estimated parameters as expressed by model df) (Brown, 2015). Its computational formula is:

$$RMSEA = \sqrt{\frac{\chi^2 - df/(N-1)}{df}} \tag{9}$$

where χ^2 is the chi-square of the model, df is the degrees of freedom, and N is the sample size. RMSEA relies on the non-central χ^2 distribution. The non-central χ^2 distribution includes a non-centrality parameter (NCP), which expresses the degree of model misspecification. The NCP is estimated as $\chi^2 - df$ (if the result is a negative number, NCP = 0). When the fit of a model is perfect, NCP = 0 and a central χ^2 distribution holds. When the fit of the model is not perfect, the NCP is greater than zero and shifts the expected value of the distribution to the right of that of the corresponding central χ^2. As can be seen in (9), RMSEA compensates for the effect of model complexity due to the freely estimated parameters addition which does not markedly improve the fit of the model. The RMSEA guidelines, as described by Byrne (1998), are that values between 0 and .05 indicate very good fit, but values up to .08 can represent reasonable errors of approximation. Values greater than .10 indicate poor fit.

Comparative fit index (CFI) is in a group of incremental fit indices that compares our model with a baseline model which assumes there is no relationship among indicator variables (i.e. the covariances among all indicators are fixed to zero). CFI (Bentler, 1990) is computed as follows:

$$CFI = 1 - \frac{\max[(\chi_T^2 - df_T), 0]}{\max[(\chi_T^2 - df_T), (\chi_B^2 - df_B), 0]} \quad (10)$$

where χ_T^2 is the χ^2 value of our model; df_T is the df of our model; χ_B^2 is the χ^2 value of the baseline model; and df_B is the df of the baseline model. Like the RMSEA, the CFI is based on the NCP (i.e. $\lambda = \chi_T^2 - df_T$), meaning that it uses information from the expected value of χ_T^2 and χ_B^2 under the non-central χ^2 distribution. CFI values of .90 or above indicate adequate fit to the data (Bentler, 1990; Byrne, 1998).

Appendix 4E. A Model of Cognitive Ability on Financial Wealth

In this model, we use an alternative definition of the dependent variable in Figure 4.3. Instead of using an indicator of financial asset holding, we use a logarithm of financial wealth as the dependent variable. Financial wealth is defined as the amount of money that is put into savings, certificate of deposits and/or stocks. Consistent with Figure 4.3, the missing data is estimated using full information maximum likelihood with the assumption that the data is missing at random (MAR). The fit of this model was not satisfactory in the first modeling step (χ^2 = 17289.420, df = 73, p<0.000, RMSEA = 0.047, CFI = 0.861, N=104,724) suggesting that the model was a weak fit to the data, and thus the model was re-specified.

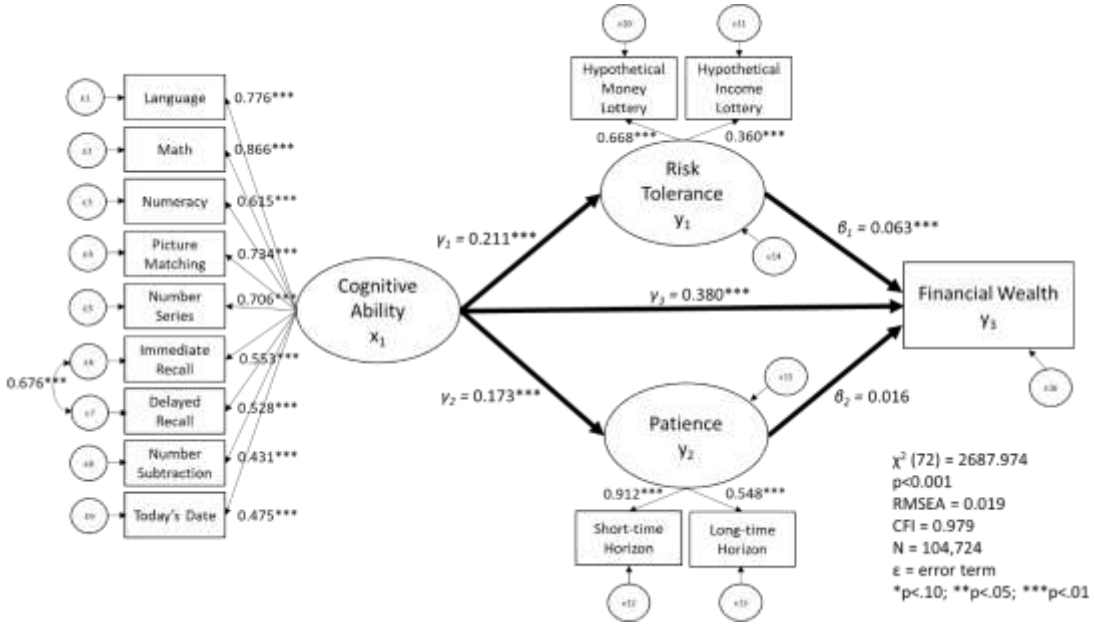
We indicated a correlated measurement error between the immediate and delayed word recall tests. The covariance between the pair of error terms for the immediate and delayed word recall tests was 0.676 (p<0.001, showing a high significant correlation. Therefore, we allowed for error covariance between the immediate and delayed word recall tests into our model. After the

re-specification, the fit was judged acceptable (χ^2 = 2687.974, df = 72, p<0.000, RMSEA = 0.019, CFI = 0.979, N = 104,724), indicating that our model was now able to reproduce the data. Figure 4.4 shows the standardized loadings of indicators, the correlation of all variables in the model, and the key measures of goodness of fit.

All loadings of the indicators of latent cognitive ability, latent risk tolerance, and latent patience were sizeable (>0.3) and significant at the p<0.010 level, implying that our indicators load on their latent variables and are consistent with our model specification. The direct effect of cognitive ability on financial wealth (γ_3) is 0.380 (p<0.010). The indirect effect of cognitive ability on financial wealth mediated by risk tolerance ($\gamma_1\beta_1$) is 0.013 (p<0.010), while its indirect effect through the patience channel ($\gamma_2\beta_2$) is 0.003, but it is not statistically significant.

Figure 4.4. The effects of cognitive ability on financial wealth

This figure shows the direct effect of cognitive ability on financial wealth (γ_3), the indirect effect of cognitive ability on financial wealth mediated by risk tolerance ($\gamma_1\beta_1$) and patience ($\gamma_2\beta_2$). It also shows factor loadings for each indicator of latent variables, covariance between error terms of the immediate and delayed word recall tests, and goodness-of-fit indices.



Appendix 4F. A Model of Observed Cognitive Ability on Financial Asset Participation

In this model, we use alternative measures of the cognitive ability, i.e. nine observed cognitive ability tests available in the IFLS (see Table 4A-1 of Appendix 4A) and include risk and time preference tests (see Table 4A-2 and 4A-3 of Appendix 4A, respectively) and demographics as control variables. We assess the effect of cognitive ability on financial asset participation by using multiple imputation by chained equations (MICE). MICE is a particular multiple imputation technique (Van Buuren, 2007). Many of the initially developed multiple imputation procedures assumed a joint normal distribution. In large datasets, with many variables of varying types, this is rarely appropriate. As our data set contains continuous, binary, and ordered categorical variables, we therefore implemented MICE in Stata software programme to deal with missing values because it is able to handle different types of variables by filling the missing values in variables using its own imputation model. This means that each variable can be modelled according to its distribution, for example, with binary variables modeled using logistic regression and continuous variables modeled using linear regression.

MICE operates under the assumption that the missing data are missing at random (MAR), which means that the probability that a value is missing depends on observed values. We provide a detailed MAR assumption justification in Section 4.4.4. The fact that many variables in the model are correlated with missingness of other variables (see Table 4A-6 of appendix 4A), suggesting that the data satisfy MAR assumption and, therefore, it is consistent with the MICE assumption. We include all variables that will be used in the analysis into the imputation model,

including cognitive ability, risk and time preferences, financial asset participation, and demographic variables.

Azur et al. (2011) and White et al. (2011) provide detailed procedures of the MICE method and describe approaches for imputing missing values in different variable types. MICE involves an imputation phase, the analysis phase, and the pooling phase. The imputation phase generates a specified number of data sets, each of which contains different estimates of the missing values. Initially, each variable would first be imputed (using the mean imputation), temporarily setting any missing value equal to the mean observed value for that variable. Then, the imputed mean values of the first variable with the missing value, say x_1, would be set back to missing. In the next step, a regression of x_1 predicted by all other variables $x_2, \ldots, x_k$ would be run using all cases where x_1 was observed. Predictions of the missing x_1 values would be obtained from that regression equation and imputed. At this point, x_1 does not have any missingness. The process would then be repeated for the second variable with missing value, say x_2. The originally missing values of x_2 would be then set back to missing and a regression of x_2 predicted by all other variables $x_1, x_3, \ldots, x_k$ would be run using all cases where x_2 was observed, and using both real and imputed values of x_1. The process is then repeated for each variable with any missing values. The cycling through each of the variables constitutes one iteration or cycle. This entire process of iterating through all other variables with missing values would be repeated until convergence; the observed data and the final set of imputed values would then constitute one complete data set.

In the imputation phase, missing values of continuous variables are imputed using a linear regression model, while missing values of binary variables are imputed using the logistic

regression model, and missing values of ordered categorical variables are imputed using the ordered logistic regression. When imputing missing values for each case, the imputation regressions incorporate random noise to preserve the proper degree of variability in the imputed data. A random component is important so that all imputed missing values of a single variable are not all exactly equal. Moreover, because the imputed value is an estimate (a predicted value), there is uncertainty about its true value. If we use imputed data as if it were real data, the resulting standard error estimates generally will be too small because the standard error calculation cannot adequately account for the fact that the data are imputed and, therefore, it does not account for additional variability in the imputed data.

The solution is to repeat the imputation process multiple times, producing multiple completed datasets. Because the random component is included in the process, the estimates of the parameters of interest will be slightly different for each imputed data set. This variability across imputed data sets is used to adjust the standard errors upwardly (Allison, 2002). Following Brown (2015), we perform multiple imputation to construct 20 complete data sets as an adequate number of imputations to improve the estimates of standard errors and the stability of parameter estimates. Table 4A-7 shows number of observations per dataset. Column 1 reports the number of complete observations for each variable in our analysis. Column 2 shows the number of observations that are imputed and Column 3 reports the total observations after imputation.

Table 4A-7. Number of Observations: Multiple Imputations.
This table reports number of observations per dataset. Columns 1 shows number of complete observations. Column 2 shows number of observations that are imputed. Column 3 reports the total observations after imputation.

	Complete (1)	Imputed (2)	Total (3)
Cognitive ability			
Language	7,768	148,433	156,201
Math	7,643	148,558	156,201
Numeracy	73,197	83,004	156,201
Picture matching	75,348	80,853	156,201
Pattern of number series	31,409	124,792	156,201
Immediate word recall	59,265	96,935	156,201
Delayed word recall	58,063	98,138	156,201
A series of subtraction of numbers	28,983	127,218	156,201
Today' date	30,685	125,516	156,201
Risk tolerance			
Hypothetical money lottery	60,330	95,871	156,201
Hypothetical income lottery	60,321	95,880	156,201
Patience			
Patience over short-time horizon	60,596	95,605	156,201
Patience over long-time horizon	60,594	95,607	156,201
Control variables			
Male	125,547	30,654	156,201
Age	115,697	40,504	156,201
Age squared	115,697	40,504	156,201
Income	56,450	99,751	156,201
Education	83,911	72,290	156,201
Outcome variable			
Financial asset participation	37,429	118,772	156,201

Following the imputation phase, is the analysis phase. In the analysis phase, logistic regression is performed in each of the 20 completed data sets to assess the effect of cognitive ability on financial asset participation. This yields 20 separate estimates of each parameter and standard error. Finally, in the pooling phase, the estimates and their standard errors are averaged into a single set of values using Rubin's (1987) formula. Pooled parameter estimates ($\hat{\theta}$) are calculated by taking the arithmetic mean of the estimates from each imputed data set:

$$\hat{\theta} = \frac{1}{m}\sum_{t=1}^{m}\hat{\theta}_t \tag{11}$$

where $\hat{\theta}_t$ is the parameter estimate (e.g. the regression coefficient) from the filled-in data set t, and m is the total number of imputed data sets ($m = 20$).

Pooling standard errors involve the standard errors from the imputed data sets (i.e. within-imputation variance) and a component that quantifies the extent to which the estimates vary across data sets (i.e. between-imputation variance). The within-imputation variance is the arithmetic average of the squared standard errors:

$$W = \frac{\Sigma SE_t^2}{m} \tag{12}$$

The between-imputation variance quantifies the variability of the estimates across data sets:

$$B = \frac{\Sigma(\hat{\theta}_t - \overline{\theta})^2}{m-1} \tag{13}$$

where $\hat{\theta}_t$ is the parameter estimate from the filled-in data set t, and $\overline{\theta}$ is the average parameter estimate. Finally, the pooled standard error combines the within- and between-imputation variance:

$$SE = \sqrt{W + B + B/m} \tag{14}$$

Table 4A-8 reports the odds ratios from logistic regression of the effect of cognitive ability tests on financial asset participation. Numeracy, pattern of number series, and immediate word recall tests are found to significantly affect financial asset participation. The findings show that a 1-standard-deviation increase in numeracy and pattern of number series test scores results in a 7.6% and 8.8% increase in the probability of financial asset participation, respectively. While a 1-standard-deviation increase in immediate word recall test scores is associated with a 11.1% increase in the probability of financial asset holding. These effects are statistically significant even

after controlling for risk and time preferences and demographics, suggesting that cognitive ability is a significant predictor of financial asset participation.

Table 4A-8. The Effects of Observed Cognitive Ability on Financial Asset Participation

This table reports odds ratios from logistic regression of the effect of observed cognitive ability on financial asset participation. The dependent variable is equal to 1 if the respondent owns savings, certificate of deposits and/or stocks. The control variables include demographics (male, age, age squared, the logarithm of income, and the level of highest education attended). The data cover from 1997 to 2014. Standard errors are reported in parentheses. *p<.10; **p < .05; ***p < .01.

Cognitive ability tests		
Language	1.012	(0.155)
Math	1.065	(0.157)
Numeracy	1.076 *	(0.038)
Picture matching	1.016	(0.028)
Pattern of number series	1.088 **	(0.035)
Immediate word recall	1.111 ***	(0.040)
Delayed word recall	0.995	(0.027)
A series of subtraction of numbers	1.009	(0.037)
Today' date	1.046	(0.027)
Risk tolerance tests		
Hypothetical money lottery	1.011	(0.018)
Hypothetical income lottery	1.026	(0.025)
Patience tests		
Patience over short-time horizon	1.091 ***	(0.022)
Patience over long-time horizon	1.009	(0.036)
Male	0.704 ***	(0.022)
Age	1.054 ***	(0.005)
Age squared	0.999 ***	(0.000)
Income	1.119 ***	(0.016)
Education	1.347 ***	(0.036)
Observations	156,201	
Imputations	20	

Chapter 5
Conclusions

Financial markets around the world have become increasingly accessible to the individual investor, as new products and financial services grow widespread. At the same time, pension systems in most developing economies are not yet mature enough to provide adequate pension income security for pensioners (Park & Estrada, 2012). Moreover, dependency on family for retirement income is decreasing and retirement costs increase as life expectancy rises. This trend is increasingly requiring people to decide how much to save and where to invest and to take on responsibility for decumulation so as not to outlive their assets while meeting their needs during retirement. Therefore, effective financial decision-making becomes a huge challenge to many individuals which requires financial literacy and cognition.

Despite the importance of financial literacy in financial decision-making, the level of financial literacy around the world are of acute concern, and it is low even in advanced economies with well-developed financial markets (Lusardi and Mitchell, 2011). In recent years, many countries have put efforts to provide financial education in schools, Universities, and workplaces, However, the continuously low levels of financial literacy across the world indicate that a piece of the puzzle is missing. Effective financial education could be delivered by first identifying specific knowledge that empirically matters for financial decision-making in the real world, and then incorporate this knowledge into financial education programmes. Accordingly, the main goal of this thesis is to investigate the specific component of financial literacy that determines

individuals' actual financial decision-making. It also takes into account cognition as financial decision-making may depend, in part, on several dimensions of cognitive ability. This study provides empirical evidence that financial literacy and cognitive ability are important determinants of real-world financial decisions.

Chapter 2 analyses the relationship between basic and advanced financial literacy and stock market participation. The analysis uses a novel survey of University students in Indonesia in 2016 which is considered as a section of Indonesian population who can be classified as being educated. The findings of Chapter 2 show that more advanced knowledge about stock market and its products increases youths' participation in the stock market. Another specific component of financial literacy explored in Chapter 3, namely knowledge about compound interest. To examine the relationship between compound interest knowledge and financial retirement, the study uses a new survey of Indonesian employees from Universities, banks, hospitals, manufacturing, wholesale and retail companies in 2019. It is found that knowledge about exponential growth affects employees' financial retirement decisions. The results show that neglecting the effect of exponential growth results in decreasing the probability of long-term asset holding and increasing propensity of short-term asset and illiquid asset ownership. This implies that misunderstanding exponential growth can have significant consequences on retirees' welfare due to poor portfolio allocation. Finally, Chapter 4 examines the importance of cognitive ability on financial asset participation. The data source for the analysis is the Indonesia Family Life Survey (IFLS) panel, a large-scale longitudinal survey which is a national representative survey of Indonesian. Using panel data IFLS from 1997 to 2014, it is found that that cognitive ability is key information-processing which significantly affects financial asset ownership.

Individuals with higher cognitive ability are more likely to hold financial assets than those with lower cognitive ability. There is also some evidence that risk tolerance and patience characteristics mediate the effect of cognitive ability on financial asset ownership. Higher cognitive ability leads to higher risk tolerance and, in turn, leads to financial asset participation. Additionally, individuals with higher cognitive ability have greater patience and these intelligent people have greater propensity to hold financial assets than those with lower cognitive ability. The policy implications of this thesis are presented in Section 5.1, while the limitations and direction for future research are discussed in Section 5.2.

5.1. Policy Implications

This thesis contributes evidence on several open questions regarding the determinants of financial decision-making in the real world and the specific component of financial literacy that significantly affects such decisions. The findings of this study have important policy implications for designing cost-effective financial education to achieve targeted financial behaviour. More specifically, by conducting the study in Indonesia, the results of the thesis convey information about the content of financial education that should be incorporated in school curriculum, college courses, and workplaces to meet the objectives of the Indonesian government in increasing individual's welfare, shifting the nation to investing society, and encouraging financial market development. Nonetheless, the findings could also be beneficial to other developing economies who have similar characteristics to Indonesia, such as having the dramatic increase in life expectancy, declining in family size, an absence of significant government-based Social

Security pensions, and thus aims to increase people's welfare by delivering financial education to improve financial literacy.

The results of Chapter 2 shows that youths display low levels of financial literacy and, most importantly, higher financial literacy is associated with a greater likelihood to participate in the stock market. Given the fact that youths possess limited financial literacy and its implication on the stock market participation, ensuring the delivery of financial education early on the life-cycle is of significant importance as providing financial literacy before individuals enter the labour market has long-term consequences on portfolio allocations (Jappelli & Padula, 2015). Furthermore, it is important to deliver financial education that covers more advanced knowledge about how the stock market works and its instruments as this knowledge reduces the barrier to entering stock market. Finally, financial education programmes are likely to be more effective when targeted to specific groups since financial literacy differs across age and years of education.

The trend toward offering financial education in school is based on the belief that additional financial education has the potential to provide students with financial knowledge that will help them develop future positive financial behaviours. In the United States, there are studies which show evidence of the positive effects of high school financial education policies on behaviours after graduation. The first study, by Bernheim et al. (2001), found positive effects of 14 state financial education policies on savings by middle-ages. Brown et al. (2016) identify 17 states where financial education policies were reported to be in place in high schools between 1998 and 2012, and estimate the effects of these policies on debt levels and loan defaults among 19- to 29-year-olds. That analysis shows that states defined as having financial education policies are associated with reductions in non-student debt and rates of loan defaults.

Urban et al. (2020) study two states that enacted financial education graduation mandates in 2007. Comparing student graduation-age cohorts in these states to students in demographically similar states with no financial education policies, they show higher credit scores and reduced rates of credit delinquencies among students exposed to financial education policies. There are three unique components of implementation which may be part of the reason the state's financial education programme appears to have strong effects on young people and thus, are instructive for education policy. First, the state provided funding for two expert to train teachers on the new curriculum which was focused on personal finance, with the remainder on microeconomics, macroeconomics, and international economics. This standardised the course offering and prepared teachers to cover the new personal finance material. After that first year, training was available through webinars and with local training organisations. Second, the state department of education tied school funding to the teacher of this course either being a certified economics teacher or having obtained a broad field certification in social studies, reducing the probability that a teacher with an unrelated specialisation (e.g. art or foreign language) was teaching personal finance. Third, student standardised testing included topics from the economics course, including personal finance content.

Another specific component of financial literacy explored in Chapter 3, namely knowledge of compound interest, is shown to significantly affect portfolio choice, which confirms the importance of delivering education covering exponential growth to assist workers with making optimal portfolio choices. Moreover, compound interest knowledge has a distinct effect from a broader financial literacy, suggesting that delivering specific financial education to debias individuals with exponential growth bias might be more cost-effective than extensive general

financial literacy. Specific education about compound interest might also eliminate a major "training the trainer" challenge of implementing general financial literacy or personal finance training programmes on a large scale, as most teachers do not feel adequately prepared to teach such courses (Way & Holden, 2009).

There are some evidences from previous studies which show that simple interventions can debias individuals. Mailing printed retirement income projections along with enrollment information affects University employees' contributions to retirement accounts (Goda et al., 2014). Teaching a formula to calculate compound growth to subjects might help to develop a grasp of exponential effects (Foltice & Langer, 2017, 2018). Providing graphical or projected account balances of retirement savings motivates both college students and employees to save more for retirement (McKenzie & Liersch, 2011; Krijnen et al., 2020). A more labour-intensive treatment is face-to-face financial education that informs subjects about compound interest, and the treatment results in increasing pension contributions in rural areas (Song, 2020).

Cognitive ability is found to be a significant determinant of financial asset participation. Chapter 4 demonstrates that cognitive ability is associated with financial asset holding. This suggests intervention designed to nurture this ability at an early stage of life with targeted school programmes, as evidence that an early childhood environment has a strong impact on cognitive ability development (Knudsen et al., 2006; Heckman et al., 2010; Chetty et al., 2011). Also, policy makers should consider the role of behavioural aspects, such as risk tolerance and patience, when designing financial education as these traits partially mediate the effect of cognitive ability on financial decision-making.

There exists previous studies which show the long-term impacts of early childhood education on outcomes in adulthood. Chetty et al. (2011) analysed the long-term impacts of Project STAR (Student/ Teacher Achievement Ratio), one of the most widely studied education experiments in the United States. The Project STAR experiment randomly assigned one cohort of 11,571 students and their teachers to different classrooms within their schools from kindergarten to third grade. They found strong correlation between kindergarten test scores and adult outcomes. An increase in end-of-kindergarten test scores is associated with an increase in wage earnings at age 27. Several other adult outcomes – such as college attendance rates, quality of college attended, home ownership, and retirement account savings – are also all highly correlated with kindergarten test scores.

Several factors contribute to the cognitive ability development and subsequently, cause improvements in adult outcomes. First, Chetty et al. (2011) find that class size matters for standardised test scores. The students assigned to small classes (15 students on average) are more likely to be enroled in college at age 20 than others assigned to large classes (22 students on average). Second, Krueger (1999) shows that Project STAR students with more experienced teachers score higher on tests and Chetty et al. (2011) find similar impacts on earnings. Students randomly assigned to a kindergarten teacher with more than 10 years of experience earn an extra 6.9% of mean income at age 27 relative to students with less experienced teachers. Third, kindergarten class quality has significant impacts on both test scores and earnings (Chetty et al., 2011). Kindergarten class quality is proxied by the average test scores of his classmates at the end of kindergarten which are an omnibus measure of class quality because they capture peer effects, teacher effects, and all other classroom characteristics that affect test scores. Using this

measure, it is found that students randomly assigned to a classroom which is 1 standard deviation higher in quality earn 3% more at age 27. Students assigned to higher quality classes are also significantly more likely to attend college and enrol in higher quality colleges. In sum, these findings suggest the policy intervention of early childhood education as it has impact on cognitive ability development which has long-term impact in adulthood.

5.2. Limitations and Directions for Future Research

There are some limitations in this thesis which could be alleviated in future work. This section also highlights several directions for future research. The results of Chapter 2 provide some guidance for future study. First, future work should consider whether respondents understand the meaning of the questions, as well as the prevalence of guessing and providing random answers. These problems can be assessed by incorporating inverted wording of the questions and exposing two randomly chosen groups of respondents to answer the same question, but with different wording. Second, new data collection should address other personality traits, such as risk and time preferences, previous studies have shown that these traits are important predictors of economic outcomes. Another promising future research is how financial literacy can be increased, as well as how is best to evaluate the effectiveness of such initiatives.

We also hope that our findings in Chapter 3 lead to further consideration for future research considering the definition of financial sophistication, as it is found that although knowledge of exponential growth may be a component of financial literacy, it has a distinct effect from broader financial literacy. Distinguishing compound interest knowledge from broader

financial literacy is important since it has different implications on the content of the financial education delivered. Another promising future research is how to debias individuals that lead to optimal financial decisions. Finally, we hope that future work collects more representative observations. Our study uses a small sample which is not a national representative sample of whole population and therefore, it can be considered as a pilot study. The demographics information has relatively few missing observations. On the contrary, however, knowledge-based questions have considerable missing values, indicating that some survey questions require probing to alleviate non-response questions. Therefore, the new data collection should consider interviewer-administered surveys, as effective interviewer probing can mitigate non-response items and generate more complete data.

Chapter 4 explores risk tolerance and patience as novel channels that partially mediate the effect of cognitive ability and financial asset participation. This findings offers an opportunity for future research to explore other behavioural biases which can serve as potential mediators by which cognitive ability influences financial decisions. For instance, limited prospective memory, i.e. not completing the task that one intended to complete (Ericson, 2011). Less intelligent individuals might have limited attention or memory that entails a real cost, such as forgetting to manage their portfolio, invest, or enroll in a retirement saving programme. Incorporating a mediator into the analysis of a relationship between cognitive ability and financial decisions improves the understanding of such a relation and can form the basis for personal finance theory.

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