Financial literacy and mental health

by

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Abstract

Being one of the essential skills in the 21st Century, financial literacy is important in its own right and for individuals' life-long financial well-being. Financial literacy has been associated with a series of positive financial outcomes in previous literature. However, we still know little about how financial literacy is related to individuals' mental well-being. This thesis aims to investigate the relationships between financial literacy, financial well-being and mental well-being among adults. To realise this, three empirical studies are conducted. The first empirical study examines the relationship between financial literacy and depressive symptoms, providing the first empirical evidence of the relationship between the two concepts in a middle-income setting: China. The second empirical study provides the first longitudinal investigation on the relationship between financial literacy and depression and its underlying economic pathways, using data from a nationally representative dataset: the Health and Retirement Study (HRS) based on the U.S.. The third empirical study investigates the moderating role of financial literacy in the association between financial shocks and depression aiming to further enclose the relationship between financial literacy and mental well-being.

The findings highlight both positive and negative effects of financial literacy on mental well-being. On one hand, financial literacy is significantly associated with fewer depressive symptoms and financial literacy may positively impact individuals' mental well-being either directly or indirectly operated through its influence on household finances such as income and wealth. On the other hand, when individuals experience financial shocks, financial literacy can magnify the negative effect of experiencing financial shocks on mental well-being. The findings suggest that investing in acquiring or sustaining financial literacy may have the potential to protect against depression and thus promote positive mental health in adults by assuring better financial well-being. However, the observed negative psychological effect of higher financial literacy suggests that the role of financial literacy on mental health is complex.

Future research is needed to further understandings of the causal impact of enhancing financial literacy on mental well-being and of its complex and multifaced underly mechanisms.

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Declaration

I declare that the work in this PhD thesis was carried out in accordance with the requirements of the University of Birmingham. The thesis has not been submitted for any other academic award. The work presented in this thesis is my own work except where indicated by specific reference in the text.

SIGNED: .....Naijie Guan.....DATE: .....05/11/2022.....

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Chapter I: Introduction

The importance of financial literacy and its positive consequences have been increasingly highlighted with research indicating that financial literacy may be one of the contributors to the achievement of life-long financial and mental well-being. This PhD thesis aims to contribute to a better understanding of the interplay between financial literacy, financial well-being, and mental well-being in adults. This introductory chapter provides the rationale for this PhD thesis project, followed by the research objectives, structure, and format of the thesis.

1.1. Overview

The financial environment is evolving rapidly, and this change is characterised by more complex financial products and services, the rapid growth of financial technology (FinTech), and a higher level of financial market volatility. Individuals and households are involved in a variety of important financial decisions every day, including but not limited to financial markets. This more complex and riskier financial environment still provides a variety of useful financial tools for people who are financially literate and capable of using these tools to maximise their benefits over their life span (Lusardi and Mitchell, 2014; Lusardi, 2019). However, effectively managing financial resources over one's life cycle seems to be a challenge for many people, especially for those with low or no financial literacy (Klapper et al., 2015). The numerous financial products and services available impose challenges for individuals who lack the fundamental financial literacy to make sound judgement and financial choices, as well as to manage their financial resources properly. Additionally, people who lack financial literacy can also face an increased risk of being susceptible to financial scams and fraud, which is a risk factor for experiencing poorer mental health and even mental disorders (Lusardi, 2012; Sarriá et al., 2019). The least wealthy people are not the only part of the population who may face financial problems. Wealthier individuals who lack the basic financial knowledge and skills to a proper financial management might also experience financial stress and difficulties in achieving their financial goals.

Financial literacy is "the ability to use knowledge and skills to manage financial resources effectively for a lifetime of financial well-being" (the President's Advisory Council on Financial Literacy [PACFL], 2008, p.2). It plays an important role in arming people with the ability that is required, not only to manage one's daily finances, but also to be active, shrewd and resilient participants in the financial environment. Financial literacy can guide individuals' financial decisions and can help to optimise financial benefits for households in the evolving

financial environment. For instance, it has been found that financial literacy is associated with enhanced households' financial decisions and behaviours on savings, consumption, investment, debts, and many other financial outcomes (see Chapter II for more detail). In addition, financial literacy is believed to contribute to the stability of financial conditions, especially during vulnerable periods when the risk of financial shocks increases. This is because being financially literate has been associated with a lower risk of experiencing financial shocks and a better ability to cope with various economic shocks (Asia-Pacific Economic Cooperation [APEC], 2014). This will, in turn, help people to build secure and sustainable financial conditions for themselves and will ensure their financial well-being, contributing to positive mental health.

Like education, financial literacy is part of individuals' human capital. Many studies have found education to be a significant determinant of mental health (WHO, 2014; Silva et al., 2016). Financial literacy, therefore, may also have the potential to break the vicious cycle of financial stress and poor mental health, and could enhance people's well-being in a sustainable way (OECD/GFLEC, 2018). While most researchers mainly concentrate on the economic importance of financial literacy, the health and mental health effects of financial literacy have been largely overlooked and are yet to be fully understood. Moreover, most of the existing evidence on the relationship between financial literacy and mental health outcomes has been cross-sectional, and based only on the high-income setting. This PhD thesis is motivated by the desire to address these gaps and to further the knowledge of the psychological impacts of financial literacy by exploring the relationship between financial literacy and depression in a middle-income (i.e., China) and a high-income setting (i.e., the U.S.). In addition to the important role of financial literacy in enhancing financial well-being, the spillover effect of financial literacy on other aspects of a person's life, particularly mental well-being, should also have been highlighted. An improved understanding of the relationship between financial literacy and mental health will have implications for interventions aimed at reducing both

financial stress and mental health problems, for the design and the assessment of financial education programmes, and for the cooperation and a better resource allocation between the health and financial sectors.

1.2. Research objectives and structure

This PhD thesis aims to explore the relationship between financial literacy and mental health and the associated economic pathways by which financial literacy may affect mental health by addressing six major research objectives as outlined below.

Objective (1) To review the existing evidence of the correlates of financial literacy

Objective (2) To systematically review the existing evidence of the relationship between finances and depression

The two literature reviews presented in Chapters II and III address the first two objectives. A systematic review focusing specifically on the association between financial literacy and mental health is not conducted due to the small number of existing studies. Thus, two stand-alone literature review chapters are incorporated to provide a theoretical foundation for the empirical research that follows.

Specifically, Chapter II reviews the evidence on the association between financial literacy and various financial outcomes, as well as mental well-being. Chapter II summarises that being financially literate is associated with making better financial decisions, more financially shrewd behaviours, better financial outcomes, such as income and wealth accumulation, and the achievement of more ultimate goals, such as financial well-being and mental well-being. Although establishing a robust causal relationship between financial literacy and its outcomes is challenging, there are findings from both the instrumental variable analysis and the experimental methods, suggesting that financial literacy can influence financial outcomes.

Chapter III systematically reviews the existing evidence (40 studies in total) on the association between various indicators of financial stress and depression, and discusses the potential mechanisms underlying the association between them. The review finds that financial stress is a key predictor of depressive symptoms, and the findings hold in both high-income settings and low-and middle-income settings.

The findings from the two literature reviews suggest a link between financial literacy and depression. Given this, the three empirical chapters (Chapters IV, V, and VI) are conducted to explore the relationship between the two concepts and its underlying mechanisms. These chapters aim to address the objectives from (3) to (6) listed in section 1.2.1.

1.2.1. Empirical evidence from China

Objective (3) To investigate the relationship between financial literacy and depressive symptoms in China

The existing evidence of the link between financial literacy and mental health has mainly focused on high-income settings, however the association has not been investigated in any low- and middle-income settings. Mental health problems have been a substantial challenge for public health, especially in low- and middle-income countries. It is estimated that more than 80 percent of people suffering from mental disorders are living in low- and middle-income countries (Rathod et al., 2017). Depression alone is the leading cause of disease burden in low- and middle-income countries. Meanwhile, compared to high-income countries, mental health resources are scarcer and investment in mental health is lower in many low- and middle-income countries (Patel, 2007). Many people in low- and middle-income countries suffering from mental disorders do not receive appropriate care and the costs of care are high (Patel, 2007). This background highlights both the value and the need for a social approach to the promotion of mental health. Understanding the effect of financial literacy on financial and

mental well-being will have important implications for the enhancement of mental health in low- and middle-income countries.

The work presented in Chapter IV addresses the third research objective and examines the relationship between financial literacy (covering financial knowledge, financial attitudes, and financial behaviours) and depression in Chinese adults using data taken from the China Family Panel Studies (CFPS) (refer to Chapter IV). To the best of my knowledge, this study is the first to link different dimensions of financial literacy to mental health in a middle-income setting, other than the U.S. and Japan, this being China. One of the strengths of this innovative empirical research is that it uses a comprehensive and reliable measurement of financial literacy, which includes financial knowledge, financial attitudes, and financial behaviours. For the first time, this study links financial knowledge, financial attitudes, and financial behaviours to mental health.

1.2.2. Empirical evidence from the U.S.

The longitudinal relationship between financial literacy and depressive symptoms in U.S. adults was then examined in Chapters V and VI.

Objective (4) To investigate the relationship between financial literacy and depressive symptoms in the U.S.

Objective (5) To investigate the mechanisms underlying the relationship between financial literacy and depressive symptoms

Evidence on the link between financial literacy and mental health outcomes is mostly cross-sectional; a longitudinal investigation of the association between financial literacy and depression is yet to be conducted. As such, it is still unclear as to whether there is a causal relationship between financial literacy and depression, and whether this association holds over time. In addition to this, little is known about the mechanisms underlying the effect of financial

literacy on mental health. Looking into the longitudinal relationship between financial literacy and mental health, and the pathways through which financial literacy is linked to mental health will be crucial for providing more solid and reliable evidence for policymakers. To fill this gap, the fourth and fifth research objectives are proposed as listed above.

Chapter V addresses the fourth and fifth research objectives of this PhD thesis by investigating the longitudinal relationship between financial literacy and depression, and the economic pathways through which this relationship operates. To realise this, fixed effects and correlated random effects regression models as well as cross-lagged mediation panel models are applied to a rich longitudinal dataset (see section 5.3 in Chapter V for more detail) based on a nationally representative sample of U.S. adults aged 50 and over. This study documents both a direct relationship between financial literacy and depressive symptoms and an indirect relationship between the two which is operated through household income and wealth. Chapter V provides a novel contribution towards our understanding of the relationship between financial literacy and depression from an economic perspective.

Objective (6) To investigate the role of financial literacy in protecting people against depression due to major financial shocks

Experiencing negative financial shocks (e.g., a job loss) can place people at a higher risk of experiencing poorer mental health or mental problems. Financial literacy is a skill which enables individuals and households to cope with financial shocks (Van Rooij et al., 2012; Kurowski, 2021). It has been connected with greater financial resilience and a lower likelihood of reporting financial fragility during financial shocks (Lusardi et al., 2021). As such, financial literacy may have the potential to reshape the effect of financial shocks on mental health. The extent to which financial literacy levels influence mental health when individuals are faced with financial shocks is yet to be fully understood. Motivated by this, the sixth research objective, as stated above, is proposed.

The research presented in Chapter VI addresses the sixth objective and provides the first evidence of the moderating effect of financial literacy on the association between financial shocks and depression. The findings of this study highlight the potentially harmful effect of being more financially literate on mental health when people experience financial shocks. This study has important implications for designing and implementing effective strategies and financial education programmes aimed at promoting financial and mental well-being.

China and the U.S., which have very different cultural and economic backgrounds, are chosen as case studies due to the following considerations. The first empirical study is based on China, a middle-income country with the largest population in the world. Over 50 million people in China are estimated to have depressive disorders and around 70 million are suffering from anxiety disorders (Huang et al., 2019; Lu et al., 2021). China provides the ideal setting for studying the association between financial literacy and mental ill-health, as it is characterised by high-level and growing mental health problems, the increasing costs of mental disorders, unevenly distributed mental health services, and unmet needs for treatment targeting mental disorders (Charlson et al., 2016; Que et al., 2019). Meanwhile, Chinese adults have been reported to have lower levels of financial literacy, as compared to those in high-income countries (Wang et al., 2021).

The second and third empirical studies are based on the U.S.. Public budgets are limited in many countries including the U.S., due, on one hand, to increasing life expectancies and the baby boomer's transition to retirement, and the decreasing labour force due to decreasing fertility levels on the other. To balance public budgets, the U.S. have implemented the public pension reform that saw a transition from a defined benefit pension scheme to private defined contribution plans (Ali and Frank, 2019). By participating in a private defined contribution scheme, individuals from the U.S. are taking more responsibility for their financial decisions and financial risks (Ali and Frank, 2019; Lusardi, 2019). Additionally, a rapid development in

the financial environment has been observed, with the introduction of complex products that are available to almost everyone in the U.S. This imposes more challenges for many individuals and households from the U.S. who do not understand and are not capable of judging the quality of financial products and who struggle to make appropriate financial decisions. However, the average financial literacy of U.S. adults is not high enough, given that the U.S. is one of the wealthiest countries in the world. It is estimated that financial literacy levels among adults in the U.S. are lower than a number of other high-income countries, including Norway, Denmark, Sweden, Israel, Canada, the United Kingdom, the Netherlands, Germany, Australia, Finland, New Zealand, Singapore, and Czech Republic, in spite of the fact that the gross domestic product (GDP) in the U.S. is the top ranked globally (Faulkner, 2022). These challenges faced by individuals in the U.S. make the topic of financial literacy even more critical in this country.

Another reason for choosing to study populations from the U.S. and China is the availability of data. Both China and the U.S. hold useful panel data on financial literacy, household finances, mental health, as well as many other areas, such as demographic, social, and economic characteristics, and health. This range of data can be used to investigate the research questions in this PhD thesis.

1.3. Format

The remainder of this thesis comprises two literature reviews, three empirical chapters and a discussion chapter. The three empirical chapters and the systematic review chapter appear in the style of journal articles with some minor adjustments to fit the overall PhD thesis. Separate sections for introduction, data, methods, results, discussion, and conclusion, as well as tables and figures are included in each empirical chapter (Chapters IV, V and VI) and the systematic review chapter (Chapter III).

Chapter III was published in PLOS One in February 2022. The citation of the paper reads: Guan, N., Guariglia, A., Moore, P., Xu, F., and Al-Janabi, H. (2022). Financial stress and depression in adults: A systematic review. PloS One, 17(2), e0264041. https://doi.org/10.1371/journal.pone.0264041. The work presented in Chapter III displays the published article with an additional paragraph discussing the "social comparison mechanism" of the financial stress and depression relationship being added to the discussion section (see Chapter III for section 3.4.2). I am the lead author, who conducted the study design, the literature review, writing and all re-writing following the feedback from supervisors and reviewers. Fangzhou Xu is the second-reviewer, who assisted with screening papers for the systematic review. Other authors, Hareth Al-Janabi, Alessandra Guariglia, and Patrick Moore are my supervisors, who provided guidance, helped with the conceptualisation and interpretation of the articles, and reviewed and commented on the manuscript.

Chapter IV was submitted to Social Science and Medicine in July 2022. The work presented in Chapter IV differs slightly from the submitted manuscript in relation to the robustness check section. Some analyses (including the linear regression and factor analysis) are not reported in the submitted manuscript, due to the word limit given by the target journal. Certain parts of the robustness check (e.g., the instrumental variable analysis) presented in the submitted manuscript are included in the supplementary materials along with Chapter IV.

Chapter V will be submitted to Social Science and Medicine soon. The work presented in this chapter is an extended version of the manuscript, incorporating all the important details in the main body of the text (i.e., the description of the method, results, and discussion sections). Some of these details were demonstrated in the appendices for the submission due to the word limit of the target journal. Compared to the manuscript, the additional analysis on the heterogeneity of the relationship between financial literacy and depression and its relevant results and discussion are further included in Chapter V. This aims to make the analyses from

Chapter V (i.e., the U.S.-based evidence) comparable to and consistent with those from Chapter IV (i.e., the China-based evidence).

1.4. Structure

From here on, the thesis moves on to Chapter II, "Financial literacy and its consequences," Chapter III, "Financial stress and depression in adults: A systematic review," Chapter IV, "Financial literacy and mental health: Micro-econometric evidence from China," Chapter V, “Financial literacy and depressive symptoms: Longitudinal Evidence from the U.S.,” and Chapter VI, “Financial shocks, depression, and the moderating role of financial literacy.” Finally, there is a discussion chapter to conclude the findings of this PhD thesis.

Chapter II: Financial Literacy and its Consequences

Chapter II aims to address the first research objective by reviewing the existing evidence on the association between financial literacy and various financial outcomes, as well as mental well-being. This chapter acts as the precursor to the empirical studies by conceptualising financial literacy and through a review of the existing literature on the relationships between financial literacy and financial as well as mental health outcomes. This chapter is structured as follows. Section 2.1 introduces the background knowledge related to financial literacy. The definition and methods for measuring financial literacy, as well as the distribution of financial literacy across populations, are provided in sections 2.2, 2.3 and 2.4, respectively. These are followed by a literature review in sections 2.5 and 2.6 about the relationships between financial literacy and financial outcomes and mental health outcomes. Section 2.7 identifies the research gaps within the existing literature.

2.1. Introduction

Financial literacy refers to the knowledge of basic economics and financial concepts and the ability to use this knowledge and other financial skills to manage financial resources effectively in order to achieve lifelong financial well-being (PACFL, 2008). It has been widely recognised that financial literacy is crucial to financial well-being for individuals, households, and for the steady growth of the economy as a whole in a country or state. Traditional microeconomic models on saving and consumption hold that consumers utilise and allocate all of their financial resources intertemporally to smooth marginal utility over their entire life cycle (Friedman, 1957; Lusardi and Mitchell, 2014). These microeconomic models on saving and consumption assume that consumers are rational, well-informed, are able to manage financial resources and make value-maximising financial decisions (Hastings et al., 2013). However, effectively managing financial resources over one's life cycle can be a challenge for many individuals who have no or low levels of financial literacy (Klapper et al., 2015).

In recent decades, the financial environment has begun to evolve more quickly, and this is characterised by the increasing complexity of financial products and services, the rapid growth of financial technology, and the increasing volatility of financial markets (Philippas and Avdoulas, 2020). Such a financial environment provides numerous useful tools and access to financial services which enable people to maximise their financial benefits. However, it can also become a significant issue for people who have no or low levels of financial literacy. A variety of financial products (involving mortgages, financial debts, retirement savings, insurances, stocks, and bonds) are offered to households (Lusardi and Mitchell, 2014; Lusardi, 2019). This wide range of complex financial products imposes difficulties for people who do not have the basic financial knowledge and skills required to make financial decisions and, thus, to effectively manage their financial resources. In addition, with the globalised financial landscape and the development of the internet, people have easier and wider access to financial

products and services and economic information can be obtained from various sources more easily. In such circumstances, individuals with no or low financial literacy are less able to process the significant quantity of economic information, and thus to make informed financial decisions and to exhibit optimal financial behaviours (Lusardi and Mitchell, 2014). Individuals with low or no financial literacy can also face an increased risk of financial fraud, which can lead to financial losses, financial concerns and stress or other psychological problems (Lusardi, 2012; Sarriá et al., 2019).

Financial literacy is increasingly becoming an essential skill for daily financial management. It can help to guide the financial decisions and behaviours which play an important role in the achievement of financial well-being for individuals and households in this rapidly evolving financial environment. Both theoretical and empirical evidence has suggested that financial literacy can enhance households' financial decisions and behaviours in relation to savings (Lusardi and Mitchell, 2007a; 2007b; 2008; 2014), consumption (Jappelli and Padula, 2013a), investment (Van Rooij et al., 2011), debts (Lusardi and Tufano, 2015), income and wealth accumulation and, thus, financial well-being (Van Rooij et al., 2012; Taft, 2013). In addition, financial literacy can help individuals and households to maintain the stability of their financial situation during an economic recession, since financial literacy is related to an improved ability to cope with various financial shocks due to unforeseen events (APEC, 2014). With regards to these elements, having financial literacy is crucial for smoothing the accumulation and decumulation of financial resources in order to achieve lifelong financial well-being.

Havingrealised the importance of financial literacy to the well-being of households and the economy as a whole, more and more countries are designing and implementing nationwide measures to improve the financial literacy levels of their populations as this is regarded as one of the key policy tools for economic development (OECD/INFE, 2015; 2018). Various

financial education programs have been launched in many high-income countries aiming to improve people's financial literacy and, thus, financial capability. For example, in the United States (U.S.), the President's Advisory Council on Financial Capability was established and signed off by President Barack Obama on January 29, 2010. It was created to assist U.S. people in understanding financial matters and making informed financial decisions. In 2001, the Government of Canada established the Financial Consumer Agency of Canada (FCAC) with the aim of empowering consumers of financial services. While these financial programs have made progress in enhancing the financial literacy of these populations, financial literacy levels remain not high in many other parts of the world. Additionally, financial literacy has substantial heterogeneity across sub-populations. Financial literacy is found to be lower among certain subgroups such as women, young adults and older adults, lower-income households, minority groups (specifically in the U.S.), and those with lower educational levels (Lusardi and Mitchell, 2011c; Klapper et al., 2015). Therefore, improving the financial literacy of households remains a global challenge. A clearer understanding of the causes and consequences of financial literacy and financial education will inform the design and targeting methods of financial education programmes. It will also highlight the importance of financial literacy being realised across different disciplines. This chapter provides a review of the existing empirical evidence related to financial literacy, its effects on financial outcomes and, more broadly, upon mental health outcomes.

2.2. What is financial literacy?

The definitions of financial literacy vary across different studies. Table 2-1 presents several examples of financial literacy definitions that are used in the existing literature (ordered chronologically). According to Table 2-1, the most basic component of financial literacy is the knowledge of financial concepts. Some studies (e.g., Hilgert et al., 2003) define financial literacy merely as financial knowledge. In addition to financial knowledge, other aspects, for

example, the ability to apply financial knowledge, confidence in financial management, financial experience or financial behaviours, and financial attitude are also included in the definition of financial literacy in the existing literature (e.g., Huston, 2010; PACFL, 2008). A widely used definition of financial literacy is provided by the President Advisory Council on Financial Literacy (PACFL) (Jump$tart, 2007; PACFL, 2008). The PACFL defines financial literacy as: "the ability to use knowledge and skills to manage financial resources effectively for a lifetime of financial well-being" (PACFL, 2008, p.35). PACFL's definition of financial literacy emphasises two key dimensions: financial knowledge and financial capability. One of the broadest definitions has been provided by the OECD International Network on Financial Education (OECD/INFE), this being: "financial literacy consists of five dimensions: awareness, knowledge, skill, attitude and behaviour that are necessary to make sound financial decisions and ultimately to achieve individual financial well-being" (OECD/INFE, 2011, p.3).

Table 2-1 Financial literacy - Definitions

Source	Definition
Vitt et al. 2000	"The ability to read, analyse, manage and communicate about the personal financial conditions that affect material well- being" (Vitt et al. 2000, p.12).
Hilgert et al., 2003	Financial knowledge (Hilgert et al., 2003, p.311)
Moore, 2003	"Individuals are considered financially literate if they are competent and can demonstrate they have used the knowledge they have learned. Financial literacy cannot be measured directly so proxies must be used. Literacy is obtained through practical experience and active integration of knowledge. As people become more literate, they become increasingly more financially sophisticated, and it is conjectured that this may also mean that an individual may be more competent" (Moore, 2003, p.29).
Mandell, 2008	"The ability to evaluate the new and complex financial instruments and make informed judgments in both the choice of instruments and extent of use that would be in their own best long-run interests" (Mandell, 2008, p.163).
ANZ Bank, 2008	"The ability to make informed judgements and to take effective decisions regarding the use and management of money" (ANZ Bank, 2008, p.1).
Lusardi, 2008	"Knowledge of basic financial concepts, such as the working of interest compounding, the difference between nominal and real values, and the basics of risk diversification" (Lusardi, 2008, p.2).
PACFL, 2008	"The ability to use knowledge and skills to manage financial resources effectively for a lifetime of financial well-being" (PACFL, 2008, p.35).
Hung et al., 2009	Financial Literacy: knowledge of basic economic and financial concepts, as well as the ability to use that knowledge and other financial skills to manage financial resources effectively for a lifetime of financial well-being. (Hung et al., 2009, p.12).
OECD/INFE, 2011; 2018	"A combination of awareness, knowledge, skill, attitude, and behaviour necessary to make sound financial decisions and ultimately achieve individual financial well-being" (OECD/INFE, 2011, p.3).
Lusardi, 2015	"The ability to process economic information and make informed decisions about financial planning, wealth accumulation, debt, and pensions" (Lusardi, 2015, p.260).

2.3. How is financial literacy measured?

Measurements of financial literacy are developed according to the definitions of financial literacy. Similar to the definitions, the methods for measuring financial literacy also vary substantially across studies. Hung et al. (2009) provide a relatively comprehensive review of the definitions and measurement methods of financial literacy based on previous studies. According to Hung et al. (2009), there are two main methods used for measuring financial literacy amongst the existing empirical evidence: test-based measures and self-assessed measures. The test-based method measures the financial literacy level through several test questions that are related to basic financial concepts, for example, interest rates, inflation, and risk diversification (Lusardi and Mitchell, 2006; 2008). The financial literacy level can be indexed by a respondent's performance in the test. The following two paragraphs show several examples of test-based methods.

The "Big Three" questions devised by Lusardi and Mitchell (2006; 2008) are the most widely used measurement of financial literacy in international studies. They were first introduced in the 2004 wave of the Health and Retirement Study (HRS). The "Big Three" uses a test-based method and contains three questions. These three questions cover three main aspects of financial literacy, which are numeracy (or the ability to do simple calculations of interest rates), understanding inflation, and understanding risk diversification. They take the following form:

1) *Suppose you had $100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow: more than $102, exactly $102, less than $102?*
2) *Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, would you be able to buy more than, exactly the same as, or less than today with the money in this account?*
3) *The following statement is true or false? "Buying a single company stock usually provides a safer return than a stock mutual fund."*

(Lusardi and Mitchell, 2009, p. 5)

The "Big Three" financial literacy questions have been widely applied in many national and international studies conducted in the U.S., such as in the Health and Retirement Study (HRS), the National Longitudinal Survey of Youth (NLSY), and in the National Financial Capability Study (NFCS) (Lusardi and Mitchell, 2013). They have also been used to measure financial literacy levels in both high-income settings and low- and middle-income settings in countries such as Germany, the Netherlands, Japan, Sweden, Austria, Romania, Mexico, Chile, India, and Indonesia (Almenberg, 2011; Allianz, 2017; Lusardi, 2019). Answers provided to the "Big Three" questions are shown to be effective for differentiating between the financial literacy levels of the general population in empirical research (Lusardi and Mitchell, 2014).

Different types of test-based measurements of financial literacy are also applied in empirical studies. Some of them are broader in terms of their components and are, thus, able to capture more aspects of financial literacy compared to the "Big Three" financial literacy questions. Many of them are closely related to the "Big Three" and contain similar questions. For example, Lusardi and Mitchell (2013) expand the "Big Three" financial literacy questions by including two further aspects: asset pricing and an understanding of debt payments. This extended version of the "Big Three", known as the "Big Five", has been applied in the 2008 wave of the HRS and the 2009 wave of the NFCS. The 2014 wave of the Standard and Poor's

Ratings Services Global Financial Literacy Survey (S&P Global FinLit Survey) also used the "Big Five" financial literacy questions to measure financial literacy. The survey contains five questions, covering four aspects of financial literacy including risk diversification, inflation, numeracy, and compound interest. In addition to the above three financial literacy questions, it also includes the following two questions:

> 4) *If interest rates rise, what will typically happen to bond prices?*
> 5) *The following statement is true or false? "A 15-year mortgage typically requires higher monthly payments than a 30-year mortgage, but the total interest paid over the life of the loan will be less."*
>
> *(Hastings et al., 2013, p.353)*

The self-reported method of measuring financial literacy focuses on capturing one's perception of, or the confidence in, one's financial literacy level (Hung et al., 2009). This usually takes the form of asking survey respondents to self-assess their financial literacy levels. For example, the Japanese Study of Aging and Retirement (JSAR) assesses perceived financial literacy by asking: "How would you score your own knowledge of economics?". The response to this question is scaled from one (lowest) to seven (highest). In the China Family Panel Studies (CFPS), the corresponding question is: "What do you think of your level of financial knowledge". Notably, individuals cannot always accurately assess their own financial literacy levels and tend to be either overconfident or pessimistic about their financial literacy levels (Lusardi, 2019). Self-assessed financial literacy is positively related to actual financial literacy. However, the correlation between the two varies from weak to strong, and people with lower financial literacy levels are less able to accurately perceive their financial literacy levels (Agnew and Szykman, 2005). Therefore, caution must be taken when applying a self-reported measure to proxy the actual financial literacy level.

2.4. Financial literacy around the world

According to the estimates by Xu and Zia (2012) and Klapper et al. (2015), global financial literacy levels are low in high-income countries, and even lower in middle- and low-income countries. The S&P Global FinLit Survey conducted an international survey of financial literacy levels based on 150,000 adults from 148 countries, where financial literacy was measured by five financial literacy questions related to risk diversification, inflation, numeracy, and compound interest (Klapper et al., 2015). According to this survey, only one-third of adults around the world could answer 75% or more of the financial literacy questions correctly in 2014 (Klapper et al., 2015). In fact, having a high level of financial literacy is also a rarity among people from high-income countries with well-developed financial markets. For example, in the U.S., according to data from the 2004 HRS survey, only 34.3% of respondents answered all of the "Big Three" financial literacy questions correctly (Lusardi and Mitchell, 2014). More recently, Sekita (2011) analysed the financial literacy levels of 5,268 respondents using the Survey of Living Preferences and Satisfaction. Sekita (2011) found that, in Japan, respondents who answered all three financial questions correctly accounted for only 27% of the total sample.

Moreover, there is heterogeneity in financial literacy levels across different countries. The rates of correctly answering all three financial literacy questions vary substantially between countries (Xu and Zia, 2012; Klapper *et al*., 2015; Stolper and Walter, 2017; G20/OECD, 2017). The average financial literacy levels of higher-income countries are higher than those of lower-income countries. Certain studies have provided a direct cross-country comparison of the financial literacy levels of households. For example, using data from the 2014 wave of the S&P Global FinLit Survey, Klapper et al. (2015) reported that financial literacy rates varied substantially across countries ranging from 13% to 71% (in 2014). Financial literacy rates in high-income countries were the highest (65% and above) while financial literacy rates in low- or middle-income countries were much lower. Less than 30% of respondents in the survey were

financially literate across middle- or low-income countries. Such a trend of financial literacy levels across countries was confirmed by another international survey conducted by the OECD. According to the OECD (G20/OECD, 2017), the proportions of people who correctly answer at least five out of seven financial knowledge questions in the most developed countries were higher than those in middle- or low- income countries (see Figure 2.1).

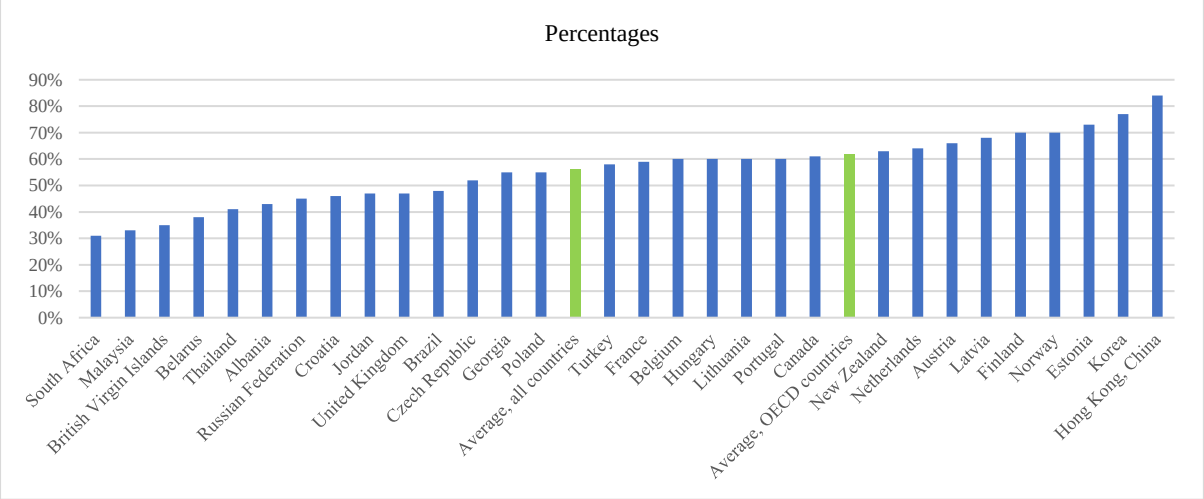

Figure 2-1 Financial literacy rates

Notes: The figure above reports the percentages of financially literate people (i.e., who correctly answer at least five out of seven on the knowledge questions) by country. "Average, all countries" and "Average, OECD countries" are indicated by green bars. Data Source: OECD/INFE International Survey of Adult Financial Literacy (G20/OECD, 2017).

Financial literacy levels also vary according to individual characteristics such as age, gender, education level and other factors. For instance, in terms of age, evidence shows that the distribution of financial literacy by age follows an inverted U-shaped trend. Specifically, younger adults have less financial experience than middle-aged adults and the financial literacy level is lowest among young people (Lusardi and Mitchell, 2011c). The ability to apply financial knowledge increases with age up to a certain point and reaches its highest level during the period of middle-age (Lusardi and Mitchell, 2011c). However, financial literacy has been

reported to decrease with age among people aged 65 or older, as older adults may face a decline in cognition which is related to decreased financial literacy (Finke et al., 2017).

There is a gender difference in financial literacy levels. Generally, men have been reported to have higher financial literacy levels than women which holds in different age groups and in various countries (Lusardi and Mitchell 2011c; Klapper et al., 2015). For example, financial literacy levels are reported to be lower in older women (or younger women) as compared to older men (or younger men) (Lusardi and Mitchell, 2008). The gender inequality in financial literacy levels has been observed in both high-income countries such as Canada, Italy, Japan, and the United Kingdom (Hasler and Lusardi, 2017) and in low- and middle-income countries such as China, Turkey, Colombia, and India (Hasler and Lusardi, 2017; Karakurum-Ozdemir et al., 2018; Financial Consumer Protection Bureau of People's Bank of China, 2019; 2021).

Other factors such as the education level, race, marital status, and income have also been connected with financial literacy levels. For instance, individuals whose educational levels are college education and above are more likely to have a higher level of financial literacy, which has been consistently observed in different countries (Lusardi and Mitchell, 2011c; Klapper et al., 2015; Karakurum-Ozdemir et al., 2018). Regarding the financial literacy distribution across ethnicity, particularly in the U.S., it has been reported that white Americans perform better in financial literacy assessment than African Americans and Hispanics (Lusardi and Mitchell, 20011c). In terms of the variation in levels of financial literacy according to income levels, it is estimated that, compared to poorer countries, the proportions of financially literate people tend to be higher in richer countries where GDP per capita is higher (Klapper et al., 2015). In addition to this, evidence based on different countries consistently shows that the proportion of people who answer financial literacy questions correctly is higher among those with higher income levels (Lusardi and Tufano, 2015; Karakurum-Ozdemir et al., 2018; Financial Consumer Protection Bureau of People's Bank of China, 2019). A more in-depth discussion on

the demographic distribution of financial literacy levels can be found in the existing literature (e.g., Klapper et al., 2015; Karakurum-Ozdemir et al., 2018).

2.5. Financial literacy and economic outcomes

Financial literacy can affect financial decision-making and behaviours and can, thereby, induce a long-run influence on household finances in a number of ways. A significant amount of empirical evidence has been uncovered on the effects of financial literacy, or financial knowledge, on various financial outcomes. Other research studies also link financial literacy to the achievement of other ultimate goals, such as financial well-being and mental well-being.

2.5.1. Financial literacy and savings

It is believed that the level of financial literacy is associated with people's intention to save. Empirical studies have consistently shown a positive relationship between being financially literate and retirement savings or precautionary savings. For example, in the U.S., Lusardi and Mitchell (2007a; 2007b; 2011b) found that financial literacy was a strong predictor of retirement planning among adults. In particular, the financial literacy question related to the ability to calculate the compound interest rates was the most significant predictor of retirement planning. The relationship between financial literacy and retirement savings still exists, even after controlling for demographic and socioeconomic factors such as gender, race, education, marital status, income, number of children, and retirement status. Additionally, financially literate people perform better in investments related to planning and saving for retirement as compared to those with low or no financial literacy (Lusardi and Mitchell, 2007a; 2007b; 2011b). A similar relationship between financial literacy and financial behaviours was also found among young adults. For example, de Bassa Scheresberg (2013) found that young adults in the U.S. (aged between 25 to 34) with higher levels of financial literacy were more likely to have savings. Both self-assessed financial literacy and self-reported numerical ability were

positively associated with holding either precautionary savings or retirement savings (de Bassa Scheresberg, 2013). The relationship between financial literacy and savings is also examined in many other countries. The strong relationship between financial literacy and retirement planning among adults was also reported in a number of other countries such as the Netherlands (Alessie et al., 2011), Switzerland (Brown et al., 2013), Germany (Bucher-Keonen et al., 2011), Russia (Klapper et al., 2015), and Japan (Sekita, 2011).

2.5.2. Financial literacy and investment

Some empirical studies focus on the relationship between financial literacy or financial knowledge and investment behaviours or investment outcomes. A number of studies have related financial literacy to financial market participantion and found that individuals with a higher level of financial literacy were more likely to invest in the financial market (e.g., Yoong, 2010; Van Rooij et al., 2011; Bucher-Koenen et al., 2021). For example, Van Rooij et al. (2011) and Bucher-Koenen et al. (2021) examined the relationship between both test-based and self-assessed financial literacy and stockholding amongst Dutch adults. They found that respondents with higher financial literacy test scores, or those who were more confident about their financial literacy, were more likely to take part in the stock market. In the U.S., Yoong (2010) found financial literacy scores were positively associated with stock market participation. This finding was robust among households of different socioeconomic statuses. The evidence of the positive relationship between financial literacy and financial market participation is consistent across countries. Similar findings have also been observed in France (Arrondel et al., 2012) and in Sweden (Almenberg and Dreber, 2011).

Moreover, prior research also reveals that more financially literate individuals can perform better in financial markets and are, thus, more likely to gain higher investment returns compared to those with a lower level of financial literacy (e.g., Clark et al., 2014; Bianchi, 2018). For example, a panel study in France reported by Bianchi (2018) found that investors

with higher financial literacy levels were better able to make more optimal choices and could outperform those with lower financial literacy levels. They received around 0.4% higher annual returns when the portfolio risk and other confounders were adjusted. In line with this, evidence from other countries also suggests that, compared with investors with low levels of financial literacy, more financially sophisticated adults can perform better in terms of their investments (e.g., higher returns) and their investment decisions are less likely to be influenced by the way in which information is framed in financial markets (Hastings and Tejeda-Ashton, 2008; Clark et al., 2014; Deuflhard et al., 2019). As a proxy for financial literacy, financial education was found to be closely related to stock market participation and the undertaking of more optimal financial decisions in the financial market (Kimball and Shumway, 2010).

2.5.3. Financial literacy and borrowing

Financial literacy has been linked to borrowing behaviours or outcomes in prior studies. Evidence shows that individuals with higher financial literacy levels display better behaviours in relation to debt management, such as being less likely to take on high-cost debts (e.g., Moore, 2003; Lusardi and de Bassa Scheresberg, 2013), or being less likely to report being over-indebted and suffering from debt problems (Gathergood and Disney, 2011; Lusardi and Tufano, 2015). Specifically, it has been shown that people with a lower level of financial literacy, particularly lower debt literacy, are more likely to choose the high-cost methods of borrowing and to undertake costly debt behaviours (e.g., late payment). This may be because individuals with lower debt literacy are not familiar with debt concepts and find it difficult to comprehend and calculate the costs of taking on different types of debt (Lusardi and Tufano, 2015). Using representative data from the 2009 NFCS, Lusardi and de Bassa Scheresberg (2013) found that a lack of financial literacy can partially explain the utilisation of high-cost methods of borrowing among adults in the U.S.. These findings are robust when different measurements of financial literacy are applied. Both actual financial literacy levels and self-assessed financial

literacy levels have been found to be negatively related to high-interest borrowing or costly behaviours in debt management that can incur higher fees and charges (e.g., late payment fees, only paying the minimum balance on credit cards) (Mottola, 2013; Lusardi and Tufano, 2015; Allgood and Walstad, 2016).

Moreover, financial literacy has also been found to be associated with debt loads and, with this, the occurrence of debt problems. For example, Lusardi and Tufano (2015) examined the effects of both test-based debt literacy and self-assessed debt literacy on the level of over-indebtedness in the U.S.. They found that those who scored higher in the measurement of debt literacy were less likely to report an excessive debt burden and debt difficulties. In a sample of UK households of people of working age, Gathergood and Disney (2011) found similar evidence that households with good debt literacy levels were less likely to report having excessive amounts of debt, debt arrears or debt payment difficulties. Gerardi et al. (2013) found a negative relationship between numerical ability (i.e., the ability to do mathematical calculations) and mortgage defaulting in the U.S.. French and McKillop (2016) also examined the importance of financial literacy to the financial situation of low-income households in Northern Ireland. However, different from Gerardi et al., (2013), French and McKillop (2016) highlighted that, for financially vulnerable households, it was the financial management skills, rather than numerical ability, that played a more important role in relation to debt behaviours and debt outcomes.

2.5.4. Financial literacy and consumption

Financial literacy/knowledge has been linked to consumption behaviours in only a few studies (Jappelli and Padula, 2013a; Dinkova and Alessie, 2016), though the findings obtained from this research are inconclusive. Using the empirical data from the Italian Survey of Household Income and Wealth (SHIW), Jappelli and Padula (2013a) found that financial literacy was positively associated with the growth rate of consumption, which was in line with the prediction

of their model. Contrary to the study by Jappelli and Padula (2013a), no supportive evidence of the positive relationship between financial literacy and the consumption growth rate was obtained in Dinkova and Alessie (2016)'s study. Using data from the Longitudinal Internet Studies for the Social Sciences (LISS) in the Netherlands, Dinkova and Alessie (2016) found that financial literacy was positively associated with consumption only among husbands in Dutch households. However, controlling for the financial literacy level of the husbands, female partners in the same households with higher levels of financial literacy tended to consume less.

2.5.5. Financial literacy and household finances

Another stream of studies examines the relationship between financial literacy and household finances, with a particular focus on the relationship between financial literacy and income or wealth accumulation (Behrman et al., 2010; van Rooij et al., 2012; Sekita, 2013). Empirical evidence shows that financial literacy, or its related concept (e.g., financial numeracy), is strongly associated with income, which has been observed in several countries such as the UK, the U.S., China, and Thailand. (Jenkins et al., 2011; van Rooij et al., 2012; Twumasi et al., 2022; Chinese consumer financial literacy survey 2019; Karakurum-Ozdemir et al., 2018; Janposri and Apinunmahakul, 2021). Prior empirical research reports a positive relationship between financial literacy and wealth accumulation in both high-income countries and low- and middle-income countries (Van Rooij et al., 2012; Sekita, 2013; Taft et al., 2013). To make any causal inferences of the relationship between financial literacy and income or household wealth based on the existing evidence is challenging, though some studies have attempted to investigate the causal effect of financial literacy on wealth. For instance, Behrman et al. (2010) are among the first to investigate the causal effect of financial literacy on household wealth (including pension assets, housing assets, and other assets minus debts). Using the instrumental variable (IV) approach, they found a significant effect of financial literacy on wealth accumulation. Furthermore, the effect of financial literacy on wealth accumulation was

reported to be independent of, and stronger than that of, general education (Behrman et al., 2010; 2012).

More broadly, the benefit of financial literacy to a person's overall financial situation has also been investigated in certain studies, all of which emphasised the potential benefits of improving one's financial literacy. For example, Son and Park (2018) studied the mediating role of financial literacy between financial education and a person's financial situation. They found that, as a consequence of financial education, financial literacy improved the soundness of personal finances (sound finances were defined as a set of financial ratios including the emergency fund ratio, debt ratio, savings ratio, financial investment ratio, and retirement preparedness ratio) of Korean adults in the high-income and middle-income groups (Son and Park, 2018). No effect of financial education and financial literacy on personal finances was found in low-income adults. Financial literacy has also been found to enhance financial well-being and reduce financial worries (Garman et al., 1999; Shim et al., 2009; Taft et al., 2013). For example, Shim et al. (2009) proposed a conceptual model of financial well-being, which was tested and supported by an online survey collected from a sample of young adults in the U.S.. Their results revealed a positive relationship between financial knowledge and attitudes and financial well-being, which is assessed through financial behavioural intention (e.g., the intention to spend from within a defined budget). Taft et al. (2013)'s research found supportive evidence of a positive relationship between financial literacy and financial well-being, as well as a negative relationship between financial literacy and financial concerns. The negative effect of financial literacy on financial satisfaction is also demonstrated in the research by Joo and Grable (2004).

Based on the evidence reviewed across previous sections, several underlying channels through which financial literacy can influence household finances can be identified. Financial literacy can affect people's financial situation and financial well-being through its influence on

financial decisions or behaviours (e.g., decisions on saving, spending, investment, insurance participation), in other words, the ability to manage financial resources. For instance, financial literacy can affect wealth accumulation via savings plans (Van Rooij et al., 2012). Financially literate households tend to have more effective plans for precautionary use or retirement, which positively affects wealth accumulation (Lusardi and Mitchell, 2007a; see section 2.5.1). In addition, financial literacy may affect wealth accumulation through participation in stock markets. As mentioned in Section 2.5.2, people with higher financial literacy levels are more likely to take part in the stock market. Investing in stock markets provides investors with more opportunities to earn higher expected interest returns. Furthermore, financially sophisticated investors perform better than those with low levels of financial literacy and the former are more likely to receive higher investment returns controlling for risks, which will contribute to higher income or wealth accumulation (Van Rooij et al. 2012; see section 2.5.2). Similarly, low financial literacy has been found to be associated with suboptimal debt management, such as substantial debt accumulation and higher unnecessary borrowing costs (Lusardi and Tufano, 2015; see section 2.5.3). Moreover, financially ignorant individuals are also more likely to become victims of financial fraud and scams (Lusardi, 2012). Overall, financial literacy, which can shape individuals' financial decisions and behaviours, is an important determinant of individual or household finances such as income or wealth accumulation.

2.6. Financial literacy and psychological health

While most researchers tend to focus on the economic importance of financial literacy, the health and psychological effects of financial literacy are rarely investigated. Four empirical studies, which are broadly related to this topic, are identified here. Taylor et al. (2011)'s study is among the first to examine the independent effect of financial capability on psychological health. In their study, financial capability was proxied by a series of financially related variables found within data from the British Household Panel Survey (such as self-assessed

financial control, financial situation, required borrowing and debt arrears). They found that a higher level of financial capability was associated with improved psychological well-being (measured by the General Health Questionnaire) (Taylor et al., 2011). Additionally, the magnitude of the effect of not having any financial capability on psychological well-being was stronger than that of being unemployed for men, and almost as strong as that of getting divorced for women (Taylor et al, 2021). Meanwhile, having a high level of financial capability could mitigate the negative influence of negative life events, such as unemployment and getting divorced, on psychological well-being (Taylor et al., 2011).

Bennett et al. (2012) extended previous studies by relating both health literacy and financial literacy to several health outcomes including cognition, functional status, and mental health (such as depressive symptoms and loneliness) among elderly people without major neuro-cognitive conditions. In their study, both health literacy and financial literacy were found to be significantly associated with some of the health-related outcomes, such as cognition, functional status, and mental health, controlling for demographics, socioeconomic characteristics, income and previous health condition (Bennett et al., 2012). Furthermore, the effect of financial literacy had a more significant impact on mental health while the effect of health literacy reflected to a greater degree on the physical health condition (Bennett et al., 2012).

However, in contrast to previous studies, other researchers (e.g., Kadoya et al., 2017; 2018) also examined the effect of financial literacy on anxiety, but no direct effect of financial literacy on anxiety was found. Instead, they found only the indirect effect of financial literacy on anxiety operated through economic variables such as household income and assets. Kadoya et al. (2017; 2018) examined whether financial literacy could help to reduce older adults' anxiety levels in both the U.S. (Kadoya et al., 2018) and Japan (Kadoya and Khan, 2017). The data analysed in the U.S. was a panel (in 2010 and 2012) and the data in Japan was cross-sectional

(in 2012). No statistically significant effect of financial literacy on anxiety was found across different age groups in both studies after controlling for demographics and socioeconomic confounders such as household income, assets, and social security income. Then, to investigate the indirect relationship between the two, the following subgroup analysis was conducted. Specifically, in the U.S. study, Kadoya et al. (2018) examined the relationship between financial literacy and anxiety in the low financial literacy group and the high financial literacy group, respectively. They found that household asset accumulation was significantly and positively associated with anxiety for financial literates, but that it did not influence the anxiety of people with low financial literacy levels. Instead, social security income was more crucial to the mental health of less financially literate individuals. In the Japanese study, Kadoya and Khan (2017) found that the interaction of financial literacy with either assets or household income was significantly and negatively associated with anxiety. Both studies listed above suggest an indirect impact of financial literacy on the anxiety of older people, while a direct relationship between financial literacy and anxiety was not observed.

2.6.1. Potential mechanisms underlying the financial literacy and psychological health relationship

Financial literacy may be linked to mental health both directly and indirectly (see Chapters IV and V for more details). On the one hand, financial literacy could influence psychological well-being directly. This may be because people who are financially literate and financially capable are more confident about their future financial situation and have improved control over their financial situation (Taylor et al., 2011; Bennett et al., 2012). Similarly, a lack of financial literacy may contribute to financial concerns and psychological stress. On the other hand, financial literacy can also affect mental well-being indirectly through its influence on household finances such as income or asset accumulation (Kadoya et al, 2017; 2018). As mentioned, financially literate people possess the ability to manage their financial resources

efficiently. Thus, people with a higher level of financial literacy are more likely to have better financial outcomes such as a higher level of disposable income and, thus, a greater level of wealth accumulation (see section 2.5). In turn, people with more financial resources tend to have a better quality of life, are more able to satisfy their material aspirations and feel better off financially, compared to people in poverty (see systematic review chapter for more details).

Additionally, high financial literacy may affect people's mental well-being by reshaping the psychological effect of financial shocks that occur due to stressful life events (see Chapter VI for more details). Financial literacy is particularly important in periods of financial crisis when many people suffer from financial stress or even mental disorders brought on by the downturn of the financial environment. During a financial downturn, being financially literate may serve as a protector by mitigating the effect of financial losses on mental well-being. This may be because individuals with higher financial literacy can better evaluate and cope with unexpected financial losses (see Chapter VI). Overall, it is reasonable to believe that financial literacy may play an important role in mental well-being.

2.7. Research Gaps

Some limitations can be found in the previous studies. First, as mentioned above, only a handful of research studies have been found which investigate the psychological effects of financial literacy or financial capability. Most of these are cross-sectional studies meaning that the direction and the causality of the relationship between the two is still unclear. To the best of my knowledge, no study has provided a longitudinal investigation of the relationship between financial literacy and depression. Furthermore, the sample size is relatively small in some of the studies referred to, which may limit their representativeness. For example, in Bennett et al. (2012)'s study, there were only 550 respondents without clinically diagnosed dementia. Therefore, empirical research on the topic using large nationally representative samples is still

lacking. Additionally, the existing evidence is based on two high-income countries, these being the U.S. and Japan, and these findings may only have implications for other high-income countries. As country-based social and cultural discrepancies may affect both financial literacy and mental health, it may not be possible to generalise the findings of the previous studies to low- and middle-income countries. Based on these points, further evidence using large and representative samples, as well as empirical evidence studies based on low- and middle-income settings, are needed. This PhD thesis aims to fill these research gaps and to further the understanding of the relationship between financial literacy and mental health by addressing six key research objectives, listed in Chapter I (refer to Section 1.2).

Chapter III: Financial Stress and Depression in Adults: A Systematic Review

Financial literacy can affect mental health through its influence on individual or household finances, given the evidence that suggests a close association between individual or household finances and mental health. Having reviewed the literature on financial literacy on financial outcomes and mental health outcomes in Chapter II, the next stage in exploring the relationship between financial literacy and mental health is to overview the potential relationship between individual or household finances and mental well-being. This chapter presents a systematic review of the existing evidence on the relationship between various indicators of financial stress and depression outcomes in adults. Depression or depressive disorders is used as an indicator of mental health as it is the most common mental illnesses, affecting around 4.4% of the global population, and over 300 million people worldwide are living with depression (Friedrich, 2017). This systematic review aims to address the second research objective by providing a comprehensive analysis of the association between different financial stressors and depression considering the characteristics of the associations of interest and discussing the proposed mechanisms underlying the associations. The reviewed studies suggest a positive relationship between financial stress and depression, which has been found in both high-income and low-and middle-income countries.

This Chapter is structured as follows: Section 3.1 introduces background, motivations and aims of the study. Section 3.2 introduces the method including the search strategies, the eligibility criteria, the study selection process, the methods of data analysis and quality assessment. The results are reported in section 3.3. Section 3.4 contains the discussion, and section 3.5 concludes.

3.1. Introduction

Depression is one of the most common mental health problems and is marked by sadness, loss of interest or pleasure, feelings of guilt or low self-worth, disturbed sleep or appetite, feelings of tiredness, and poor concentration (WHO, 2017). Depression is a leading cause of disability and poor health worldwide (WHO, 2017) and is expected to rank first worldwide by 2030 (Malhi and Mann, 2018). According to a survey from the World Health Organization, more than 322 million people, which accounted for approximately 4.4% of the world population, suffered from depressive disorders in 2015 (Friedrich, 2017). The lifetime risk of developing depression was estimated to be 15%-18% (Bromet et al., 2011). Mental health problems including depression have imposed a heavy economic burden on individuals and households who are suffering from mental disorders and even on society (WHO, 2003; Trautmann et al., 2016; Tran et al., 2018). Specifically, the global costs of mental health problems are increasing each year in many countries. Those costs are estimated to reach approximately 16 trillion dollars by 2030 (Bloom et al., 2011; Patel et al., 2018). There is a considerable need to explore the risk factors of mental disorders or the determinants of mental health, which will inform preventive strategies and actions aimed at reducing the risk of getting mental disorders and thereby promoting public mental health.

Many social and economic determinants of depression have been identified. These include proximal factors like unemployment, low socioeconomic status, low education, low income and not being in a relationship and distal factors such as income inequality, structural characteristics of the neighbourhood and so on (Assari, 2017; Antunes et al., 2018; Lund et al., 2018a). Research has emerged in the past two decades focusing on the association between the individual or household financial stressors and common mental disorders such as depression and anxiety. However, findings regarding the relationship between different indicators of financial stress and depression are inconclusive in the previous literature. Studies have shown

positive associations between depression and various indicators of financial stress such as debt or debt stress, financial hardship, or difficulties (Butterworth et al., 2009; Bridge and Disney, 2010; Sweet et al., 2013). Some other studies find no relationships when financial stress was indicated by low income. For example, Zimmerman and Katon (2005) found that when other socioeconomic confounders were considered, no relationship between low income and depression was observed. Besides, there is evidence showing a negative association between low income and major depressive disorder in South Korea (Cho et al., 2007). A 2010 review on poverty and mental disorders also finds that the association between income and mental disorders (including depression) was still unclear (Lund et al., 2010).

The social causation theory is one of the theories that has been proposed to explain possible mechanisms underlying the effect of poverty on mental disorders (Lund et al., 2010; 2012). It states that stressful financial circumstances might lead to the occurrence of new depressive symptoms or maintain previous depression. This might be due to exposure to worse living conditions, malnutrition, unhealthy lifestyle, lower social capital, social isolation, or decreased coping ability with negative life events. Individuals or households with limited financial resources are more vulnerable to stressful life events (e.g., economic crises, public-health crises), which might increase the risk of mental health problems (Lund et al., 2010; 2012; 2018b). However, practically, social causation might not be applicable to situations where individuals are not in poverty or deprivation but still can experience depression due to financial stress.

Reviews to date have examined the relationship between debt specifically and broader mental health outcomes with depression being one of them. For example, two reviews published in 2013 and 2014 reviewed the literature on the relationship between debt and both mental health and physical health (Richardson et al., 2013; Turunen and Hiilamo, 2014). They concluded that there was a significant relationship between personal unsecured debt or unpaid

debt obligations and the increased risk of common mental disorders, suicidal ideation and so on (Richardson et al., 2013; Turunen and Hiilamo, 2014). In terms of depression, they found that there was a strong and consistent positive relationship between debt and depression. Another focus of the literature is on the relationship between poverty and mental health problems including depression in low-and middle-income countries (LMIC). In those reviews, indicators of poverty include low socioeconomic status, low income, unemployment, low levels of education, food insecurity and low social class (Lund et al., 2010; Patel and Kleinman, 2003). Both reviews find a positive relationship between poverty and common mental disorders, which exists in many LMIC societies regardless of their levels of development. Being related to low income, factors such as insecurity, low levels of education, unemployment, and poor housing were found to be strongly associated with mental disorders, while the association between income and mental disorders was unclear.

The reviews discussed above focus mainly on the relationship between debt or poverty and mental health outcomes. As sources of financial stress are complex and multidimensional, indicators such as low income or debt are not the only economic risk factor of mental health problems. Other sources of financial stress such as lack of assets, economic hardship or financial difficulties (e.g., whether an individual finds it difficult to meet standard living needs like buying food, clothes, paying bills and so on) might also relate to depression. In addition, various sources of financial stress might be related to mental health problems in different ways. Based on the existing reviews, it is still unknown which domains of financial stress have clearer associations with depression and whether there is heterogeneity in the relationship between financial stress and depression for different populations and contexts. Moreover, the existing reviews do not discuss the possible mechanisms underpinning the association between financial stress and depression. To better understand the association between financial stress and depression and the possible mechanisms underlying it, a systematic review was conducted

bringing together a wide range of indicators of financial stress. The eligible economic indicators of financial stress in this review include objective financial variables like income, assets, wealth, indebtedness; as well as measures that capture subjective perceptions of financial stress, such as perceived financial hardship (e.g., subjective feelings of sufficiency regarding food, clothes, medical care, and housing), subjective financial situation (e.g., individuals' feelings about their overall financial situation), subjective financial stress, subjective financial position, and financial dissatisfaction.

This study aims at providing a comprehensive review of the association between different financial stressors and depression considering the characteristics of the associations of interest and discussing the proposed mechanisms underlying the associations. An understanding of the relationship between financial stress and depression would not only advance our understanding and knowledge of the economic risk factors of mood disorders but also provide policymakers with more understanding of additional public mental health benefits of intervention aimed at alleviating poverty and/or at improving people's financial conditions.

3.2. Methods

3.2.1. Search strategies

A systematic review of published literature was conducted using online searches on bibliographic databases. At the first stage, six bibliographic databases including CINAHL, PsycINFO, EMBASE, EconLit, AMED, and Business Source Premier were searched for related peer-reviewed journal articles to April 2019. The search terms are listed in Table 3-1. The broad strategy was to combine terms related to finances, with terms related to depression, and terms related to the unit of analysis (individual, household etc). Several key studies that were eligible for inclusion criteria were pre-identified. Before the formal search, pilot searches were performed to make sure the pre-identified key studies can be found by the search. More details of search strategies are displayed in Appendix A.1. All the search results were limited to the English language. No time restriction was added to the search. The reference lists of the eligible studies and several relevant review papers were checked manually to supplement the main electronic searching.

Table 3-1 A simplified search strategy

Search term sets	Combination strategy
1) Finances or financial situation	"income" or "debt*" or "indebt*" or "loan*" or "mortgage" or "wealth" or "asset* or "financ*" or "economic situation*" or "economic stat*" or "economic condition*" or "economic position*" or "economic hardship*" or "economic str*" or "economic difficult*" or "financial situation*" or "financial stat*" or "financial condition*" or "financial position*" or "financial str*" or "financial hardship*" or "financial satisf*" or "financial difficult*" or "poverty" or "deprivation"
2) Depression	"depress*" or "mood disorder" or "depressive disorder*" or "depressive symptom*" or "depressed mood*" or "affective disorder*" or "dysthymia*"
3) Household/individual	"household*" or "family" or "individual" or "personal"
Boolean logic	1) and 2) and 3)

3.2.2. Eligibility criteria

The inclusion and exclusion criteria for study selection were designed to ensure a focus on primary studies and secondary studies conducted on adults, using measures of financial stress (exposure) and depression (outcome). The eligibility criteria were tested on a selection of papers by multiple members of the study team to ensure that studies were categorised accurately. Based on the piloting process, the eligibility criteria were further modified. The following is the list of the final inclusion and exclusion criteria applied in this study.

Studies were included if they met the following criteria: (1) observational and experimental studies on the relationship between the individual or household financial stress and depression or depressive symptoms; (2) original research in peer-reviewed journals; (3) conducted on general population samples aged 18 and over; (4) used indicators which capture different dimensions of an individual or household financial stress, such as income, assets, debt, wealth, economic hardship, financial strain, financial stress, and financial satisfaction; (5)

studies that measure depression through both non-clinical and clinical techniques (e.g., Centre for Epidemiologic Studies Depression Scale), were eligible for this review.

Studies were excluded if they were: (1) systematic reviews, dissertations, conference abstracts, or study protocols; (2) studies focusing on a specific population including female-only, male-only, people with a special occupation (e.g., soldiers), migrants, or people with specific illnesses; (3) studies relating to societal (as opposed individual) economic circumstances (e.g., income inequality measured at the community level or the country level) or shocks to the macroeconomy (e.g., stock market crashes, hyperinflation, banking crises, economic depressions, and financial crisis); (4) studies that only reported the joint association between several socioeconomic determinants and depression. These were included only if the association related to individual or household finances were reported and explained individually; (5) studies based on overall mental health, or other types of mental disorders (e.g., anxiety, suicide, self-harm, bipolar disorder, schizophrenia, dementia) where the association between household financial stress and depression was not reported and explained independently.

3.2.3. Study selection

Search strategies were applied to six databases (i.e., CINAHL, PsycINFO, EMBASE, EconLit, AMED, and Business Source Premier EBSCO) to generate a long list of candidate studies. All the search results were exported into Mendeley. Search results, after the removal of duplicates, were screened for relevance using the title and abstract information. The full texts of relevant articles were then checked for eligibility based on the selection criteria. Screening and selection were undertaken by two reviewers independently. All authors were consulted when a disagreement arose. The study selection process and reasons for study exclusions were recorded in a flow chart shown in Figure 3-1.

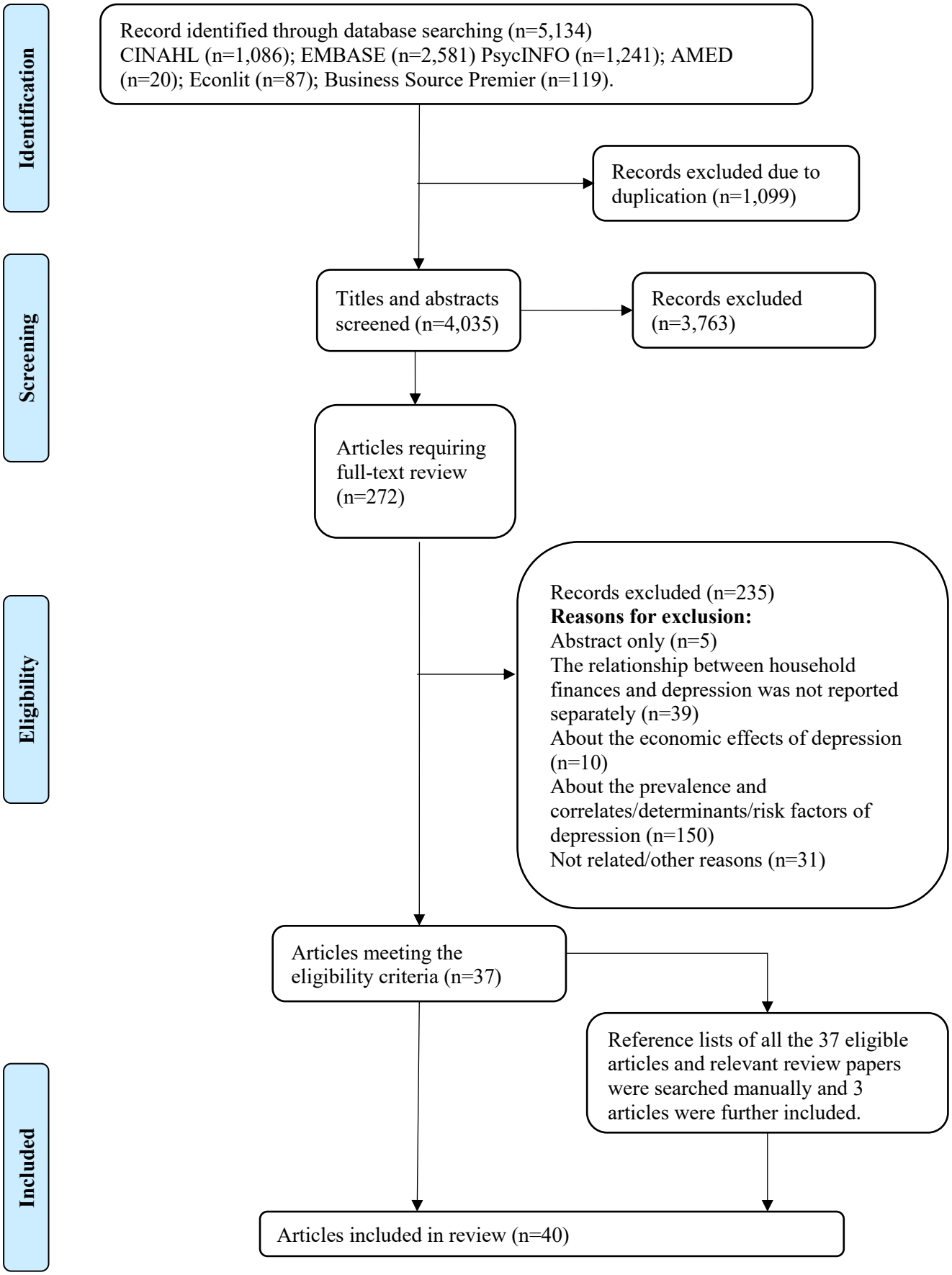

Figure 3-1 Study selection flow chart

3.2.4. Data analysis

A pre-designed data collection form (listed in Appendix A.2) was used for the data extraction process. The data extracted from the eligible studies covered the following categories: (1) characteristics of studies: year, author, journal, aim of study, countries, study type, data sources, responsible rate, level of study, eligibility of ethical approval; (2) characteristics of the population: sample size, age group, mean age of the participants, gender; (3) depression measures, definition of depression, validity of the measures; (4) measures of financial stress (exposures) used, measures of the exposure, definition of the exposure, validity of the measures; (5) statistical analysis: econometric methodologies, covariates, whether reverse causality was taken into account, whether there are subgroup analyses and methods (6) main results. The key information being extracted is presented in Appendices A.4 and A.7, which is a simplified version of the extracted data.

This review focused on the association between each dimension of financial stress and depression and analysed the heterogeneity of the association in different contexts. The eligible studies were reviewed narratively, and the results were stratified by different indicators of financial stress (e.g., low income, low assets, low wealth, debt, financial difficulties and so on). Causal inferences and proposed mechanisms underlying the association between financial stress and depression based on the reviewed evidence were discussed in the discussion section. No meta-analysis was conducted to pool the reviewed evidence due to the substantial heterogeneity in the measurements and definitions of the exposure and outcome variables, study context, and methodologies.

3.2.5. Quality assessment

The quality of the included studies was assessed using an adapted version of the Quality Assessment Tool for Quantitative Studies used in Glonti et al. (2015) (see Appendix A.3). The

original version of this tool is developed by the Effective Public Health Practice Project (EPHPP) (Glonti et al., 2015). Seven key domains relating to study design, selection bias, withdrawals, confounders, data collection, data analysis and reporting were considered. Studies can have between six and seven component ratings. The score of each domain equals 1 if the quality is high, 2 if the quality is moderate and 3 if the quality is low. An overall rating for each study was determined based on the ratings for all domains. The overall rating of studies' quality was classified as high, moderate, or low. Full details of the design and usage of the quality assessment tool can be found in Glonti et al. (2015). The quality assessment of the included studies was conducted by two reviewers independently. The results of the quality assessment were based on consensus between the two reviewers.

3.3. Results

5,134 papers were identified after searching online databases including CINAHL, PsycINFO, EMBASE, EconLit, AMED, and Business Source Premier. The flow chart for the study selection process is displayed in Fig 3-1. The total number of papers after removing duplicates was 4,035. Both titles and abstracts of the identified 4,035 papers were screened. 3,763 papers were removed since they did not satisfy the eligibility criteria. The full texts of the remaining 272 papers were accessed and further screened separately by the two reviewers based on the eligible criteria. 235 papers were further excluded leading to 37 studies for consideration. The main reasons for exclusion were that the exposure, the outcome variables of interest, or the targeted population of those studies did not meet the inclusion criteria. Three additional articles were further added after checking the reference lists of all the eligible papers and those of the past relevant review papers (e.g., Lund et al., 2010; Richardson et al., 2013). 40 articles were finally identified for the data extraction.

3.3.1. Study Characteristics

Regarding the number of reviewed studies by years of publication, most of the reviewed studies were published in the past two decades, with a noticeable spike in the last five years. The majority of studies (32 out of 40) reported evidence from high-income European countries, the UK, and the U.S., Australia, Japan, and South Korea. Eight studies were based on low- and middle-countries including China, Chile, and South Africa. In terms of study design, 17 studies were cross-sectional, and 23 studies were longitudinal. The age groups considered in the 40 studies vary: 17 studies focused on the general adult population including young adults, middle-aged adults, and older adults, while 23 studies focused specifically on working-age, young adults, middle-aged, or older adults. Data of study characteristics were displayed in the data extraction form in Appendix A.4.

3.3.2. Measures of depression

The most commonly used measure for depression was the Centre for Epidemiological Studies Depression Scale (CES-D) (e.g., Berger et al., 2016; Gillen et al., 2017; Hiilamo and Grundy, 2018). Various versions of the CES-D were used in the reviewed studies: six studies used the full version, that is, the 20-item CES-D; 19 studies used the shortened version of the CES-D scale. Other measures were also used to assess the individual's depressive symptoms such as the Hospital Anxiety and Depression Scale (HADS) (Ellaway et al., 2016), the World Mental Health Composite International Diagnostic Interview (WMH-CIDI) (Butterworth et al., 2012; Virtanen et al., 2008), a subsection of the General Health Questionnaire (GHQ depression) (Martikainen et al., 2003; Virtanen et al., 2008; Gathergood, 2012), the Alcohol Use Disorder and Associated Disabilities Interview Schedule-IV (AUDADIS-IV) (Sareen et al., 2011), the 21-item Beck Depression Inventory (BDI) (Rautio et al., 2012) and the Geriatric Depression Scale (GDS) (Boey and Chiu, 2005; Butterworth et al., 2009; Cheung and Chou, 2019). Two

studies used self-reported depression by asking participants whether or not they had any experience of depression (Bridges and Disney, 2010; Reeves et al., 2016).

3.3.3. Measures of financial stress

A wide variety of concepts and measures of financial stress were used across the reviewed studies. The financial exposure in the reviewed studies can be divided roughly into two categories. First, personal or household finances, which include income, assets or wealth, debt or hardship were investigated. These economic indicators were measured in different ways. Some studies measured the total amount of assets while other studies measured assets by counting the number of durable items owned by an individual (such as motor vehicles, bicycles, computers, or cameras) or a household (such as fridges, microwaves, TV, cameras). The measures of debt were more diversified: the onset of debt, the amount of debt in general and of different types of debt, the debt-to-asset ratio, debt problems like over-indebtedness, debt arrears, and debt stress. Financial hardship was defined as difficulties in meeting the basic requirements of daily life due to a lack of financial resources. For example, not having enough money for food, clothes, shelter and medical expenses; being unable to pay bills on time or heat the home; having to sell assets; going without meals; or asking for financial help from others were used by these studies as proxies for financial hardship (Butterworth et al., 2012; Mirowsky and Ross, 2001). Second, some studies examined the associations between depression and subjective perceptions of financial stress such as perceived financial hardship (e.g., subjective feelings of insufficiency regarding food, clothes, medical care, etc.), subjective financial situation (e.g., individual's feelings of their overall financial situation), subjective financial stress, subjective financial position, financial dissatisfaction and so on.

3.3.4. Quality of reviewed studies

Full details of the quality assessment of the 40 included studies are displayed in Appendices A.5 and A.6. An observational study design was utilised in all of the included papers. 29 (72.5%), and 11 (27.5%) studies were rated as methodologically strong (e.g., Zimmerman and Katon, 2005; Butterworth et al., 2009; Bridges and Disney, 2010; Virtanen et al., 2008; Sareen et al., 2011; Butterworth et al., 2012; Sweet et al., 2013; Berger et al., 2016; Gillen et al., 2017; Tran et al., 2018; Lund and Cois, 2018; Hiilamo and Grundy, 2018) and moderate (e.g., Virtanen et al., 2008; Gathergood, 2012; Ellaway et al., 2016), respectively. Among the 40 included studies, 34 (85%) had a low risk of selection bias, five (12.5%) had a moderate risk and one had a high risk of selection bias. Eight studies were able to be rated on withdrawals and drop-outs: two of them were rated as "strong", four achieved a "moderate" rating and one received a "weak" rating. This study found that 15 studies (37.5%) had a low risk while 25 (62.5%) had a moderate risk of confounding bias. Regarding the data collection, two studies were rated as 'strong', 37 received a 'strong' score, and one study was rated as 'weak'. All the studies received a 'strong' rating for data analysis except for one study that was rated as 'weak'. 35 (87.5%) studies received a 'strong' rating for reporting, while five studies had a 'moderate' quality of reporting.

3.3.5. Association between income and depression

Eleven studies were identified examining the relationship between individual or household income levels and depression. All controlled for other socioeconomic confounders or/and health status. Seven studies found a statistically significant association between low income and a higher risk of depressive symptoms after adjustment. The positive association between low income and depression was reported in both high-income countries and low- and middle-income countries and found in different age groups (i.e., younger adults, middle-aged adults, and older adults).

The intertemporal relationship between individual or household income and depression was investigated in three longitudinal studies (Sareen et al., 2011; Osafo Hounkpatin et al., 2015; Lund and Cois, 2018b). Osafo Hounkpatin et al. found that in the UK, an increase in household relative income (i.e., income rank) was statistically related to a decreased risk of depression at a given time point (Osafo Hounkpatin et al., 2015). The effect of household income at baseline on the risk of showing depressive symptoms in the following time point was weakened but still statistically significant, controlling for the baseline depression level. Lund and Cois reported similar results: they found that lower household income at baseline could predict a worse depression status during the follow-up period in South Africa (Lund and Cois, 2018b). Based on evidence from the U.S., Sareen et al. found that individuals with lower levels of household income faced an increased risk of depression compared to those with higher levels of household income (Sareen et al., 2011). Furthermore, a reduction in income was also related to an increased risk of depression (Sareen et al., 2011).

Focusing on pension income, which is one of the main sources of household income for the retired population, Chen et al. found that pension enrolment and pension income were significantly associated with a reduction in CESD scores among Chinese older adults, controlling for other socioeconomic factors and health status (Chen et al., 2019).

The strength of the relationship between income and depression varies and can be affected by how income is measured. For example, compared to absolute income, a household's relative income level within a reference group was found to be a more consistent household financial predictor of depression (Osafo Hounkpatin et al., 2015). Osafo Hounkpatin et al. compared the effect of relative income with that of the absolute value of household income (Osafo Hounkpatin et al., 2015). They found that a deterioration in the rank of household income was associated with a higher possibility of showing depression at a given time point, as well as the subsequent time point (Osafo Hounkpatin et al., 2015).

The relationship between income and depression holds for all income groups but is more pronounced among lower-income groups. According to Zimmerman and Katon, the association between depression and income is stronger among people with income levels below the median (Zimmerman and Katon, 2005). Based on a quasi-natural experiment, Reeves et al. also found that the reduction in housing benefits significantly increased the prevalence of depression for low-income UK households (Reeves et al., 2016). Additionally, the association between pension income and depressive symptoms in older adults were more pronounced among lower-income groups (Chen et al., 2019). More broadly, the income-depression relationship might be influenced by the economic status of the regions where households live. For example, Jo et al. found that the association between income and depression was significant among participants from low-economic-status regions, while it was insignificant among participants from high-economic-status regions (Jo et al., 2011).

3.3.6. Association between material assets and depression

Two studies on the relationship between assets and depression were identified: one cross-sectional study (Ellaway et al., 2016) and one longitudinal study (Lund and Cois, 2018b). Those studies showed that assets were a significant predictor of depression after controlling for demographic and other socioeconomic confounders. Furthermore, the household assets-depression association was found to be stronger for individuals with lower levels of assets at baseline (Ellaway et al., 2016; Lund and Cois, 2018b). The directions of the assets-depression relationship were investigated in one study. Lund and Cois simultaneously examined both directions of the relationships using a nationally representative survey on South Africa (Lund and Cois, 2018b). They found that low levels of individual and household material assets were significantly related to depression in the follow-up period after controlling for age, gender, race and education. Conversely, having more depression symptoms at baseline was significantly

associated with lower levels of individual assets in the follow-up period (Lund and Cois, 2018b).

3.3.7. Association between wealth and depression

Three studies explored the relationship between wealth and depression in adults. All of them were based on high-income country contexts including the UK and the U.S. and suggested a positive relationship between individual or household low wealth and depression among middle-aged and older adults. Two longitudinal studies examined the association between wealth and depression. Specifically, Pool et al. found that an increase in household wealth was statistically related to a decrease in the risk of depressive symptoms (Pool et al., 2017). Osafo Hounkpatin et al. compared the effect of relative wealth (i.e., wealth rank) and absolute wealth on depressive symptoms (Osafo Hounkpatin et al., 2015). Their results showed that, instead of the absolute wealth, the wealth rank within a social comparison group was the primary driver of the association between wealth and depressive symptoms (Osafo Hounkpatin et al., 2015). The strength of the relationship between wealth and depression varies according to the level of wealth at baseline (Osafo Hounkpatin et al., 2015). For example, Martikainen et al. found the association between household wealth and depression was most pronounced among the lowest wealth group (Martikainen et al., 2003).

3.3.8. Association between debt and depression

Fourteen studies investigated the association between debt and depression and provided empirical evidence based on high-income countries (Europe and the U.S.) and Chile. Three studies were cross-sectional and all of them reported a positive association between debt (assessed by student debt, the occurrence of any debt, or unsecured debt) and depressive symptoms after controlling for demographic and other socioeconomic factors (Zurlo et al., 2014; Gillen et al., 2017; Tran et al., 2018). Eleven longitudinal studies identified by this

review investigated the association between debt and depression over time. The definitions and measures of debt vary across studies. Associations between the occurrence and/or amount of financial debt, the occurrence and/or amount of housing debt, excessive mortgage debt, the occurrence of any debt, the debt-to-asset ratio, and the debt-to-income ratio, on the one hand, and depression, on the other, were investigated in the reviewed studies.

The association between changes in debt status and changes in depressive symptoms was investigated in six studies. Specifically, using five waves of data from the Survey of Health, Ageing and Retirement in Europe (SHARE), Hiilamo and Grundy found that both men and women switched from having no financial debt to having substantial financial debt suffered from a deterioration in depressive symptoms (Hiilamo and Grundy, 2018). Also, switching from no mortgage debt to having substantial mortgage debt was positively associated with the deterioration in depressive symptoms among women (Hiilamo and Grundy, 2018). Using a large nationally representative dataset from the Chilean Social Protection Survey (SPS), Hojman et al. also found that individuals who were always over-indebted or switch from having moderate levels of debt to over-indebtedness had more depressive symptoms than those who were never over-indebted (Hojman et al., 2016). Additionally, they found that those who were not over-indebted, regardless of the previous debt status, did not experience a worsening in depression, showing that the effect of over-indebtedness on depressive symptoms faded away as the debt levels decreased (Hojman et al., 2016).

Various measures of debt were used in the reviewed studies such as the occurrence of debt (Zurlo et al., 2014; Berger et al., 2016; Gillen et al., 2017), the amount of debt (Sweet et al., 2013; Zurlo et al., 2014; Berger et al., 2016; Tran et al., 2018; Hiilamo and Grundy, 2018), and the debt-to-income ratio or debt-to-asset ratio (Sweet et al., 2013; Leung and Lau, 2014; Hojman et al., 2016). The debt-depression relationship varies with different operationalisations of debt with the debt to asset ratio being a more reliable predictor of depression than the total

debt. Both Sweet et al. (2013) and Hojman et al. (2016) found that only the debt-to-assets ratio or debt-to-income ratio (rather than the absolute amount of debt) were consistently and positively associated with higher depression scores before and after adjustment (see Appendices A.4 and A.7 for details of the covariates used).

Different types of debt such as secured debt (e.g., mortgage debt) and unsecured debt (e.g., consumer debt) might be related to the depression in different ways. The reviewed studies reported a positive association between high levels of mortgage debt and high unsecured consumer debt (regardless of the amount) and depression (Sweet et al., 2013; Leung and Lau, 2014; Zurlo et al., 2014). For example, Leung and Lau examined the causal relationship between mortgage debt and depressive symptoms and found that a high level of mortgage indebtedness (defined as a mortgage loan to home value ratio over 80%) was associated with more depressive symptoms among mortgagors (Leung and Lau, 2014). Both Zurlo et al. and Sweet et al. found that unsecured debt (e.g., consumer debt) was a significant predictor of more depressive symptoms (Sweet et al., 2013; Zurlo et al., 2014). Three studies compared the effect of different types of household debts on depression (Berger et al., 2016; Hojman et al., 2016; Hiilamo and Grundy, 2018). The results of those three studies suggested that the association between household debt and depressive symptoms was predominantly driven by short-term debt. Specifically, unsecured debt (e.g., financial debt), or short-term debt were associated with a higher risk of experiencing depression, while secured debt itself (e.g., mortgage debt) or long-term debt were not related to depressive symptoms. For example, using longitudinal data from SHARE, Hiilamo and Grundy (2018) found that household financial debt was positively and significantly associated with more depressive symptoms, while the effect of household housing debt on depression was weak or even insignificant. Berger et al. found a similar result using longitudinal data from the U.S.. Their results (controlling for baseline characteristics and socioeconomic factors) showed that only short-term debt (i.e., unsecured debt) was positively

and statistically significantly associated with depressive symptoms, while the effects of mid-term and long-term debt (e.g., mortgage loan) on depressive symptoms were not significant (Berger et al., 2016).

However, it is not always the case that the association between debt and depressive symptoms is only driven by consumer debt. As reported in two longitudinal studies by Hiilamo and Grundy (2018) and by Gathergood (2012), a secured debt like mortgage might be associated with depression when the secured debt becomes a problem debt. Hojman et al. (2016) found that mortgage debt had no association with depressive symptoms, while consumer debt was positively and significantly related to more depressive symptoms. Nevertheless, both Hojman et al. (2016) and Alley et al. (2011) found that mortgage arrears had a significant effect on more severe depression, even when the effect of consumer debt on depression was controlled. In line with their study, Gathergood (2012) also found that housing payment problems were strongly associated with a higher depression score.

3.3.9. Association between financial hardship and depression

The association between financial hardship and depression was reported in four studies, all of which were based on high-income countries such as the U.S. and Australia (Ross and Huber, 1985; Mirowsky and Ross, 2001; Butterworth et al., 2009; 2012). They all observed a cross-sectionally positive relationship between financial hardship and depression, which holds after adjustments (see Appendices A.4 and A.7 for details of the covariates used). The intertemporal association between financial hardship and depressive symptoms was reported in two longitudinal studies (Mirowsky and Ross, 2001; Butterworth et al., 2009). However, the consistency of the findings is sensitive to the statistical methods applied. Mirowsky and Ross (2001) found that current financial hardship was associated with a subsequent increase in depression in the U.S.. The other study only observed an association between financial hardship at baseline and baseline depression, as well as a weak or even no association between prior

financial hardship and current depression (Butterworth et al., 2009). When the same statistical strategy was applied, the findings from Butterworth et al. (2009) were consistent with those were observed in Mirowsky and Ross's study (Mirowsky and Ross, 2001).

Furthermore, the reviewed studies showed that the effect of past financial hardship on depressive symptoms decayed with time. In other words, current financial hardship mattered the most for current depressive symptoms. Following Mirowsky and Ross (2001), changes in financial hardship were stratified into four types. An individual experiencing (not experiencing) current financial hardship and hardship in the past belongs to the always hardship group (no hardship group). An individual experiencing only current (past) financial hardship belongs to the new hardship group (resolved hardship group). Mirowsky and Ross (2001) found that the effects of consistent hardship and new financial hardship (3 years later) on depressive symptoms were positive and significant. Moreover, there was no significant difference in the follow-up depressive symptoms between the consistent hardship group and the new hardship group (Mirowsky and Ross, 2001). Furthermore, the association between both resolved hardship and no hardship on depressive symptoms was not significant (Mirowsky and Ross, 2001). Consistent with this, Butterworth et al. (2009) also found that the individuals who currently experienced financial hardship were more likely to have depression than those who only experienced financial hardship in the past or never experienced it.

Age was the most analysed moderator of the association between financial hardship and depressive symptoms among the reviewed studies. This review found that there is no consistency in terms of the association between financial hardship and depression across different age groups. Butterworth et al. (2012) reported that the effect of financial hardship on depressive symptoms increased with age among Australian adults. However, Butterworth et al. (2009) and Mirowsky and Ross (2001) reported different results. Specifically, they found that the positive association between financial hardship and depressive symptoms decreased with

age in the U.S.. In contrast to the two studies listed above, Butterworth et al. (2009) did not find any statistically significant differences regarding this association among different age cohorts in Australia.

3.3.10. Association between subjective financial strain and depression

Eleven studies examined the association between subjective financial indicators (i.e., subjective financial strain, financial dissatisfaction or financial stress) and depression, providing empirical evidence based on high-income countries (Europe, the U.S., the UK, Japan and Korea) and on China. All of them (including four cross-sectional and seven longitudinal studies) reported a positive relationship between subjective financial strain and depression, holding after adjustments (see Appendices A.4 and A.7 for details of the covariates used)). The intertemporal association between subjective financial strain and depression was reported in two studies (Chi and Chou, 2000; Richardson et al., 2016). For example, Richardson et al. (2016) found that increased subjective stress at baseline was associated with greater depression over time. Similarly, Chi and Chou also found that higher levels of subjective financial strain measured at baseline were associated with more depressive symptoms after three years among Chinese older people (Chi and Chou, 2000). The association between changes in subjective financial strain and depression was found in one longitudinal study (Lorant et al., 2007). Using data from the annual Belgian Household Panel Survey, Lorant et al. (2007) found that the worsening subjective financial strain was significantly associated with the increased risk of depressive symptoms and that of caseness of depression.

The positive and significant association between perceived financial strain in childhood and depression in adults was found in both a cross-sectional study and a longitudinal study (Kim et al., 2016; Boe et al., 2017). Using cross-sectional data from 19 European countries in 2014, Boe et al. (2017) found that younger adults (25-40) who had experienced financial difficulties as children had higher depression scores in adulthood, while older adults (over 40)

did not. A similar association between adverse childhood financial situation and adults' depression was also found in a longitudinal study (Kim et al., 2016). Based on a national representative sample of 9,645 South Korean adults without depressive symptoms at baseline, Kim et al. (2016) found that experiencing financial difficulties in childhood was associated with the increased chance of depression in adulthood. Furthermore, the effect of experiencing financial difficulties in childhood on depression was weaker than that of current financial difficulties (Kim et al., 2016).

The gender difference of the association between perceived financial strain and depression was examined in two studies and no statistical difference between females and males was observed, though women tended to report worse depression (Chi and Chou, 2000; Boey and Chiu, 2005).

3.4. Discussion

3.4.1. Summary and discussion of the findings

This systematic review is the most comprehensive synthesis of observational studies quantifying the association between indicators of financial stress and depression in both high- and low- and middle-income countries to date. Findings regarding the relationship between financial stress and depression vary across different indicators of financial stress. Economic indicators such as material assets, unsecured debt, financial hardship, and subjective measures of financial stress are relatively strong and persistent predictors of depressive symptoms, while absolute income and wealth levels have an inconclusive association with depression. The only longitudinal evidence on relative income and relative wealth suggests a stronger relationship between relative income or relative wealth and depressive symptoms than that between absolute income or wealth and depression. Additionally, this review finds that the association between indicators such as income, material assets or wealth and depression is more

pronounced in lower socioeconomic groups (i.e., low income or low wealth group). This review is unable to make a conclusion regarding the association between debt and depression across different socioeconomic subgroups. The only evidence is provided in one study showing that there is no difference in the association between debt and depression by assets level. Additionally, there is insufficient evidence to conclude a common pattern regarding the association between financial stressors and depression by gender or age groups, though differences of this relationship across age or gender groups are observed in some of the reviewed studies.

The income-depression association is inconclusive, although income is one of the most commonly used indicators of the individual or household's economic situation. The reviewed studies consistently reported a positive association between low income and depressive symptoms in univariable analyses. However, this association was largely reduced or even became insignificant when other social and economic factors (such as educational level, employment status and so on) and health status were controlled for (Martikainen et al., 2003; Virtanen et al., 2008). The findings are consistent with the results from the previous reviews and empirical research where different mental disorders were considered including depression (Lund et al., 2010; Patel and Kleinman, 2003; Silva et al., 2016). It is likely that income has a close correlation with other dimensions of the socioeconomic condition such as educational levels and employment status that affect an individual's mental health independently from income *per se* (Patel and Kleinman, 2003).

Furthermore, this review finds that compared to *absolute* income (or wealth), *relative* income (or wealth) in a reference group is a more important risk factor of depression. There is evidence showing a positive association between low-income ranks and current depression scores as well as follow-up depression scores, while no association is found between absolute low income and depression (Osafo Hounkpatin et al., 2015). The findings here are in line with

the previous review, which mainly focused on the association between income inequality and depression (Patel et al., 2018). Patel et al.'s (2018) review concluded that a higher level of income inequality at the neighbourhood level was strongly associated with a higher risk of depression. This review only identified one study investigating the association between relative income or relative wealth and depression. The insufficient evidence on this topic suggests the need for more research to investigate the mental health effects of relative income (or wealth).

Some of the reviewed studies have suggested a positive association between debt and depression despite the substantial heterogeneity in definitions and measurements of debt, study methods, study contexts, and targeted population. The association between debt and depressive symptoms is mainly driven by unsecured debt (e.g., credit card) or late mortgage payments. Secured debt (e.g., mortgage debt) *per se* is not associated with depressive symptoms. However, depression may still be more likely when individuals or households are no longer able to manage their debt or perform debt obligations. For example, the reviewed evidence shows that mortgage arrears have a significant effect on more severe depression, even when the effect of consumer debt and mortgage debt on depressive symptoms are considered within the same model (Leung and Lau, 2014; Hojman et al., 2016). The findings regarding the relationship between debt and depression are consistent with the findings from the previous reviews on the association between debt and health where depression was one of the outcomes (Fitch et al., 2011; Turunen and Hiilamo, 2014).

An important consideration regarding the debt-depression relationship is that having personal or household debt does not always lead to depression, as debt is not always a sign of financial problems. Some personal and household loans are taken to finance housing purchases, business, and investments, which are granted based on the borrower's financial situation and payback abilities. Additionally, except for stress, debt might also bring benefits to mental well-being by generating consumption, feelings of attainment or satisfaction or making investments

(Dew, 2007; Dwyer et al., 2011). As a result, the financial stress derived from debt could be partially offset by such positive mental well-being effects. The review suggests that future longitudinal research on the impact of debt on depression should consider mediators to understand the nature of the causal association between debt and mental health.

It should be noted that nearly a half of the reviewed studies are cross-sectional, limiting the ability to draw a conclusion on the directions and the causality of the associations between some indicators of financial stress and depression. A few of the longitudinal studies considered the reverse relationship and/or the unobserved bias using econometric methods. The majority of these longitudinal studies mainly focused on the relationship between debt or subjective measures of financial stress and depression. They provide supportive evidence that, debt and subjective financial stress might lead to subsequent depressive symptoms. Longitudinal evidence remains limited as to the understanding of both directions and causality of the relationships between other indicators of financial stress and depression. For example, only three longitudinal studies provided an exploration of the association between income and depression. The casual relationship between some indicators of financial stress (such as low income, material assets, wealth, financial hardship) and depression should therefore be interpreted with caution.

This review includes a number of studies focusing on the older-aged population. The signs of the relationship between financial stress and depression in different age subgroups do not show a significant difference. Despite this, it should be noted that there might be heterogeneity in the magnitude of the relationship between financial stress and depression across different age subgroups. However, it is difficult to identify if including the studies based on adults aged 50 and over would make the generalisability of the findings towards this population. Because a cross-study comparison is almost impossible as there is a substantial heterogeneity in

different studies regarding country contexts, measurements of exposures and outcome variables, study methods and so on.

3.4.2. Mechanisms

Based on the reviewed evidence, four possible mechanisms may be behind the relationship between financial stress and depression.

Social causation

Firstly, as highlighted in the introduction, the effects of financial stress on depression can be explained by social causation theory. The reviewed evidence supports the social causation pathway according to which individuals or households who have low income or low wealth are more likely to be exposed to economic uncertainty, unhealthy lifestyle, worse living environment, deprivation, malnutrition, decreased social capital and so on (Kim et al., 2016; Lund and Cois, 2018b; Jin et al., 2020). Those factors might lead to a higher risk of developing depressive symptoms. Individuals or households with limited financial resources are more vulnerable to stressful financial events, which might increase the risk of experiencing depression. This mechanism is applicable to the studies where financial stress is measured by economic indicators related to poverty, such as income poverty, deprivation, and financial hardship.

Social comparison

Social causation theory, however, appears limited in explaining the effect of financial stress on depression among people above the poverty line. The impact of financial stress on mental health is not limited to extreme cases such as absolute poverty or deprivation (Enns et al., 2019). This review finds that there is a strong and consistent relationship between financial stress and depression when financial stress is measured by relative indicators of financial situation, such as relative income or relative wealth. Such effects may be better explained by social

comparison theory. According to Collins and Verduyn et al., people tend to make upward social comparisons against their reference groups (Collins, 1996; Verduyn et al., 2017). The disparity between expectations and actual financial conditions can make people feel depressed. The social and economic comparison can also be magnified by social media, and such a technology-based social comparison might also magnify the negative effects of financial stress on depression. Therefore, it is likely that the financial stress derived from the relative disadvantage in financial situation can be associated with depression through upwards social comparison with others.

Psychological stress

The reviewed studies also show that subjective measures of financial stress have adverse effects on depression. Indeed, some studies state that subjective financial stress is more important than objective measures such as the amount of debt (Reading and Reynold, 2001; Bridge and Disney, 2010; Asebedo and Wilmarth, 2017). Objective indicators of financial stress might have an indirect effect on depression, which is mediated by the individual's perception of those objective indicators as resulting in financial stress. Experiencing a similar objective financial situation, people may report different perceptions of the objective financial situation due to the heterogeneity of personal experiences, abilities to manage financial resources, aspirations, and perceived sufficiency of financial resources (Gasiorowska, 2014). For example, individuals with limited financial resources are more likely to be concerned about the uncertainty of the future financial situation. The expectation of financial stress, not just their occurrence, may also cause depression. Furthermore, people living in poverty face substantial uncertainty and income volatility. The long-run exposure to stress from coping with this volatility may also threaten mental health (Staufenbiel et al., 2013). Therefore, it is reasonable to believe that both the respondent's perception of financial stress and objective measures of financial stress lie at the heart of the relationship between financial stress and depression.

Social selection

Other studies suggest that depression might negatively impact the finances of individuals (Lund and Cois, 2018; Ridley et al., 2020). Social selection theory states that individuals who have mental disorders are more likely to drift into or maintain a worse financial situation (Lund and Cois, 2018). Evidence shows that mental problems might increase expenditure on healthcare, reduce productivity, and lead to unemployment, as well as be associated with social stigma, all of which are related to lower levels of income (Saraceno et al., 2005; Lund et al., 2010; Jin and Zhu, 2020). However, some scholars argue that the relative importance of social causation and social selection varies by diagnosis (Dohrenwend et al., 1998). Social causation theory is more important to the relationship between financial stress and depression or substance use; while social selection theory is more important in relation to severe mental disorders such as schizophrenia (Saraceno et al., 2005; Dohrenwend et al., 1992).

3.4.3. Limitations of the review

This systematic review is the first to comprehensively pool observational studies on the association between individual or household finances and depression or depressive symptoms. However, this review is subject to several limitations. First, since there is substantial heterogeneity in the measurements and definitions of exposure (financial stress) and the outcome variable (depression), targeted populations, and methodologies between studies, a meta-analysis combining the data from the reviewed studies is neither appropriate nor practical. As such, only a narrative approach is used in this review without quantitatively synthesising the data from the studies, which are difficult to compare.

Second, the majority of studies reported evidence on high-income countries like the U.S., the UK, European countries. Therefore, the conclusions of this review are more immediately generalisable to these contexts as opposed to low-and middle-income country contexts.

Third, this review undertakes the search on six databases for any related peer-reviewed journal articles without searching for other resources to find grey or unpublished literature and conference abstracts. Excluding the unpublished studies might limit the findings of this review since studies with significant results are more likely to get published (Dwan et al., 2013). The published studies may lead this review to overestimate the associations between any financial exposures and depressive symptoms.

Fourth, the included exposures in this review are the most direct indicators (i.e., proximal indicators) of financial stress. The findings in this review might not be generalisable to the relationship between a distal factor (e.g., job loss) and depression. Evidence has suggested that a significant life event or experience, for example, job loss, is associated with financial stress and thereby can predict subsequent major depression (Andreeva et al., 2015). Future review on financial stress and mental health outcomes might benefit from further including the effect of distal factors (such as job loss, changes in working hours, changes in marital status, and so on) on mental health.

3.4.4. Implications

This review has a number of implications for public policy around financial circumstances and depression. Firstly, it highlights the role that measures aimed at alleviating financial poverty and inequality could have in improving public mental health. Secondly, it suggests attention needs to be focused on unsecured debt as a public health measure. For example, providing financial counselling services and financial education to those who have debt stress and depression may help them to effectively deal with individual debt problems and associated depression. Meanwhile, the regulation of unsecured debt markets is crucial to the sustainable development of unsecured lending markets, and thereby supports both financial health and mental health. Thirdly, this review highlights the importance of targeted interventions to break the cycle of financial stress and depression. For example, instead of a one-for-all intervention

focusing on the general population, interventions targeted at lower socioeconomic groups might be more effective since the association between financial stress and depression is more pronounced in these groups.

In terms of practical support, the interdisciplinary collaboration of psychologists and financial professionals in the development of interventions aiming to break the vicious cycle of depression and financial stress could be useful. For example, interventions such as poverty alleviation programs, the provision of financial advice or financial education might have a beneficial influence on mental health. The collaboration of policymakers in both mental health areas and financial areas might create win-win situations, having mutual benefits for both areas and saving costs to society in the long run.

Finally, this review highlights the need for further research in certain areas. First, this review suggests that more longitudinal research or randomised control trials (where feasible) are needed to further clarify the directions of the causal relationships and possible mechanisms between different financial stressors and depression or other mental disorders. A better understanding of this can help to design more effective interventions either aimed at alleviating financial stress or at improving mental health. For example, anti-poverty programs such as direct cash transfers might be more helpful for families in poverty or deprivation, where social causation plays the main role in the effect of financial stress on depression (Haushofer and Shapiro, 2016). However, if financial stress is due to social comparison, rather than absolute poverty, changing social attitudes may be more beneficial. This review also calls for more future research to investigate the heterogeneity of the relationship and the difference in the direction of the relationship between financial stress and depression or other mental disorders across different populations. This would provide more precise and solid evidence for developing targeted interventions as noted above.

Second, this review finds that the majority of the existing studies on the financial stress-depression relationship are based on high-income countries. However, low-and middle-income countries have higher levels of poverty and economic inequality, as well as a high economic burden caused by mental disorders and low levels of investment in mental health (James et al., 2017; Ridley et al., 2020). Therefore, more future research that is based on low-and middle-income country contexts would be important.

3.5. Conclusion

In conclusion, this systematic review of the link between financial stress and depression in adults found that financial stress is positively associated with depression, in particular among low socioeconomic groups. The findings suggest directions for policymakers and the need for greater collaboration between psychology and financial professionals, which will be beneficial to developing targeted interventions either to mitigate depression or alleviate financial stress. Further longitudinal research would be useful to investigate the causality and mechanisms of the relationship between different dimensions of financial stress and depression.

Supporting information

Appendix A.1. Sample search in PsycINFO

Appendix A.2. Data extraction form

Appendix A.3. Quality assessment tool

Appendix A.4. Basic characteristics data extraction

Appendix A.5. Quality assessment form

Appendix A.6. Quality assessment of the reviewed studies

Appendix A.7. Methods and findings data extraction

Chapter IV: Financial Literacy and Mental Health: Micro-Econometric Evidence from China

Financial literacy has been regarded as a key driver of financial well-being, which is one of the essential components of mental well-being. A lack of financial literacy might increase the risk of poor mental well-being and potentially mental health problems. As noted in section 2.6 in Chapter II, there are no studies on the link between financial literacy and mental well-being focused on countries other than the U.S. and Japan. The study presented in this chapter aims to investigate whether there is an association between financial literacy and mental health in Chinese adults. This study uses data taken from the China Family Panel Studies (CFPS), where financial literacy incorporates financial knowledge, financial attitude, and financial behaviour and mental health is measured by the Kessler Psychological Distress Scale (K6 scale). This study provides the first empirical evidence linking different dimensions of financial literacy to mental health in a middle-income country context.

This chapter is structured as follows. Section 4.1 presents the background knowledge related to financial literacy and mental health. 4.2 introduces the method including hypotheses and a description of models, the used data and variables. The results are reported in section 4.3. Section 4.4 contains the discussion, and section 4.5 concludes.

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4.1. Introduction

A good mental health is a fundamental component of health and overall well-being, which is, in turn, intrinsically associated with many positive outcomes of one's life such as physical well-being, a stronger ability to cope with life's stress, and higher quality of life (WHO, 2004; Burton et al., 2008; Ohrnberger et al., 2017). Conversely, poor mental health or having mental disorders such as depression and anxiety have been found to have negative effects on well-being. Specifically, moderate to severe mental disorders might lead to poor health conditions related to insomnia, weight fluctuations, fatigue, weakened immune system and so on, which are followed by a deterioration in the quality of daily life (Fiske et al., 2009). Mild to moderate mental problems may also affect individuals' daily lives through their effects on social activities and employment, which are related to well-being. Mental health problems have become one of the leading causes of disease burden around the world (James et al., 2017). As a result, mental health problems presents a substantial challenge to public health in many countries, especially in low- and middle-income countries (Bridges, 2014).

Mental health can be shaped by a variety of determinants such as biological, social, cultural, and economic factors (WHO, 2014; Silva, et al., 2016; Lund, et al., 2018a). These include proximal factors like unemployment, low education, low income and not being in a relationship and distal ones such as economic inequality, structural characteristics of the neighbourhood and so on (Antunes et al., 2018, Assari, 2017, Lund et al., 2018a)[1]. Previous studies have examined the relationship between economic variables and common mental disorders. Factors such as low income, debt problems, unemployment, and financial difficulties have been found to have a negative impact on mental health (Chapter III). Conversely, evidence from low- and

[1] According to Lund *et al*. (2018a), structural characteristics of neighbourhoods include infrastructure, safety, aggregate socioeconomic deprivation, built environment, leisure opportunities, urbanicity, crime, community violence, social cohesion and so on.

middle-income countries show that income or wealth increases (e.g., cash transfers) have a positive impact on mental well-being and a negative impact on the chance of experiencing depression and stress (e.g., Haushofer and Shapiro, 2016; Egger et al., 2019).

Financial literacy can be defined as: "the knowledge of basic economics and financial concepts and the ability to use this knowledge and other financial skills to manage financial resources effectively to achieve lifelong financial well-being" (PACFL, 2008, p.10). Financial literacy enables individuals and households to make value-maximising financial decisions. Empirical evidence has shown that higher levels of financial literacy are associated with higher disposable income and wealth accumulation, achieved through better financial decisions and behaviours on saving, spending, borrowing, investment and insurance usage (see Chapter II for more details).

Like literacy in general acquired from education, financial literacy is also a part of individuals' human capital. Many studies have found education to be a significant determinant of mental health (WHO, 2014; Silva et al., 2016). Financial literacy is therefore also likely to be associated with mental health. While studies have investigated economic determinants of mental well-being and separately the benefits of financial literacy, the relationship between financial literacy and mental health outcomes has been investigated in only a scant number of studies and has not been well-understood (e.g., Kadoya et al., 2017; 2018). Those studies mainly focus on the association between one specific aspect of financial literacy, that is, financial knowledge in old age. For example, according to Kadoya et al. (2017; 2018), financial literacy can reduce anxiety in old age through its interaction with households' income and assets. They suggest that this might be because financially literate people are more likely to have better retirement saving plans, and thereby less likely to become anxious about life in old age as they are well-prepared financially. Bennett et al. (2012) also find that financial literacy is associated with better mental health in older people without dementia. The findings of those

studies have implications for older adults, but they might not be applied to young and middle-aged adults. Moreover, both Bennett et al. (2012) and Kadoya et al. (2017; 2018) only consider financial literacy defined as financial knowlecge, without taking into account other dimensions of financial literacy such as financial behaviours and attitudes. Finally, the existing evidence is based on the high-income country context, and their findings may not be generalisable to the low-and middle-income country context.

To the best of my knowledge, no study has looked at how different multiple dimensions of financial literacy (namely financial knowledge, financial attitude, and financial behaviours) relate to mental health among adults. This study addresses this gap in the literature by focusing on China, a middle-income country, with the largest population in the world, and characterised by high and increasing mental health problems (Que et al., 2019). China provides an ideal setting for studying the association between financial literacy and mental health, given its high and increasing mental health problems (Que et al., 2019), coupled with low levels of financial literacy (Zou and Deng, 2019). Mental health problems in China showed an increasing trend over the past two decades and it was estimated that approximately 11%-15% of individuals had moderate mental problems and 2%-3% of individuals had severe mental problems in 2018 (Chen et al., 2019). Moreover, the disability-adjusted life years (DALYs) caused by mental disorders accounted for 13% of the DALYs due to all non-communicable disease (Charlson et al., 2016). Finally, since 2013, the total costs of mental disorders have accounted for more than 15% of the overall health expenditure in China (Xu et al., 2016). Mental health has therefore become one of the major social and public health issues in China (Que et al., 2019). Meanwhile, financial literacy levels of Chinese adults have been found to be low, especially to be lower than those observed in high income countries (Wang et al., 2021).

Using the 2014 wave of the China Family Panel Studies (CFPS), for the first time, this study investigates the association between financial literacy and depression in Chinese adults.

This study extends the previous studies through the following aspects: first, to the best of my knowledge, this study is among the first to explore the relationship between financial literacy and mental health targeting adults aged 18 and over. Second, this study is the first to investigate the association between financial literacy and depression using a national representative dataset in a middle-income country. Third, this study is also the first to explore if indebtedness has an effect on the association between financial literacy and mental health. Finally, compared to the previous literature, this study uses a more comprehensive measurement of financial literacy (including several dimensions: financial knowledge (both basic and advanced knowledge), financial attitude, and financial behaviour), and links these different dimensions of financial literacy to mental health for the first time. This is important as the knowledge of basic economic and financial concepts can only be beneficial if used to manage financial resources effectively. This can be achieved through positive financial attitudes and savvy financial behaviours, which, in turn, may lead to better financial outcomes, and thus to better mental health (refer to Chapter II). Therefore, financial literacy should be viewed as a multifaceted concept, which in addition to financial knowledge is also made up of financial attitudes and behaviours.

The remainder of this study is structured as follows. Section 4.2 introduces the method and describes the dataset. The results are reported in section 4.3. Section 4.4 contains the discussion, and section 4.5 concludes.

4.2. Method

4.2.1. Hypotheses

Main hypothesis

Different dimensions of financial literacy (i.e., financial knowledge, financial attitudes, and financial behaviours) can be positively associated with mental health. This can be explained by a purely psychological process: more financially knowledgeable people are likely to be more

confident and feel more in control over their financial situation, which is related to better mental health (Bennett et al., 2012). Similarly, people showing more positive financial attitudes and more savvy financial behaviours may feel in control over the use of income and expenditures, which may result in a feeling of economic empowerment (Haque and Zulfiqar, 2016), and, ultimately, in better mental health (Keeton et al., 2008; Shooshtari et al., 2018). In light of these considerations, the following hypothesis is proposed:

H1: Higher levels of financial literacy are associated with better mental health.

The role of household finances

According to the social causation theory, economic conditions associated with poverty (e.g., financial stress, worse living environment, lower socioeconomic status, fewer accesses to social resources) might increase the risk of depression or anxiety (Simmons et al., 2008; Lund and Cois, 2018b). Conversly, people with high financial literacy levels possess the ability to manage financial resources more efficiently than their counterparts with lower financial literacy. As a result, they are more likely to have a safe and sound household financial situation. This may be reflected in the form of higher disposable income, more assets accumulation, and an appropriate level of debt (Lusardi and Mitchell, 2007a; 2007b; 2008; 2011b; Van Rooij et al., 2011; Lusardi and Tufano, 2015). Individuals with more financial resources tend to have better life quality and mental well-being (Lund and Cois, 2018b; Ridley et al., 2020). Therefore, financial literacy might be associated with mental health indirectly through its influence on household finances.

H2: There is an indirect relationship between financial literacy and mental health operating through household finances

The role of indebtedness

A number of studies have found that indebtedness is negatively associated with mental health and debt problems (e.g., over-indebtedness or debt arrears) can cause anxiety and depression in high-income countries (Brown et al., 2005; Bridges and Disney, 2010), as well as in China (Liu et al., 2020; 2021; Gong et al., 2014). Studies also have demonstrated the positive effects of financial literacy on borrowing (Gathergood and Disney, 2011; Lusardi and Tufano, 2015). Consequently, financial literacy may be more beneficial to indebted people, compared to non-indebted people. This might be because indebted people are more likely to suffer from mental health problems, which financial literacy may contribute to alleviating. Indebted individuals may indeed worry that they will not be able to repay their debt, which may lead to depressive symptoms (Liu et al., 2021). However, if these individuals are financially literate, they may be able to better manage their debt and make more appropriate decisions relate to debt, thus limiting their worries about repayment. Specifically, more financially literate individuals will be able to put in place plans to avoid these worries, for instance, by putting aside enough money each month to repay their debt in a relatively short time period or investing in safe assets which provide a return that can be used to repay the debt. This study, therefore, argues that the positive association between financial literacy and mental health is stronger for indebted individuals. This leads to the third hypothesis:

H3: The association between financial literacy and mental health is stronger for individuals with debt than for individuals without debt.

4.2.2. Baseline specifications and estimation methods

To test the first hypothesis, the following model is estimated:

$$K6_i = \alpha_0 + \alpha_1 FL_i + \alpha_2{}' X_i + \varepsilon_i \qquad 4\text{-}1$$

where $K6_i$ is the level of depression of respondent *i*, which is measured using the K6 scale. As clarified in section 4.2.4, the higher the K6 score shown in an individual, the more likely he/she is of showing a worse mental health status. FL_i represents, in turn, the score of basic financial knowledge, advanced financial knowledge, financial behaviour and financial attitude of the i^{th} respondent. More details of the measurement of financial literacy are displayed in section 4.2.4. X_i is the vector of control variables related to respondent *i*'s demographic and socioeconomic characteristics including age, age square, gender, residence (urban versus rural), educational level, marital status, employment, health status, exercise, household income, household assets, household debt, and provincial dummies. The rationale for including these control variables is discussed in section 4.2.4. ε_i is the error term.

For Hypothesis 1 to hold, the estimated coefficients associated with all financial literacy variables (α_1) should be negative and statistically significant. For Hypothesis 2 to hold, the absolute value of the estimated α_1 is expected to be lower or insignificant in the models where household income, assets, and debt are included, as compared to that obtained in the models that do not control for household finances.

Baseline regressions

First, this study uses a multivariable ordinary least squares (OLS) regression model to estimate Equation 4-1. Then, considering that the dependent variable (K6 score) is discrete and overdispersed, following Ruiz et al. (2019), this study also uses a negative binomial regression model to estimate Equation 4-1.

Robustness check I

To verify whether the results are robust to replacing the K6 score with a dummy equal to 1 if K6 ≥ 11, and 0 otherwise. This dummy is used to identify moderate or serious mental disorders (Prochaska et al., 2012). Based on the characteristic of this new dependent variable, logistic

regression is used to estimate the association between financial literacy and the probability of having moderate or serious mental disorders.

Robustness check II

In a further robustness test, the financial knowledge score is replaced with constructed financial knowledge indexes calculated using factor analysis (described in Section 4.2.4 and Appendix B.3). This study then conducts the baseline regression by replacing different components of financial knowledge with an indicator measuring total financial knowledge levels (also see Section 4.2.4). The purpose of this is to assess whether the results are sensitive to a different measurement of financial literacy.

Robustness check III

Financial literacy may be endogenous (Lusardi and Mitchell, 2014). It has in fact been shown that mental disorders are associated with reduced cognitive function (Kaur et al., 2019; Gotlib and Joormann, 2010), which may hinder an individual's ability to grasp financial concepts, leading to low financial literacy. Additionally, depressed individuals are more likely to show compulsive consumption, weak self-control, reduced labour supply and productivity, and higher health expenditure (Ridley, et al., 2020), which are harmful to their financial situation, making them less likely to invest in improving financial literacy (Hasting et al., 2013; APEC, 2014).

To take this issue into account, this study also examines if the main results are robust when using the instrumental variable analysis, where the financial literacy variable is instrumented using the average financial literacy of others living in the same county as the respondent[2], as well as the respondent's father's education (Bucher-Koenen and Lusardi, 2011). These instruments are considered to be appropriate given that individuals who are exposed to people

[2] There is a total of 129 counties in the sample used for the IV estimations.

who are financially literate (i.e. people living in the same county and/or their father) are likely to become more financially literate themselves. At the same time, the financial literacy of others is beyond the control of the respondent.

Taking indebtedness into account

To assess whether the association between financial literacy and mental health is stronger among individuals with debt than those without debt, the following model is estimated:

$$K6_i = \alpha_0 + \alpha_1 FL_i + \alpha_2 X_i + \alpha_3 FL_i * Debt_i + \varepsilon_i \quad \text{4-2}$$

where FL_i*$Debt_i$ is the interaction between financial literacy and a debt dummy (equal to 1 if the respondent has debt, and 0 otherwise). FL_i represents in turn the score of basic financial knowledge, advanced financial knowledge, financial behaviour and financial attitude of the i^{th} respondent. Both OLS and the negative binomial model are used to estimate Equation 4-2. All other variables are the same as in Equation (1). A significant coefficient on the interaction term (α_3) would imply that there is a statistically significant difference in the association between financial literacy and depression between the indebted group and the non-indebted group.

4.2.3. The CFPS dataset

This study uses the China Family Panel Studies (CFPS) dataset conducted by the Institute of Social Science Survey (ISSS). The CFPS is a nationally representative longitudinal survey launched in 2010 by Peking University and is conducted biannually since 2010. It covers 25 provinces/cities/autonomous regions and is based on 16,000 Chinese households. It includes data on all family members in each household. The 2014 wave of the CFPS has unique a financial literacy module, which allows for the analyses in this study. In addition to this, the CFPS has detailed survey data on respondents' mental health, demographics and socioeconomic characteristics. More details about the data and variables in the CFPS dataset

can be found in Xie et al. (2017). This study focuses on the respondents aged 18 and over. Obvervations with missing values for any of the regression variables are dropped. This leads to a total sample of 3,277 observations in the estimation (The sample size flow chart is reported in Appendix B.7).

4.2.4. Measurements of variables

Dependent variable

The 2014 wave of the CFPS includes the Kessler Psychological Distress Scale (K6) as a quick tool to screen and measure the severity of an individual's mental health problems. The K6 has been widely used to detect common mental disorders in epidemiological studies and primary care (Prochaska et al., 2012). Some national surveys (e.g., the National Health Interview Survey) include the K6 to screen the mental health condition of the general population (Kim et al., 2016). The K6 has been reported to have a satisfying performance in screening common mental disorders in both high-income countries such as Japan and Korea (Fu et al., 2017; Min and Lee, 2015), and middle-income countries like China (Kang et al., 2015; Chan and Fung, 2013). The wording of the K6 questions in the CFPS is shown in Appendix B.1. It captures the following six dimensions: feeling depressed, feeling nervous, feeling hopeless, restless or fidgety, feeling that everything is an effort, and feeling that life is meaningless. For each dimension, respondents are asked to assess the frequency of each feeling over the past month, with scores ranging from 1 to 5, where 1 refers to "never" while 5 refers to "almost daily". An individual's K6 score is obtained as the sum of his/her total scores of the six questions (e.g., Prochaska et al., 2012). This yields a minimum score of 6 and a maximum score of 30. Higher scores indicate a worse mental health status. The internal consistency estimate (Cronbach alpha) of the K6 scores is 0.87 for the total sample, indicating a relatively good internal consistency among the respondents.

Financial literacy

According to the OECD-INFE (2011, p.3), financial literacy is "a combination of awareness, knowledge, skills, attitude and behaviours necessary to make sound financial decisions and ultimately achieve individual financial well-being." Accordingly, the OECD thus uses the combination of three components including financial knowledge, financial behaviours and financial attitude to measure overall financial literacy (OECD, 2011; 2018). Following this, the 2014 wave of the CFPS includes 25 questions aimed at measuring overall financial literacy considering the three components: financial knowledge, financial attitudes and financial behaviours.

Financial knowledge

Financial knowledge is measured by thirteen financial knowledge questions in the 2014 CFPS. The thirteen financial questions are displayed in Appendix B.2. The thirteen financial questions included in the CFPS reflect different levels of difficulty. Following the previous research (Van Rooji et al., 2011; Wang et al., 2021), to differentiate different levels of financial knowledge, the thirteen questions are re-grouped into basic financial knowledge and advanced financial knowledge.

Basic financial knowledge is measured by the first five financial questions (see Appendix B.2). Basic financial knowledge means financial knowledge and numerical skills that are fundamental and necessary for daily financial decision-making. The five questions are designed to measure a respondent's awareness of the bank's interest rates, understanding and calculation of simple interest and compounding interest, understanding of inflation and the time value of money.

The remaining eight financial questions are grouped to measure advanced financial knowledge (also see Appendix B.2). Compared to basic financial knowledge, advanced

financial knowledge means more complex financial knowledge that is related to investment decisions. The eight financial questions aim to capture respondents' understanding of the central bank, investment-related concepts (such as risks and returns, risk diversification and stock markets), and the ability to differentiate various financial products (e.g., stocks, capital funds, bank's financial products).

This study uses two approaches to measure the financial knowledge of respondents. First, a financial knowledge score is calculated by counting the total number of correct answers to the questions. The "do not know" answer is scored as zero. This approach is commonly used in previous studies to measure financial knowledge levels (e.g., Lusardi and Mitchell, 2007a; 2008). The basic and advanced financial knowledge scores respectively range from 0 to 5 and 0 to 8.

Second, an alternative measure of the level of financial knowledge is developed through principal factor analysis. Following previous studies (Van Rooij et al., 2011; Wang et al., 2021), this study applies factor analysis to the financial knowledge questions to construct combined indexes to measure financial knowledge. This procedure aims to combine the financial questions capturing different aspects of financial knowledge into a more general measure of financial knowledge. First, factor analysis is performed on the five basic financial questions and the eight advanced financial questions, in turn, yielding a basic financial knowledge index and an advanced financial knowledge index. It will be instructive to consider the "do not know" answers. The respondents who choose "do not know" answers might have lower levels of financial literacy as they think they are not familiar with or even do not understand the financial questions and related concepts (Van Rooij et al., 2011). Therefore, both "do not know" answers and correct answers are considered when performing the factor analysis of the financial questions. Specifically, two dummies are created for each financial

knowledge question to differentiate between the correct answer and the "do not know" answer. More details of factor analysis are presented in Appendix B.3.

Financial attitudes

The 2014 CFPS includes three statements to assess the respondents' attitudes towards money, spending and saving (Appendix B.2). Those statements are designed to measure one's preference for short-run (i.e., spending now) or long-run budgeting (i.e., planning for the future). A five-point scale is used where 1 indicates that the statement is completely inapplicable for the respondent and 5 indicates the statement is completely applicable. People with more savvy financial attitudes tend to have a preference for long-run budgeting, which is usually beneficial for financial well-being. Therefore, more financially literate people should be less likely to agree with each statement (Atkinson and Messy, 2012). For simplicity of interpretation, the answers to each statement are reverse coded. Following OECD/INFE (2018), for each respondent, this study uses the average score of the three questions related to financial attitudes. The average financial attitude score ranges therefore from 1 to 5, where higher scores indicate more financially literate attitudes.

Financial behaviours

Financial behaviours reflect one's ability to apply financial knowledge and skills in practice, which is directly related to various financial outcomes. As suggested by the OECD/INFE (2011; 2018), financial behaviours should also be considered when measuring overall financial literacy. The 2014 CFPS contains nine questions focusing on a series of financial behaviours like making a considered purchase, paying bills on time, concerning financial situation, saving, budgeting, borrowing and so on. The respondents were asked to specify whether these statements are applicable or inapplicable to them. Following OECD/INFE (2011; 2018), the

financial behaviour score is calculated by counting the total number of rational financial behaviours of each respondent. The total score of financial behaviour ranges from 0 to 9.

Control variables

To isolate the relationship between financial literacy and mental health, it is crucial to control for other possible determinants of mental health. Based on the literature (Kadoya et al., 2016; 2017; 2018), demographic and social factors such as age, gender, residence, education level, marital status, employment, health status, exercise and provincial dummies are considered, together with economic factors such as household income, household assets, household debt. These variables and their expected signs are discussed hereafter. Detailed definitions of the dependent variable and the control variables are displayed in Table 4-1.

Table 4-1 Variables and Definitions

Variables	Definitions in the survey
Psychological distress	Mental health is measured by the 6-item Kessler Psychological Distress Scale (K6) (Appendix B.1). Each item is coded 1-5, where 5 = daily and 1 = never. The total score (ranging from 6 to 30) of the six questions is calculated as the index of an individual's mental health in the model. A higher score indicates a worse mental health status.
Age	Respondents' age in 2014.
Gender	Dummy variable equal to 1 if the respondent is male, and 0 otherwise.
Education	Respondents' years of education.
Residence	Dummy variable equal to 1 if the respondent lives in an urban area, and 0 if he/she lives in a rural area.
Marital status	Respondents' marital status, which includes five categories: never married, married, cohabitating, divorced, and widowed.
Employment	Respondents' employment status. It is categorised into four groups: employed, unemployed, out of labour market, and retired.
Health status	Respondents' self-assessed health status. The answer is grouped into five items: excellent, very good, good, fair or bad.
Exercise	1 = exercise at least once a week, 0 = otherwise
Income	Logarithm of the household's net income, which includes net income of agricultural production, profit from self-employment or operating private enterprises, various subsidies and alms from government, social donation, pension, wages of all family members, income from renting and selling properties, savings interests, and income from financial investments.
Asset	Logarithm of the household's total assets, which include houses, land, financial assets (such as deposits, stocks, funds, bonds, financial derivatives, and other financial products), productive fixed assets and durable goods.
Debt	Logarithm of the total amount of the household's debt, which includes total housing liabilities and total non-housing liabilities.

Source: 2014 wave of the CFPS.

Age is closely related to mental health or the prevalence of mood disorders (Mirowsky and Ross, 1992; WHO, 2014). Studies have reported that the relationship between age and mental well-being is negative and the relationship between age squared and mental well-being is positive. To show the importance of controlling for age, in Figure B.4-1 in Appendix B.4, the distribution of mental health sorted by age is diaplayed. In light of the pattern in Figure B.4-1, the models include both age and age square as controls.

Gender is considered as a control since women are more likely to report emotional disorders such as depression or anxiety (WHO, 2014). It has been reported that women are more likely to be exposed to factors such as socioeconomic disadvantage, pregnancy, violence, and lack of emotional support, which are typically related to poorer mental health (WHO, 2014).

Economic inequality in different areas might affect people's mental health. People living in less developed areas may experience worse mental well-being possibly due to less convenient living environment, worse access to education, lack of access to medical services and so on (Wang et al., 2021). Therefore, the estimation models take into account whether a respondent lives in an urban or rural area. Provincial dummies are also included as controls in models.

In general, having a partner seems to be a protector of both mental and physical health for most people (Williams et al., 2010; Bulloch et al., 2017). For example, people who are married have been shown to have lower depression rates, better psychological well-being and lower death rates than the unmarried (Williams et al., 2010; Bulloch et al., 2017). Meanwhile, people who are separated and divorced display poorer health compared with married and single people. Therefore, maritial status is included as a control variables, with the following five categories are considered: never married, married, cohabitating, divorced, and widowed.

Health status and exercise are included as control variables, since better physical health and regular exercise are found to be related to a lower risk of depression or anxiety (Ohrnberger et al., 2017; Penedo et al., 2005). In the CFPS, the health status is measured by asking the respondent to self-rate their health status. A five-point scale is used to measure the health status of respondents with 1, 2, 3, 4, 5 indicating excellent, very good, good, fair, and poor health respectively. Health status is thus considered by constructing five dummies, respectively for each of the above-mentioned characterisations of health. For exercise, a dummy variable is created and it equals to 1 if the respondent exercises at least once a week, and 0 otherwise.

Studies have uncovered the profound effects of socioeconomic factors like education, family income, family assets, and employment status on mental health/disorders. Factors such as a lack of education, unemployment, and financial poverty have been associated with a higher chance of developing anxiety or depression (Assari, 2017). Therefore, socioeconomic factors such as educational level, employment status, and household finances are included as control variables. The educational level is measured by years of education. Employment status is categorised into employed, unemployed, out of labour market and retired. The models also include the logarithm of family income, family debt and family assets as controls. Each of the continuous economic variables is winsorised at a 1% level before taking the logarithms.

4.3. Results

4.3.1. Descriptive Statistics

Financial literacy

The distribution of responses to financial questions is displayed in Table 4-2 for basic financial knowledge and Table 4-3 for advanced financial knowledge. Table 4-2a (Table 4-3a) shows the proportion of correct, incorrect, do not know and refuse answers to the five basic (eight advanced) financial knowledge questions. Over half of the respondents provide the correct

answers to basic questions related to the banks' interest rate, compound interest calculation, inflation and time value of money. Focusing on advanced questions (Table 4-3a), 87.24% of respondents answered the question on the relation between risks and returns correctly and just under 70% of respondents gave the correct answer to the question on differentiating financial instruments.

The percentage of correct answers hovers between 25% and 35% among more advanced financial questions related to risk diversification, the function of the central bank, banks' financial products and the function of the stock market. Finally, only between 13% and 17% of respondents gave the correct answer to the questions on the stock market and capital funds. In Table 4-2b, 16.42% of respondents answer all five basic financial knowledge questions correctly. At the same time, 7.72% of respondents provide "do not know" answers to all the five questions. In Table 4-3b, only less than 5% of the respondents answer seven or more advanced financial questions correctly. The results imply that most of the respondents have a certain grasp of basic financial concepts like the time value of money and inflation. However, the overall basic financial knowledge level of the respondents is not high, which is in line with that observed in Feng et al. (2019), Zou and Deng (2019) and Wang et al. (2021).

Table 4-2 Distribution of responses to basic financial knowledge questions

Table 4-2a. ***Percentage of responses to basic financial knowledge questions***

Questions	Correct	Incorrect	Do not know	Refuse
Q1. Current annual interest rate	56.88	9.61	33.51	0
Q2. Simple interest calculation	46.66	33.32	19.99	0.03
Q3. Compound interest calculation	52.85	24.93	22.22	0
Q4. Inflation	60.24	19.10	20.66	0
Q5. Time value of money	70.80	13.53	15.65	0

Table 4-2b. ***Distribution of the number of correct answers to five basic financial knowledge questions***

Proportion	All	Four	Three	Two	One	None
Correct	16.42	24.72	21.51	15.07	11.78	10.50
Do not know	7.72	6.26	5.74	6.84	17.52	55.94

Note: Data in this table is calculated using the 2014 wave of the CFPS. The total number of observations is 3,227. The exact wording of the basic financial knowledge questions is displayed in Appendix B.2.

Table 4-3 Distribution of responses to advanced financial knowledge questions

Table 4-3a. ***Percentage of responses to advanced financial knowledge questions***

Questions	Correct	Incorrect	Do not know	Refuse
Q6. Relation between returns and risks	87.24	5.65	7.11	0.00
Q7. Risk diversification	24.57	36.31	39.12	0.00
Q8. The function of the central bank	32.29	38.45	29.26	0.00
Q9. Differentiating financial instruments	69.91	11.66	18.43	0.00
Q10. Understanding of Stocks	17.27	43.40	39.33	0.03
Q11. Understanding of Capital funds	13.37	33.26	53.37	0.00
Q12. Understanding of bank's financial products	31.52	34.24	34.24	0.00
Q13. Function of the stock market	29.75	23.59	46.66	0.00

Table 4-3b. ***Distribution of the number of different type of answers to advanced financial knowledge questions***

	All	Seven	Six	Five	Four	Three	Two	One	None
Correct	1.56	3.60	7.57	10.62	17.18	19.93	19.77	13.46	6.32
Do not know	4.46	6.93	7.48	8.48	8.30	9.31	10.86	13.27	30.91

Note: Data in this table is calculated using the 2014 wave of the CFPS. The total number of observations is 3,227. The exact wording of the advanced financial knowledge is displayed in Appendix B.2.

Table 4-4 displays descriptive statistics of financial literacy scores. The data show a relatively low level of financial knowledge among Chinese adults. The average basic (advanced) financial knowledge score is 2.87 (3.18) out of 5 (8). This means that, on average, the respondents could only answer around six financial knowledge questions (out of 13) correctly. The average financial attitude score is 3.37 out of 5 and the average financial behaviour score is 4.63 out of 9. The description of the constructed financial knowledge indices is reported in Table 4-5. All the indices are standardised, so the mean value and standard deviation of the three financial knowledge indices are zero and one respectively.

Table 4-4 Descriptive statistics for financial knowledge, attitudes, and behaviours

Variable	*Mean*	*SD*	*Min*	*Max*
Basic financial knowledge	2.87	1.57	0	5
Advanced financial knowledge	3.18	1.88	0	8
Financial behaviours	4.63	2.08	0	9
Financial attitudes	3.38	1.00	1	5

Note: The total number of observations is 3,277. SD denotes the standard deviation.

Table 4-5 Descriptive statistics for constructed financial knowledge indices

Variable	*Mean*	*SD*	*Min*	*Median*	*Max*
Basic financial knowledge index	0	1	-2.08	0.39	1.02
Advanced financial knowledge index	0	1	-1.95	0.19	1.67

Note: Data in this table is calculated using the 2014 wave of the CFPS.

Descriptive statistics of other variables

Table 4-6 presents the descriptive statistics of other variables used in this study. The mean value of the K6 scores is 9.00 (on a scale which runs from 6 to 30), which is lower than the cut-off point of 11.00, which has been associated with moderate mental illness (Prochaska et al., 2012; Kessler et al., 2002) [3].

[3] As the K6 scale used in this study ranges from 6 to 30, whilst that typically used in the literature ranges from 0 to 24, the threshold of 11 that is used to identify moderate mental illness is equivalent to the threshold of 5 frequently used in the literature (e.g., Prochaska et al., 2012; Fu et al., 2017).

Table 4-6 Descriptive statistics of other variables

Variable	Mean	SD/N=X	Min	Max
K6 score	9.00	3.86	6	30
Age	49.68	15.08	18	92
Male	45.59%	1570	0	1
Marital status				
Never married	6.04%	208	0	1
Married	81.39%	2,803	0	1
Cohabitation	0.78%	27	0	1
Divorced	4.44%	153	0	1
Widowed	7.35%	253	0	1
Residence (=1 if urban)	94.55%	3222	0	1
Education	10.12	4.29	0	19
Employment status				
Unemployed	1.28%	44	0	1
Employed	58.42%	2012	0	1
Retired	27.53%	948	0	1
Out of labour market	12.78%	440	0	1
Health status				
Health-Excellent	9.49%	327	0	1
Health-Very good	15.33%	528	0	1
Health-Good	44.98%	1549	0	1
Health-Fair	17.13%	590	0	1
Health-Poor	13.07%	450	0	1
Exercise	56.68%	1952	0	1
Income	71588.89	77177.26	10	600,000.00
Log income	10.77	1.02	2.30	13.30
Family assets	730639.90	1031593.00	0	5,780,200.00
Log Family assets	12.47	1.89	0	15.57
Debt	39847.90	104985.30	0	600,000.00
Log Family debt	3.01	5.00	0	13.31

Notes: a. All values in Table 4-6 are calculated by the author based on the 2014 wave of the CFPS. Definitions of each variable are displayed in Table 4-1. b. The total sample size is 3,277 in Table 4-6.

All of the respondents are aged 18 or higher, and the mean age is 49.68. The proportion of females is slightly higher than that of males (female: 54.63%). The majority of respondents are married (81.39%) Most of the respondents are from urban areas (94.55%). Around 70% of respondents assess their health status as good or very good, and 56.68% report exercising at least once a week.

In terms of socioeconomic characteristics, the mean value of educational years of the respondents is around 10 years. Over half of the respondents are employed and 27.53% are retired. The average net household income and assets are respectively 71, 588.89 Chinese yuan (10, 226.98 U.S. $s)[4], and 730, 639.90 Chinese yuan (104, 377.13 U.S. $s). The average amount of household debt is 39, 847.90 Chinese yuan (5, 692.56 U.S. $s), accounting for around 5.45% of average household assets and 55.66% of income.

Correlation matrix

The paired correlations among the included variables are presented in Table 4-7. The majority of the correlations are statistically significant. The correlation between the basic financial knowledge score and advanced financial knowledge score is the highest at 0.54. There are moderate positive correlations between the years of education and financial knowledge (0.42 and 0.48 for basic and advanced financial knowledge respectively). This implies that more educated respondents also tend to be more financially literate. Except for the three correlations listed above, the correlations among other variables generally vary from weak to moderate and are no larger than 0.40[5]. This suggests that the independent variables included in the multivariate analysis are free from multi-collinearity bias.

[4] The exchange rate used is 1 U.S. $ = 7.00 Chinese Yuan.

[5] One exception is the high correlation between being retired and age, which is expected as older people are more likely to be retired. Other exceptions are the negative correlations between being divorced/widowed and being married. These are also expected given the definitions of these dummies.

Table 4-7 Correlation matrix of variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
K6 score	1.00																							
Basic FK	-0.10***	1.00																						
Advanced FK	-0.04*	0.54***	1.00																					
FA	-0.02	0.11***	0.09***	1.00																				
FB	0.03	0.17***	0.23***	0.03	1.00																			
Age	-0.05**	-0.23***	-0.32***	-0.18***	-0.11***	1.00																		
Male	-0.08***	0.11***	0.15***	0.01	-0.02	0.04*	1.00																	
Married	-0.08***	0.07***	0.03***	0.05**	0.04*	0.01	0.04*	1.00																
Cohabiting	0.03	-0.00	0.01	-0.01	0.01	-0.02	0.02	-0.20***	1.00															
Divorced	0.05**	-0.04**	-0.01	-0.02	-0.00	0.02	-0.01	-0.46***	-0.02	1.00														
Widowed	0.04*	-0.17***	-0.17***	-0.07***	-0.05**	0.32***	-0.13***	-0.56***	-0.02	-0.06**	1.00													
Urban	-0.02	0.10***	0.11***	-0.02	0.06***	0.05**	-0.03*	-0.00	0.01	0.02	-0.00	1.00												
Health-poor	0.28***	-0.14***	-0.12***	-0.04*	-0.03	0.18***	-0.07***	-0.03	0.02	0.02	0.09***	-0.01	1.00											
Health-fair	0.02	-0.09***	-0.11***	-0.03	-0.07***	0.11***	-0.05**	0.03	-0.01	-0.01	0.01	-0.01	-0.17***	1.00										
Health-good	-0.06***	0.12***	0.12***	0.02	0.03	0.01	0.04*	0.06**	-0.01	-0.02	-0.01	0.05**	-0.34***	-0.41***	1.00									
Health-very good	-0.10***	0.07***	0.05**	0.05**	0.03	-0.18***	0.03	-0.04*	-0.02	0.01	-0.06**	-0.04*	-0.16***	-0.19***	-0.39***	1.00								
Exercise	-0.10***	0.06**	0.06**	-0.06***	0.10***	0.18***	0.01	-0.01	-0.02	-0.01	0.05**	0.08***	-0.03	-0.02	0.07***	-0.03	1.00							
Education	-0.06***	0.42***	0.48***	0.05**	0.11***	-0.41***	0.09***	0.04*	0.01	0.01	-0.23***	0.12***	-0.17***	-0.08***	0.12***	0.05**	0.08***	1.00						
Unemployed	0.04*	-0.04*	-0.03	0.03	-0.01	-0.04*	-0.01	-0.01	0.05**	0.01	-0.02	0.01	0.03	0.03	-0.02	-0.03	0.02	-0.01	1.00					
Retired	-0.08***	-0.12***	-0.24***	-0.17***	-0.04*	0.68***	-0.05**	-0.07***	0.00	-0.02	0.26***	0.05**	0.12***	0.10***	0.00	-0.13***	0.19***	-0.25***	-0.07***	1.00				
Out of labour market	0.11***	-0.12***	-0.09***	0.02	-0.02	-0.04*	-0.19***	0.03	0.02	0.02	0.00	0.01	0.12***	0.00	-0.05**	-0.02	-0.07***	-0.12***	-0.04*	-0.23***	1.00			
Log of income	-0.10***	0.29***	0.25***	-0.01	0.07***	-0.06**	0.07***	0.17***	-0.05**	-0.10***	-0.16***	0.06***	-0.09***	-0.02	0.08***	0.00	0.07***	0.27***	-0.08***	-0.01	-0.14***	1.00		
Log of assets	-0.14***	0.26***	0.23***	-0.03	0.07***	0.02	0.04*	0.23***	-0.08***	-0.11***	-0.12***	0.09***	-0.11***	0.00	0.09***	0.00	0.11***	0.21***	-0.09***	-0.07***	0.09***	0.40***	1.00	
Log of debt	0.09***	-0.01	0.09***	0.04*	0.07***	-0.22***	0.02	0.08***	0.00	0.04*	-0.10***	-0.01	0.00	-0.03	0.01	0.01	-0.06**	0.10***	0.05***	-0.21***	0.01	0.02	0.07***	1.00

Notes: FK stands for financial knowledge. FA stands for financial attitudes. FB stands for financial behaviours. * p < 0.1, ** p < 0.05, *** p < 0.01

4.3.2. Regression results

This section starts by reporting the results of the OLS estimates of Equation 4-1. This is followed by the results of negative binomial regression results. Finally, the results of the robustness checks and the analysis which differentiates the effects of financial literacy on the mental health of indebted and non-indebted respondents are presented.

OLS estimation results

Table 4-8 reports the results of the OLS estimates of Equation 4-1. The results of the OLS estimates without adjusting for health status are reported in Appendix B.8.

First, Model 1 and Model 5 are estimated to examine the association between basic financial knowledge and K6 scores. The results in Model 1 show that there is a negatively significant association between basic financial knowledge and K6 scores, which is in line with the first hypothesis. The coefficient implies that for one additional correct answer in the basic financial knowledge questions, the K6 scores would be 0.11 points lower. Here, to assess the economic significance of this effect, it is compared to the estimated effects associated with other control variables. For example, the effect of having one additional correct answer to the basic financial knowledge questions accounts for approximately 53.80% of the effect of being male and 13.71% of being married, both of which are believed to have a large impact on mental health.

When adding family economic variables, the association between basic financial knowledge and the K6 score is substantially reduces and becomes insignificant (Model 5). At the same time, a strong association between assets (or debt) and K6 scores is observed in all models in Panel B. Specifically, having more assets and lower levels of debt) are associated with lower K6 scores. In Models 2 and 6, no significant associations between the two variables are observed.

Table 4-8 Financial literacy and mental health: OLS regression results

	Panel A				Panel B			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Basic financial knowledge score	-0.113**				-0.073			
	(0.045)				(0.045)			
Advanced financial knowledge score		-0.002				0.023		
		(0.037)				(0.038)		
Financial behaviour score			-0.063**				-0.063**	
			(0.031)				(0.031)	
Financial attitude score				-0.126*				-0.128**
				(0.064)				(0.064)
Age	-0.015	-0.014	-0.014	-0.015	-0.006	-0.005	-0.005	-0.007
	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)
Age squared	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Male	-0.210	-0.231*	-0.245*	-0.227*	-0.239*	-0.264**	-0.267**	-0.249*
	(0.133)	(0.133)	(0.133)	(0.133)	(0.133)	(0.133)	(0.133)	(0.133)
Urban/Rural	-0.094	-0.139	-0.110	-0.141	-0.064	-0.100	-0.060	-0.089
	(0.268)	(0.267)	(0.266)	(0.265)	(0.264)	(0.263)	(0.264)	(0.261)

Table 4-8 Continued

	Panel A				Panel B			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Marital status (reference group: Never married)								
Married	-0.824**	-0.822**	-0.804**	-0.798**	-0.797**	-0.783**	-0.777**	-0.759**
	(0.321)	(0.320)	(0.322)	(0.321)	(0.328)	(0.328)	(0.329)	(0.329)
Cohabitation	0.009	0.000	0.028	0.008	-0.143	-0.148	-0.117	-0.135
	(0.746)	(0.744)	(0.744)	(0.746)	(0.7342)	(0.741)	(0.740)	(0.742)
Divorced	0.050	0.095	0.104	0.103	-0.105	-0.082	-0.078	-0.074
	(0.457)	(0.457)	(0.458)	(0.457)	(0.455)	(0.454)	(0.455)	(0.455)
Widowed	-0.094	-0.051	-0.049	-0.029	-0.169	-0.145	-0.148	-0.122
	(0.458)	(0.458)	(0.459)	(0.459)	(0.461)	(0.462)	(0.462)	(0.463)
Exercise	-0.455***	-0.461***	-0.439***	-0.464***	-0.425***	-0.431***	-0.404***	-0.429***
	(0.136)	(0.137)	(0.137)	(0.137)	(0.137)	(0.137)	(0.137)	(0.137)
Years of education	-0.027	-0.041**	-0.038**	-0.042**	-0.021	-0.032	-0.026	-0.029
	(0.019)	(0.020)	(0.019)	(0.019)	(0.020)	(0.020)	(0.020)	(0.020)
Employment status (reference group: Employed)								
Unemployed	0.323	0.375	0.363	0.400	0.123	0.147	0.131	0.163
	(0.720)	(0.715)	(0.712)	(0.713)	(0.709)	(0.705)	(0.704)	(0.705)
Retired	-0.584***	-0.592***	-0.605***	-0.610***	-0.572***	-0.570***	-0.589***	-0.596***
	(0.205)	(0.206)	(0.206)	(0.205)	(0.216)	(0.216)	(0.216)	(0.216)
Out of labour market	0.361	0.390	0.380	0.388	0.323	0.339	0.328	0.332
	(0.221)	(0.243)	(0.242)	(0.243)	(0.240)	(0.240)	(0.240)	(0.241)

Table 4-8 Continued

	Panel A				Panel B			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Health status (reference group: Excellent)								
Health-poor	4.255***	4.267***	4.244***	4.280***	4.179***	4.180***	4.160***	4.196***
	(0.313)	(0.314)	(0.314)	(0.313)	(0.313)	(0.312)	(0.313)	(0.312)
Health-fair	1.667***	1.677***	1.640***	1.692***	1.659***	1.667***	1.627***	1.679***
	(0.233)	(0.233)	(0.234)	(0.232)	(0.233)	(0.233)	(0.233)	(0.232)
Health-good	1.272***	1.248***	1.232***	1.268***	1.269***	1.249***	1.238***	1.275***
	(0.188)	(0.188)	(0.188)	(0.187)	(0.188)	(0.188)	(0.187)	(0.186)
Health-very good	0.423**	0.396**	0.392**	0.419**	0.431**	0.412**	0.411**	0.438**
	(0.197)	(0.197)	(0.197)	(0.195)	(0.196)	(0.196)	(0.196)	(0.194)
Log of income					-0.067	-0.085	-0.076	-0.083
					(0.075)	(0.075)	(0.074)	(0.075)
Log of assets					-0.130***	-0.141***	-0.135***	-0.140***
					(0.047)	(0.048)	(0.047)	(0.047)
Log of debt					0.051***	0.052***	0.054***	0.052***
					(0.013)	(0.013)	(0.013)	(0.013)
Constant	10.680***	10.496***	10.706***	10.913***	12.478***	12.602***	12.704***	13.032***
	(0.809)	(0.813)	(0.811)	(0.836)	(1.111)	(1.108)	(1.106)	(1.128)

Note: Data in this table is calculated using the 2014 wave of the CFPS. The number of observation in Table 4-8 is 3,277. Provincial dummies are also included but the related coefficients are not reported in the table for brevity. Standard errors in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01

Model 3 (and Model 7 in Panel B) and Model 4 (and Model 8 in Panel B) estimate the association between financial behaviour (financial attitude) and K6 scores. Both financial attitude and behaviour scores are significantly associated with the K6 score. This is, once again, consistent with the first hypothesis. Specifically, an additional point of positive financial behaviour (or financial attitudes) is associated with a 0.06 lower K6 score (or a 0.13 lower K6 score). The effect of having one additional point of postivie financial behaviour (or financial attitudes) accounts for approximately 25.71% (or 55.50%)of the effect of being male. The association between the two variables remains strong and significant after including the three household financial variables (Models 7 and 8).

The estimated parameters associated with control variables such as age, gender, marital status, employment status, health and exercise are significant and consistent in both Panel A and Panel B. Specifically, a strong negative relationship is found between gender and mental health. This is consistent with previous evidence that males are less likely to report depressive symptoms (WHO, 2014). No association between age or age square and the K6 score is observed. In line with Assari (2017), marital status is a strong predictor of mental health. Compared to the never-married respondents, having a spouse is significantly and negatively associated with K6 scores. As for employment status, retired respondents are less likely to show symptoms of depression compared to those out of the labour market (or employed).

Additionally, both health status and doing exercises are significant predictors of better mental health in all models. The magnitude of the estimated effect on health status is the largest in all models. Compared to respondents with excellent health status, respondents who assessed their health as “poor” and “fair” tend to have higher K6 scores. Furthermore, doing exercises at least once a week is also found to be significantly and negatively associated with higher K6 scores. The strong positive relations between health status and doing exercise, on the one hand,

and better mental health conditions, on the other, are consistent with previous studies (Ohrnberger et al., 2017; Penedo et al., 2005).

Models 5 to 8 include household assets, income, and debt. In all models, household assets are negatively associated with the K6 scores, whilst household debt is positively associated with the same scores. The first finding is consistent with the social causation theory, according to which poverty might increase the risk of depression or anxiety (Simmons et al., 2008; Lund and Cois, 2018b). Conversely, individuals with more financial resources tend to have better mental health. The second finding is consistent with Bridges and Disney (2010) and Drentea and Reynolds (2015) who find that debt problems have a negative impact on mental health.

To test for the multi-collinearity issue, the variance inflation factor (VIF) is checked based on all independent variables including financial knowledge, financial behaviour, financial attitude, age, gender, residence, marital status, education, exercise, employment status, health status, household income, assets and debt (see Table 4-9). The VIF score associated with all variables is less than 5, indicating no multi-collinearity issues in models. In model 5 (and Model 10 in Panel B), all components of financial literacy are introduced together. The results are similar to those reported in Models 1 to 4 (Models 6 to 9).

Table 4-9 VIF test results

Variables	VIF	Tolerance (1/VIF)
Basic financial knowledge score	1.600	0.625
Advanced financial knowledge score	1.740	0.575
Financial behaviour score	1.090	0.921
Financial attitude score	1.070	0.932
Age	2.860	0.350
Gender	1.190	0.843
Urban/Rural	1.090	0.915
Marital status (reference group: Never married)		
Married	3.190	0.313
Cohabitation	1.160	0.864
Divorced	1.850	0.541
Widowed	2.580	0.388
Exercise	1.130	0.886
Years of education	1.690	0.591
Employment status (reference group: Employed)		
Unemployed	1.040	0.963
Retired	2.220	0.451
Out of labour market	1.230	0.814
Health status (reference group: Excellent)		
Health-poor	2.190	0.457
Health-fair	2.420	0.414
Health-good	3.280	0.305
Health-very good	2.220	0.449
Log of income	1.400	0.712
Log of assets	1.460	0.687
Log of debt	1.140	0.880
Mean VIF	2.020	

Negative binomial regression estimation results

Table 4-10 presents the results of a series of negative binomial estimates of Equation 4-1. The estimated results of negative binomial regressions are consistent with those of the OLS regressions. Models 1 and 5 also show that there is a negatively significant association between basic financial knowledge and K6 scores with the estimated parameter of 0.113. Yet, the association becomes insignificant at a significance level of 0.05 when the household financial

variables are introduced. Similar to the results from the OLS regressions, the association between advanced financial knowledge and K6 scores is insignificant in all models. Both financial attitude and financial behaviours are still negatively and significantly associated with K6 scores in the negative binomial regressions. In sum, the results of the negative binomial regressions in Table 4-10 support those of the OLS regressions in Table 4-8. This implies that the association between financial literacy and mental health is robust to the use of different types of estimation methods. In terms of control variables, the marginal effects obtained from the negative binomial models are also consistent with the coefficients reported in Table 4-8.

Table 4-10 Financial literacy and mental health: Negative binomial regression results

	Panel A				Panel B			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Basic financial knowledge	-0.113***				-0.073*			
	(0.043)				(0.043)			
Advanced financial knowledge		-0.002				0.022		
		(0.037)				(0.038)		
Financial behaviours			-0.064**				-0.065**	
			(0.029)				(0.029)	
Financial attitudes				-0.127**				-0.129**
				(0.060)				(0.060)
Age	-0.015	-0.014	-0.014	-0.015	-0.008	-0.007	-0.007	-0.008
	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)
Age squared	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Male	-0.219*	-0.240*	-0.256**	-0.238*	-0.249*	-0.274**	-0.280**	-0.261**
	(0.127)	(0.128)	(0.127)	(0.127)	(0.127)	(0.128)	(0.127)	(0.127)
Urban/Rural	-0.096	-0.139	-0.109	-0.140	-0.066	-0.101	-0.060	-0.090
	(0.252)	(0.253)	(0.252)	(0.252)	(0.251)	(0.252)	(0.251)	(0.251)

Table 4-10 Continued

	Panel A				Panel B			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Marital status (reference group: Never married)								
Married	-0.813***	-0.810***	-0.791***	-0.788***	-0.794***	-0.781***	-0.772***	-0.758***
	(0.278)	(0.278)	(0.278)	(0.278)	(0.282)	(0.282)	(0.282)	(0.282)
Cohabiting	-0.103	-0.102	-0.074	-0.097	-0.229	-0.241	-0.208	-0.229
	(0.670)	(0.670)	(0.670)	(0.670)	(0.668)	(0.668)	(0.668)	(0.668)
Divorced	0.004	0.047	0.060	0.055	-0.167	-0.148	-0.139	-0.139
	(0.387)	(0.387)	(0.387)	(0.387)	(0.389)	(0.389)	(0.389)	(0.389)
Widowed	-0.090	-0.046	-0.041	-0.027	-0.166	-0.141	-0.141	-0.121
	(0.378)	(0.378)	(0.377)	(0.378)	(0.378)	(0.378)	(0.378)	(0.378)
Exercise	-0.444***	-0.451***	-0.428***	-0.454***	-0.417***	-0.422***	-0.396***	-0.422***
	(0.125)	(0.125)	(0.125)	(0.125)	(0.124)	(0.124)	(0.125)	(0.124)
Education	-0.027	-0.041**	-0.038**	-0.042**	-0.021	-0.032*	-0.027	-0.029*
	(0.018)	(0.018)	(0.017)	(0.017)	(0.018)	(0.018)	(0.017)	(0.017)
Employment status (reference group: Employed)								
Unemployed	0.254	0.298	0.287	0.326	0.043	0.059	0.044	0.080
	(0.504)	(0.505)	(0.504)	(0.504)	(0.505)	(0.505)	(0.505)	(0.505)
Retired	-0.582***	-0.589***	-0.604***	-0.609***	-0.571***	-0.569***	-0.591***	-0.598***
	(0.207)	(0.208)	(0.208)	(0.208)	(0.207)	(0.207)	(0.207)	(0.207)
Out of labour market	0.309	0.339*	0.330*	0.339*	0.265	0.283	0.271	0.277
	(0.190)	(0.190)	(0.190)	(0.190)	(0.190)	(0.190)	(0.190)	(0.190)

Table 4-10 Continued

	Panel A				Panel B			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Health status (reference group: Health-excellent)								
Health-poor	3.978***	3.992***	3.969***	4.005***	3.907***	3.908***	3.887***	3.924***
	(0.263)	(0.263)	(0.263)	(0.263)	(0.263)	(0.263)	(0.263)	(0.263)
Health-fair	1.748***	1.756***	1.719***	1.772***	1.742***	1.750***	1.709***	1.763***
	(0.252)	(0.252)	(0.253)	(0.252)	(0.251)	(0.251)	(0.252)	(0.251)
Health-good	1.349***	1.325***	1.307***	1.346***	1.347***	1.327***	1.314***	1.354***
	(0.223)	(0.223)	(0.223)	(0.223)	(0.222)	(0.222)	(0.222)	(0.222)
Health-very good	0.463*	0.437*	0.434*	0.462*	0.472*	0.454*	0.454*	0.482*
	(0.254)	(0.255)	(0.254)	(0.255)	(0.254)	(0.254)	(0.253)	(0.254)
Log of income					-0.065	-0.083	-0.073	-0.080
					(0.070)	(0.069)	(0.069)	(0.069)
Log of assets					-0.120***	-0.131***	-0.126***	-0.130***
					(0.037)	(0.037)	(0.037)	(0.037)
Log of debts					0.049***	0.050***	0.052***	0.050***
					(0.012)	(0.012)	(0.012)	(0.012)

Note: Data in this table is calculated using the 2014 wave of the CFPS. The dependent variable is the K6 score. Marginal effects are reported with standard errors in parentheses. Provincial dummies are also included but the related coefficients are not reported in the table for brevity. * p < 0.1, ** p < 0.05, *** p < 0.01

Robustness checks

The results of the first robustness check, where a dichotomised outcome variable (i.e., using 11 as a cut-off point for the K6 scale is applied, are displayed in Table B.6-1 (Appendix B.6).

The results obtained from the logit models are similar to those reported in Table 4-8. Specifically, the results show that one additional correct answer in the basic financial knowledge questions is associated with a 1.1 percentage point (pp) lower chance of showing moderate to serious mental health problems (Model 1). This effect disappears altogether once financial variables are included in the model (Model 5). The marginal effects associated with the advanced financial literacy score are insignificant. As for the marginal effects associated with financial attitudes and behaviour, they are both negative and significant (Models 3 and 4) and remain unchanged once financial variables are further included (Models 7 and 8). They suggest that one additional positive financial behaviour is associated with a 0.7 pp lower chance of showing moderate to serious mental health problems, whilst one additional point on the average financial attitude score is associated with a 1.7-1.8 pp lower chance of showing a K6 score of 11 or above.

The results of the further robustness check are displayed in Table B.6-2 (see Appendix B.6). The results are again similar to those reported in Tables 4-8 and 4-10. They suggest that the main results are robust when measuring financial literacy differently.

Generally, the results of the IV regressions (Table B.6-3 in Appendix B.6) are consistent with those of the negative binomial regressions reported in Table 4-10. Model 1 and Model 6 examine the association between basic financial knowledge and the K6 score. There is a negative and significant association between basic financial knowledge and the K6 score, which disappears when the household financial variables are included. As in the negative binomial regressions, the association between advanced financial knowledge and depressive

symptom score is insignificant in all models (Model 2 and Model 6). Both financial attitude and financial behaviours are still significantly associated with the K6 score and the association remains after including financial variables (Models 3, 4, 7, and 8). In sum, the results of the IV regressions are in line with those in Table 4-8. It should be noted that the IV estimates of the coefficients associated with the financial literacy variables are larger compared to the OLS estimates and the negative binomial estimates. This is consistent with previous studies that looked at the social determinant of mental health (e.g., Dursun and Cesur, 2016; Kondirolli and Sunder, 2022). The discussion for why this may be the case can be found in Kondirolli and Sunder (2022).

Taking indebtedness into account

Tables 4-11 and 4-12 present the results of the estimates of Equation 4-2 obtained using OLS regression models and negative binomial models, respectively. The results presented in Table 4-11 are very similar as those in Table 4-12.

For instance, focusing on Table 4-12 (Models 1 to 4), the estimated marginal effect associated with the interaction between basic financial knowledge and debt is negative and significant. This implies that the association between basic financial knowledge and K6 scores is stronger for indebted individuals. An extra point on the basic financial knowledge score is associated with a 0.10 lower K6 score for non-indebted individuals (Model 1). The corresponding figure for indebted individuals is 0.29 (0.10+0.19). The association between advanced financial knowledge and depressive symptoms remains insignificant. However, the estimates associated with the interaction between advanced financial knowledge and debt becomes significant. This implies that advanced financial knowledge is only associated with mental health for indebted individuals. For indebted individuals, an extra point on the advanced financial knowledge score is associated with a 0.18 lower K6 score (Model 2).

Financial attitude and financial behaviours show negative and significant marginal effects. Specifically, an additional savvy financial behaviour is associated with a 0.07 lower K6 score (Model 3). An additional point on the financial attitudes score is associated with a 0.12 lower K6 score (Model 4). However, the estimated marginal effects associated with the interaction between either financial attitudes or behaviours and debt are not statistically significant. This reveals that the association between financial attitudes or behaviours and mental health does not vary according to the respodnents' debt status.

When the financial variables are added to the models (Models 5 to 8), the estimated marginal effect associated with both the basic financial knowledge scores becomes smaller

than 1, and only marginally significant (Model 5). The estimated marginal effect associated with the interaction between basic financial literacy and debt remains significant and is only slightly smaller than Model 1. Comparing Model 6 with Model 2, a similar pattern is observed for the interaction between advanced financial knowledge and debt. In Models 7 and 8, the estimates associated with financial attitudes and financial behaviours remain significant and similar in magnitude compared to those observed in Models 3 and 4. The marginal effects associated with the interaction between financial attitudes and behaviours and debt remain insignificant.

Table 4-11 Taking indebtedness into account: OLS regression results

	Panel A				Panel B			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Basic financial knowledge	-0.105**				-0.075*			
	(0.043)				(0.044)			
Basic financial knowledge * Debt	-.193**				-0.196**			
	(0.085)				(0.078)			
Advanced financial knowledge		-0.004				0.021		
		(0.037)				(0.038)		
Advanced financial knowledge * Debt		-.178**				-0.183***		
		(0.072)				(0.069)		
Financial behaviour score			-0.067**				-0.067**	
			(0.029)				(0.029)	
Financial behaviour * Debt			-0.090				-0.090	
			(0.066)				(0.057)	
Financial attitude score				-0.122**				-0.131**
				(0.060)				(0.060)
Financial attitudes * Debt				0.132				0.054
				(0.133)				(0.114)
Log of income					-0.066	-0.079	-0.079	-0.085
					(0.071)	(0.070)	(0.070)	(0.070)
Log of assets					-0.122***	-0.134***	-0.134***	-0.131***
					(0.037)	(0.037)	(0.037)	(0.037)
Log of debt					0.154*	0.154*	0.110	0.105
					(0.091)	(0.091)	(0.089)	(0.089)

Note: The dependent variable is the K6 score. Debt is a dummy equal to 1 if the respondent has housing and/or non-housing debt, and 0 otherwise. The sample size is 3,277. All models control for age; age squared; gender; urban versus rural residence; marital, health, employment, and exercise status; years of education; and provincial dummies, but their marginal effects are not reported for brevity. Models 1 to 4 also control for the Debt dummy non-interacted. Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4-12 Taking indebtedness into account: Negative binomial regression results

	Panel A				Panel B			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Basic financial knowledge	-0.104**				-0.076*			
	(0.043)				(0.043)			
Basic financial knowledge * Debt	-0.192**				-0.195**			
	(0.085)				(0.079)			
Advanced financial knowledge		-0.004				0.020		
		(0.037)				(0.038)		
Advanced financial knowledge * Debt		-0.176**				-0.183**		
		(0.072)				(0.069)		
Financial behaviours			-0.072**				-0.067**	
			(0.029)				(0.028)	
Financial behaviours * Debt			-0.077				-0.089	
			(0.066)				(0.057)	
Financial attitudes				-0.123**				-0.129**
				(0.060)				(0.060)
Financial attitudes * Debt				0.134				0.055
				(0.133)				(0.114)
Log of income					-0.063	-0.076	-0.075	-0.078
					(0.069)	(0.069)	(0.070)	(0.070)
Log of assets					-0.121***	-0.132***	-0.131***	-0.128***
					(0.037)	(0.037)	(0.037)	(0.037)
Log of debt					0.100***	0.105***	0.091***	0.032
					(0.024)	(0.024)	(0.029)	(0.038)

Note: The dependent variable is the K6 score. Debt is a dummy equal to 1 if the respondent has housing and/or non-housing debt, and 0 otherwise. The sample size is 3,277. Marginal effects are reported with standard errors in parentheses. All models control for age; age squared; gender; urban versus rural residence; marital, health, employment, and exercise status; years of education; and provincial dummies, but their marginal effects are not reported for brevity. Models 1 to 4 also control for the Debt dummy non-interacted. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

4.4. Discussion

4.4.1. Summary and Interpretation

Using the data from the 2014 wave of the China Family Panel Studies (CFPS), the current study investigates the cross-sectional association between financial literacy and mental health among Chinese adults aged 18 and over. Respondents in the sample show an average K6 score of 9.00 on the 6 to 30 scale. Rescaling this figure to fit the 0-24 scale, this is equivalent to a score of 3.00 which is consistent with the average K6 score observed in Japan by Fu et al. (2017) over the period 2005-2013.

Firstly, in line with the first hypothesis, the results show that all three components of financial literacy: basic financial knowledge, financial behaviours and financial attitudes are positively and significantly associated with mental health. These results are robust to using different estimation strategies and different measures of both financial knowledge and the outcome variable.

The finding that basic financial knowledge is negatively associated with K6 scores is in line with the findings of prior literature showing that financial literacy, when measured by financial knowledge, is associated with anxiety, depression, and health (Bennett et al., 2012; Kadoya et al., 2017; 2018). When controlling for family economic indicators (such as income, assets and debt), the association between basic financial knowledge and mental health becomes smaller and either marginally significant or insignificant. Meanwhile, assets levels are found to be negatively and significantly associated with K6 scores and debt was positively associated with K6 scores. This might suggest that the association between basic financial knowledge and mental well-being is mediated by household assets and debt. Similarly, Kadoya et al. (2017; 2018) also find no direct association between financial knowledge and anxiety after considering household economic indicators. They also documented that financial knowledge

can reduce anxiety in older age through increased household finances. In these regards, the findings of this study suggest that financial knowledge can influence mental well-being through its impacts on household finances.

The finding of a significant relationship between financial attitudes or financial behaviours and mental health is novel. The relationship remains significant when controlling for economic indicators, suggesting that the association is not mediated by income, debt, and/or assets. In the case of financial attitudes, this is confirmed by the fact that the correlation matrix shows that financial attitudes are not significantly associated with income, assets, and debt. However, it is likely that financial attitudes might reflect specific types of personality trait that can either affect or be affected by mental health status (Brooks and Williams, 2021), though financial knowledge is believed to help shape the financial attitudes. Therefore, future research is needed to examine in-depth if financial attitudes are related to mental health through other factors that have not been considered in this study.

The fact that the relationship between financial behaviours and mental health remains after controlling for income, wealth, and indebtedness suggests that the link between the two variables is not mediated by household finances. This can happen as individuals with more financially savvy behaviours can feel better control over their financial situation, which is a critical component of financial and psychological well-being (Frenkel et al., 1998). Moreover, studies have shown that people with more financially savvy behaviours are more likely to experience better financial satisfaction as well as economic empowerment (Joo and Grable, 2004; Cole et al., 2008; Haque and Zulfiqar, 2016), which are closely related to better mental health (Rautio et al., 2012; Taft et al., 2013; Shooshtari et al., 2018). Therefore, financial behaviours may influence mental health through other pathways that have not been considered in this study and that are on the agenda for future research.

This study also shows that the negative association between financial knowledge and

depression is stronger among respondents with debt than those without any debt. The association between both basic and advanced financial knowledge and mental health for respondents with debt does not diminish when household finances are accounted for. This finding supports to the third hypothesis. It can be explained considering that indebted individuals have been reported to suffer from poor mental health (Brown et al., 2005; Bridges and Disney, 2010). This problem is likely to be exacerbated in China, where the debt to GDP ratio has been increasing significantly in recent years from 18% in 2008 to around 56% by the end of 2019 (see Appendix B.5). China's household debt level is much higher than that of other developing economies like India and is almost on par with household debt levels in Japan and many European countries. These rising levels of debt have been shown to be strongly related to a rising incidence of depression in China (Liu et al., 2021). According to the data, the K6 score is 8.78 for people without debt and 9.58 for indebted respondents and the difference between the two figures is highly significant. It is therefore not surprising that financial literacy is more beneficial to indebted individuals in terms of helping to better manage their debt, thus alleviating their mental health problems. Moreover, as just under 60% of respondents' total debt in the sample is made up of housing debt, a better financial knowledge will help indebted respondents understand that property may appreciate in value over time, which may bring psychological satisfaction.

Unexpectedly, there are no significant differences in the association between financial attitudes or financial behaviours and mental health between adults with household debt and those without debt. The differences in these findings might be due to the following reason. The measurement questions of financial attitudes and financial behaviours mainly focuses on the respondent's attitudes and behaviour towards savings and spending, rather than debt management. By contrast, the measurement questions of financial knowledge captures respondents' understanding of financial concepts and the ability to calculate in the financial

arena. This type of financial knowledge helps people better manage their debt (Lusardi and Tufano, 2015).

4.4.2. Strengths

This paper has threemain strengths. First, this is the first paper to explore the relationship between multiple dimensions of financial literacy and mental health (i.e., financial knowledge, attitudes, and behaviours). This is important as the knowledge of basic economic and financial concepts can only be beneficial if used to manage financial resources effectively, which can be achieved through positive financial attitudes and savvy financial behaviours. Second, this study is the first to look at the nexus between financial literacy and mental health among individuals aged 18 and over in a middle-income setting. This is important as mental health problems are widespread across adult populations as well as in middle- and low-income countries. Third, this study makes use of a wide range of econometric techniques, including a negative binomial estimator to account for the discrete nature of the main outcome variable, an IV estimator to account for the possible endogeneity of financial literacy, and a logit model when using a dichotomous left-hand-side variable.

4.4.3. Limitations

This study suffers from a number of limitations that need to be acknowledged. First, since the key independent variable, financial literacy, is only available in the 2014 wave of the CFPS, the study is cross-sectional. The confounding effects of unobservable variables such as personal traits, self-control, ability cannot be fully accounted for in this study. The estimates in this study may therefore suffer from omitted variable bias. To alleviate this concern, the estimation models in this study have controlled for a wide range of individual- and household-specific variables in all the models.

Furthermore, making any causal inferences on the association between financial literacy and mental health based on this study can be difficult due to the potential influence ofreverse causality. For instance, it has been shown that mental disorders are associated with reduced cognitive functions (Gotlib and Joormann, 2010; Kaur et al., 2019). Reduced cognitive ability might hinder an individual's ability to acquire and apply financial literacy. Additionally, individuals with common mental disorders like depression and anxiety are highly likely to have irrational consumption, weak self-control, reduced labour supply and productivity (Ridley, et al., 2020). These factors can be harmful to their financial situation and the accumulation of financial resources, which in turn, makes them become less likely to invest in improving their financial literacy (Hasting et al., 2013; APEC, 2014). This problem is taken into account by making use of an instrumental variable estimator whereby financial literacy is instrumented using the average financial literacy of others living in the same county as the respondent, as well as the respondent's father's education (Bucher-Koenen and Lusardi, 2011).

Third, it should be noted that measurement of the outcome variable, the K6 scale used in this study, is not designed to screen for mental disorders clinically. It is usually used in epidemiological studies or general health surveys to assess the prevalence of common mental problems (Prochaska et al., 2012). Therefore, the results of this study should be interpreted as the association between financial literacy and mental health in general rather than clinically diagnosed mental disorders. Yet, the K6 scale has a strong correlation with clinically diagnosed mood disorders and is widely used in mental health research (Kessler et al., 2002; Prochaska et al., 2012).

Finally, whilst this study identifies household finances as a possible mechanism underpinning the association between financial knowledge and mental health, due to the unavailability of data, it does not investigate potential alternative pathways underpinning the association between financial attitudes/behaviours and mental health. Examples of these

pathways could be personality traits, financial satisfaction, and/or as economic empowerment. It will be beneficial to analyse these pathways in future research once additional data become available.

4.4.4. Implications

The findings of this study have the following implications. First, Policy makers should not overlook the psychological benefits of improving financial literacy when evaluating the costs and effectiveness of financial education programmes. Increasing investments in financial education might have a profound influence on mental health both in the short term and the long term, especially for those who bear a heavy debt burden.

Our results also highlight the importance of exposure to financial education programs designed to enhance not only financial knowledge, but also other dimensions of financial literacy, such as financial behaviours and financial attitudes. Programs aimed at enhancing financial knowledge should focus on giving people the tools necessary to perform basic financial calculations of interest and principal, as well as to understand concepts such as the time value of money. Programs aimed at enhancing financial attitudes could address people's excessive short-term focus, whilst programs aimed at enhancing financial behaviours should make people aware of the benefits of making long-term plans, spending responsibly, paying bills on time and so on.

Social prescribing approaches for improving mental health are important, especially in low- and middle-income countries like China, where mental health services are distributed unevenly, and there are unmet needs for treatment targeting mental disorders (Charlson et al., 2016). In other words, in addition to the traditional treatment of mental health, strategies targeting the socioeconomic determinants of mental health may be helpful. Medical practitioners and mental health counsellors might benefit from assessing patients' financial

situation regularly, with a specific focus on their debt status. If mental health problems are due to financial problems such as an excessive debt burden, they might refer the patients to social or non-clinical services, for example, seeking financial advice or financial education from financial professionals. For those with moderate mental health problems and a relatively poor financial situation, financial education aimed at improving not only financial knowledge, but also financial behaviours and attitudes may be particularly helpful in preventing a worsening in mental health.

4.5. Conclusion

To the best of my knowledge, this study is the first to explore the relationship between the different dimensions of financial literacy, namely, financial knowledge, financial behaviour and attitudes and mental health targeting Chinese adults. This study found that financial literacy (intended as financial knowledge, financially attitude and financial behaviours) was significantly associated with lower levels of depression. Furthermore, the association between financial knowledge and depression was found to be stronger among indebted respondents. The findings suggest that the education programme aimed at improving financial literacy might have the potential to enhance mental health in Chinese adults. It should be borne in mind that this study is cross-sectional due to the limited availability of data. Thus, it is difficult to make causal inferences regarding the relationship between financial literacy and mental health. Future research is needed to further investigate the causality and direction of the association between financial literacy and mental health outcomes using either longitudinal or experimental research methods. It is also important to know more about the mechanisms underlying the relationship between financial literacy and mental well-being.

Chapter V: Financial Literacy and Depressive Symptoms: Longitudinal Evidence from the U.S.

Having explored the relationship between financial literacy and depression in Chinese adults, the next stage in investigating the nature of the financial literacy and mental health relationship is to explore if this relationship also holds over time to get stronger causal inferences (i.e., the second research question). Moreover, this chapter aims to explore the potential mechanisms that can explain the relationship between financial literacy levels and mental health (i.e., the third research question). Chapter IV suggests that the relationship between financial literacy and depression may be partially explained by household finances. Based on this, this chapter explicitly examines the mediating role of household finances (i.e., income and wealth) on the relationship between financial literacy with depression using a longitudinal mediation analysis.

This chapter addresses research gaps that were discussed in the previous chapter, provides the first longitudinal analysis of the relationship between financial literacy and depression, with the objective of identifing the economic pathways by which financial literacy is related to depression. This chapter begins by presenting the introduction and the research hypotheses. (i.e., sections 5.1 and 5.2). Section 5.3 introduces the method, which describes the dataset, the variables, and the econometric models. The results are reported in section 5.4, which is followed by a discussion of the key findings in section 5.5, and a brief conclusion in section 5.6.

5.1. Introduction

Depression has long been regarded as an important public health issue worldwide including the U.S. (Fiske et al., 2009; Morichi et al., 2015; The Center of Disease Control and Prevention [CDC], 2010). In the U.S., it is estimated that about 20% of middle-aged and older adults experience some types of mental health problem (Fiske et al., 2009; CDC, 2012). Depression is the most prevalent mental health problems among middle-aged and older adults in the U.S. (McLaughlin, 2011). About 15% of middle-aged and older adults have depressive symptoms (Fiske et al., 2009; CDC, 2012). Depression might cause great suffering and is significantly associated with impairment in physical, mental and social functioning, worsening health outcomes, higher health care resource utilisation, and reduced quality of life (Hickie et al., 2005; Van Milligen et al., 2011; McLaughlin, 2011; WHO, 2017). Besides, depressive symptoms and depression history have also been reported to predict the risk of developing Alzheimer's disease or dementia in older ages (Gatz, et al., 2005; Li et al., 2011). Considering the consequences of depression, the prevention of depressive symptoms in middle-aged and older individuals is critical to improving the overall well-being of these populations. Identifying ways to reduce or prevent depression will have implications for interventions aimed at reducing the population health burden of depression. This study examines financial literacy as an underexplored risk/protective factor for depression among older adults in the U.S..

In recent decades, the financial environment has begun to evolve more quickly, which is marked by the increasing complexity of financial products and services, the rapid growth of financial technology, and the increasing volatility of financial markets (Philippas and Avdoulas, 2020). In such a financial environment, individuals need to make an increasing number of financial decisions throughout their lifetime, and the financial decisions that they may face are becoming more complex. This requires them to possess the ability to understand and to apply financial information and concepts in making appropriate financial decisions and effective

financial management . This ability, which is often referred to as financial literacy, is essential for individuals to effectively operate in this constantly evolving financial environment. It is the key element of making sound and value-maximising financial decisions and is critical to the money management and the achievement of financial well-being. People with low financial literacy levels tend to make suboptimal financial decisions or make mistakes with decisions on saving, borrowing, investment and so on (Chapter II). This can, in turn, affect financial outcomes. For example, evidence has shown that low financial literacy levels are associated with worse financial outcomes such as lower income and lower wealth accumulation (refer to Chapter II for more details).

Making appropriate financial decisions and maintaining financial well-being may be especially challenging among middle-aged and older adults. While older adults are faced with a myriad of complex healthcare and financial decisions, they are highly vulnerable to poor decision makings (James et al., 2012). It has in fact been shown that adults face declines in cognition function from later middle age and the older population displays a low level of financial literacy, which can negatively affect the ability of making appropriate financial decisions (Best et al., 2021; Redmer and Grotlüschen, 2021). A declining cognition can also make older people more vulnerable to financial scams and frauds, or financial exploitation (OECD, 2020; Lusardi, 2012; DeVaney, 2016). Thus, older individuals without sufficient financial literacy levels might face an increased risk of struggling to maintain a healthy financial situation. Being one of the most important risk factors of mental disorders, stress due to insufficient financial resources can contribute to the development of depressive symptoms and predict depression (Taylor et al., 2011; Ridley et al., 2020). This suggests that there may be an indirect relationship between financial literacy and depression operating through household financial resources such as income and/or wealth.

Financial literacy may also have a direct effect on mental health. This might be because being financially literate implies a better feeling of control over one's financial situation, personal and social confidence in day-to-day financial management, and self-esteem, which are all related to mental well-being (Taylor et al., 2011; Orth and Robins, 2013; Ellicock, 2019). In summary, low levels of financial literacy can be associated with depressive symptoms both directly and indirectly through insufficient financial resources such as household income and wealth.

A handful of studies have analysed the link between financial literacy and mental health outcomes (Bennett et al., 2012; Kadoya et al., 2017; 2018). However, the existing studies make use of cross-sectional analyses, and, as a result, the sequence between financial literacy and depression has not been established. In addition, this relationship has only been studied in small samples representing specific population groups. Therefore, their findings may not be representative of the general population. Finally, the possible pathways through which financial literacy is related to mental health outcomes have not been investigated in the existing literature.

To fill these gaps, this study aims to investigates the longitudinal relationship between financial literacy and depressive symptoms in a nationally representative sample, sourced from the Health and Retirement Study (HRS) over the period 2002-2014. Using a cross-lagged longitudinal mediation analysis, it explicitly examines the mediating role of both household income and wealth underlying this relationship. Given the costs of mental disorders and the age-related declines in financial literacy, a better understanding of how financial literacy is related to depression will be informative for developing policies aimed at improving mental well-being in middle-aged and older adults.

The remainder of this study is organised as follows. Section 5.2 proposes the hypotheses that are investigated in this study. Section 5.3 introduces the method, which describes the dataset, the variables, and the econometric models. The results are reported in section 5.4,

which is followed by a discussion of the key findings in section 5.5, and a brief conclusion in section 5.6.

5.2. Literature Review and Hypotheses

5.2.1. Financial literacy and mental health

Financial literacy has been associated with health and mental health outcomes in a few studies (Bennett et al., 2012; Zheng et al., 2021). For example, previous cross-sectional studies have shown the existence of a negative relationship between financial literacy and depression and anxiety (Bennett et al., 2012; Kadoya et al., 2017; 2018). Based on a group of the elderly without dementia from the U.S., Bennett et al. (2012) found that lower levels of financial literacy were correlated with adverse mental health outcomes including depression. Financial capability, which is indicated by a series of financial behaviours, has also been found to have a significant impact on mental health (Taylor et al., 2011). Moreover, lower levels of financial capability were found to aggravate the psychological stress due to negative life events, for example, unemployment (Taylor et al., 2011). These findings can be explained bearing in mind that being financially literate may lead to a better feeling of control over one's financial situation, to personal and social confidence in day-to-day financial management, and to self-esteem, which are all positively associated with mental well-being (Taylor et al., 2011; Ellicock, 2019). In light of these considerations, the first hypothesis reads:

H1: There is a negative association between financial literacy and depressive symptoms.

5.2.2. The mediation role of household income and wealth

The financial consequences of financial literacy have been increasingly investigated. As discussed in Chapter II, financial literacy is crucial for the financial decision making in the evolving financial environment and is closely related to a variety of financial outcomes such as income and wealth accumulation. Specifically, higher financial literacy levels have been

found to be associated with greater levels of unspent income, the upward micro income mobility or improved income status (Klapper et al., 2013; Monsura, 2020; Wang et al., 2021). Other studies associated with numeracy, which is an important component of financial literacy, also provide supportive evidence of a positive relation between financial literacy and income (Grinyer, 2005; Jenkins et al., 2011). Evidence related to wealth shows a similar trend: financial literacy or numeracy is positively associated with more household wealth accumulation (Van Rooij et al., 2012; Behrman et al., 2010; 2012). The causal effect of financial literacy on wealth accumulation has been investigated in Van Rooij et al. (2012) and Behrman et al. (2010). Both studies found that financial literacy can positively affect household wealth accumulation (Behrman et al., 2010; Van Rooij et al., 2012). Moreover, the effect of financial literacy on wealth accumulation was independent of and stronger than that of general education (Behrman et al., 2010; 2012). Besides, prior literature also shows that attending financial literacy programmes can positively affect saving behaviours and thus increase savings or wealth accumulation, though the magnitudes of such an effect varies substantially across studies and populations (Atkinson et al., 2015; Gale et al., 2012).

Previous research suggests several reasons as to why financial literacy can affect personal and household income or wealth. For example, people with low financial literacy are less capable of accurately evaluating and processing information, are more likely to make suboptimal financial decisions, make financial mistakes, and are more vulnerable to financial exploitation, all of which can reduce their disposable income and/or wealth accumulation (Agarwal and Mazumder 2013; Wood et al., 2016). Conversely, more financially literates are more likely to take part in the stock market and better performance in investment, have better saving and retirement plans, less likely to encounter financial shocks, etc., all of which have been documented to boost household income and wealth (refer to section 2.5 in Chapter II for more details).

One's financial situation is an important determinant of mental well-being. The lack of sufficient financial resources such as income and wealth are associated with increased risk of experiencing depressive symptoms; while individuals with more financial resources are less likely to develop depressive symptoms (Alloush, 2017; Osafo Hounkpatin et al., 2015; Jin et al., 2020). Longitudinal evidence shows that an increase (or decrease) in household income is associated with a decreased (or increased) risk of the incidence of depression (Golberstein, 2015; Sareen et al., 2011; Alloush, 2017). Longitudinal evidence on wealth also provides similar results showing that low wealth or negative changes in wealth can lead to the increased risk of experiencing depressive symptoms (Pool et al., 2017; Lund et al., 2018b).

Income and wealth can be linked to mental health outcomes for several reasons. First, from a welfare perspective, individuals who lack financial resources such as income and wealth are more likely to experience financial strain and less able to deal with unexpected financial situations. These individuals also face substantial uncertainty and income volatility. They are also more likely to have poor living conditions and nutrition status, worse physical health and life quality, and limited access to medical, health and many other services (Lund et al., 2018b ; Jin et al., 2020), which can all lead to a worsening in mental health. Second, this can be explained from a psychological perspective. On one hand, psychological stress due to upward social comparison against a reference group or concerns about the uncertain future situation can also have adverse effects on mental health (Staufenbiel et al., 2013; Verduyn et al., 2017). On the other hand, the psychological stress induced by financial issues, for example, having problem debt, financial uncertainty, or negative income shocks, can lead to worsen mental health outcomes and increased risk of experiencing depression (Gathergood, 2012; Ridley et al., 2020; also see section 3.3 in Chapter III).

Taking all this evidence together, it is reasonable to assume that individuals with higher financial literacy are prone to make more rational and value-maximising financial decisions,

and thus more likely to accumulate financial resources such as income and wealth. At the same time, all else equal, individuals with more household income and wealth are less likely to develop depressive symptoms. Accordingly, this study proposes that financial literacy to affect mental health through two potential mediators: income and wealth. This leads to the following hypotheses:

H2: The relationship between financial literacy and depressive symptoms is partially mediated by household income. Those who have higher levels of financial literacy tend to have higher family income and are thereby less likely to show depressive symptoms.

H3: The relationship between financial literacy and depressive symptoms is partially mediated by household net wealth (defined as total assets minus total debt). Those who have higher levels of financial literacy are more likely to accumulate wealth, and thereby less likely to show depressive symptoms.

5.3. Methods

This study, which uses data from the Health and Retirement Study (a nationally representative sample of adults aged 50 and older) over the period 2002-2014, is the first major longitudinal investigation of financial literacy and depressive symptoms. A measure of financial literacy is proxied using three numeracy related questions covering percentage calculation, lottery division, interest rate calculation. The eight-item Centre for Epidemiologic Studies Depression Scale (CESD-8) is used to measure depressive symptoms. The survey questions for financial literacy and depression are displayed in Appendices C.1 and C.2. More details regarding the used variables are showed in section 5.3.2.

First, this study uses fixed effect models and correlated random effects negative binomial regression models to examine the relationship between financial literacy and depressive symptoms. Then, it performs autoregressive cross-lagged mediation analyses within structural

equation modelling to investigate the mediating roles of household income and wealth on the relationship between financial literacy and depressive symptoms. By applying the temporal ordering of the variables, this method enables the examination of the mediation effects whilst accounting for potential reverse causation. Additionally, the models include previous values of the dependent variable, as well as of all key variables to alleviate concerns about potential unmeasured confounders that can influence both financial literacy and mental health (Cole and Maxwell, 2003). The following sections provide a detailed description of the data and sample, variables, and the statistical methods used in this study.

5.3.1. Data and sample

The Health and Retirement Study (HRS) is a nationally representative biannual longitudinal survey of U.S. adults aged 50 and over and their spouses, conducted by the University of Michigan's Institute for Social Research. Since 1992, the HRS collects data on demographics, health, cognition, financial condition, financial capacity, social welfare, insurance, retirement preparation, labour force status, family characteristics and so on. The HRS also includes data on numeracy, financial literacy and mental health, which are relevant for the analyses in this study. The key variables are described in section 5.3.2. This study mainly uses data from waves 6 (2002), 8 (2006), 10 (2010), and 12 (2014) of the HRS. Starting with HRS 2002, questions measuring numeracy (or numerical ability) have been added to the core modules of the survey. Numeracy questions are asked every second wave and are included in waves 6, 8, 10, and 12. Numeracy is collected in waves 7, 9, 11 and 13 only for the respondents who had not been asked previously (i.e., in waves 6, 8, 10 and 12, respectively). Following previous research (McArdle et al., 2009), to maximise the number of observations, this study uses the information on numeracy from either an even wave or an odd wave (i.e., 6 or 7, 8 or 9, 10 or 11, and 12 or 13), depending on where it is available. The total number of available observations in these four waves is 85,428. As the HRS typically focuses on respondents aged 50 and over,

respondents aged less than 50 are removed (3,489). Then observations with missing data on numeracy and the CESD-8 score are also dropped, together with observations with missing values in any of the control variables (7,367). Finally, the baseline panel analysis is based on a sample of 74,572 observations.

5.3.2. Variables

Depressive symptoms

In the HRS, the depressive symptoms measured by a subset of the 20 items from the Centre for Epidemiological Studies Depression Scale (CESD). The CESD scale is designed to measure depressive symptomatology in the general population and is tested to be reliable and valid for a variety of subpopulations. Eight items of the CESD scale (CESD-8) are included in all waves of the HRS, except for the 1992 HRS (with 11 items of the CESD scale). Specifically, participants are asked to rate aspects such as "felt depressed," "restless sleep," "felt lonely" over the past week using a binary Yes (1) and No (0) scale. Two items expressed in the positive direction such as "happiness" and "life enjoyment" are reversely coded. Following Zurlo et al. (2014) and Asebedo and Wilmarth (2017), for each respondent, the total CESD-8 score is calculated by summing up any symptoms associated with depression. This leads to the total scores of CESD-8 range from 0 to 8 where a higher score indicates more depressive symptoms. The Cronbach's alpha of the CESD-8 measure varies from 0.81 to 0.83 across waves, indicating an adequate internal consistency (Steffick, 2000). The specific questions used to construct the index are listed in Appendix C.2.

Numeracy

In the last chapter, financial literacy is measured by 24 questions related to financial knowledge, financial attitudes and financial behaviour. Due to the difference between datasets, this study uses a different indicator of financial literacy-numeracy. Numerical ability is an important

aspect of financial literacy, and it is reported to be highly related to financial literacy, financial capability (OECD/INFE, 2018; Sunderaraman, 2020). Numeracy has also been used in some previous studies to indicate financial literacy (Gousia, 2016; Arts, 2018; Nolan and Doorley, 2019). The measurement of numeracy can be found in the cognition function section in the core module of the HRS since the 2002 HRS. All respondents in the core survey are asked the three basic calculation questions aimed at assessing their numerical ability. The three numeracy questions are percentage calculation, lottery division and interest rate calculation, respectively. The detailed content of the three numeracy questions is listed in Appendix C.1. To get financial literacy scores (i.e., measured by numeracy questions), the correct answers to the three numeracy questions are summed for each respondent. The total score of financial literacy ranges from zero to three, where higher scores indicate higher levels of financial literacy.

Financial literacy

In the HRS, the measurement of financial literacy was developed by Lusardi and was firstly introduced in the experimental module in the 2004 HRS (wave 7). The Big Three - the three financial literacy questions that capture the aspects such as simple calculation of interest rates, understanding the inflation and the relationship between risks and returns. Financial literacy questions are included in waves 7, 10, and 13 of HRS with 1261, 1805, 1640 respondents participating in the module respectively. The detailed content of the three financial literacy questions is listed in Appendix C.1. In this study, financial literacy score is measured by the sum of correct answers on three financial literacy questions. The financial literacy scores range from zero to three, where higher scores indicate higher financial literacy levels.

In this section, the relationship between numeracy and financial literacy is examined using the HRS dataset. This aims to further confirm that whether numeracy can be used as an indicator of financial literacy in each wave. The results are displayed in Table 5-1. The results in Table 5-1 show that in each of the waves analysed (wave 7, wave 10 or wave 13), there is a

significant and positive association between financial literacy scores and numeracy scores. This suggests that it is reasonable to use numeracy to proxy financial literacy in the following analyses.

Table 5-1 The correlations between numeracy score and financial literacy

Financial literacy score	**Wave 7**	**Wave 10**	**Wave 13**
Numeracy score (Wave 7)	0.428***		
	(0.06)		
Numeracy score (Wave 10)		0.351***	
		(0.022)	
Numeracy score (Wave 13)			0.403***
			(0.048)
N	207	1833	352

Notes: Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. N denotes number of observations. Only waves 7, 10 and 13 have information on financial literacy.

Income and wealth

One of the objects of this chapter is to investigate whether financial literacy affects mental health through the household financial situation. Household income and wealth are used as two indicators of household financial situation. Household income and wealth are time-varying variables that repeatedly measured in each wave of the HRS. A household's wealth is calculated as the total amount of household assets minus the total amount of household debt. Both household income and household wealth are included as two mediators in the mediation analyses. The annual values of household income and household wealth in each wave are adjusted for inflation based on the United States Consumer Price Index. Then the inflation-adjusted household income and household wealth are winsorised at the 1% level to eliminate extreme values that can have a substantial impact on the accuracy of analysis results (Kwak and Kim, 2017). The nature logarithm is taken for the above financial variables considering the

skewed nature of data. This lowers the possible impact of heteroscedasticity (Wang et al., 2021). Prior to taking the logarithm, financial variables are recoded to be above zero by adding 1 to each of the two financial variables to assure the logged form of zero values is reported as zero (Feng et al., 2014).

5.3.3. Empirical strategy

The analyses are started with the summary statistics of variables including mean, minimum, maximum, standard deviation (SD). The multivariable analyses are described as below.

Baseline model

To test for the overall effect of financial literacy on depressive symptoms, the following model is estimated:

$$DEP_{it} = \beta_0 + \beta_1 FL_{i,t} + \beta_2{}' X_{i,t} + \beta_3{}' Z_i + c_i + \eta_t + u_{i,t}, \quad (i = 1,\ 2,\ 3,\ \ldots,\ N;\ t = 1,\ 2,\ 3,\ 4) \qquad 5\text{-}1$$

In equation 5-1, *i* indicates the individual and *t* indicates the time. The dependent variable DP_{it} represents depressive symptoms experienced by the respondents in the past week. It is measured by the CESD-8 scale. $FL_{i,t}$ is the total financial literacy score. $X_{i,t}$ is a vector of time-varying control variables related to the respondent's characteristics. They include age, health condition, residence, marital status, and employment status. Z_i is a vector of time-invariant control variables including gender, race and educational attainment. The control variables are described in section 5.3.3. Definitions of all variables are displayed in Table 5-2. The error term comprises three terms: c_i denotes individual-specified unobserved heterogeneity. it is taken into account by estimating the model using panel data estimators. η_t is a time-specific component, which is taken into account by including year dummies. u_{it} is an idiosyncratic component of the error term. The analysis assumes that u_{it} is independent and identically

distributed. For hypothesis 1 to hold, β_1 is expected to be negative and significant in equation 5-1.

Estimation methods

First, this study applies fixed-effect linear models to assess the within-person relationship between financial literacy and depressive symptoms. The fixed effects model has the advantage of netting out all time-invariant individual-specific heterogeneity. In this study, the fixed-effects model is preferable to the random-effects model since it allows for the correlation between the individual-specific effect and the included independent variables (Greene, 2008). Additionally, the results of the Hausman test also indicate that a fixed effects model is preferred based on this study's sample ($p<0.000$).

Considering the characteristics of the dependent variable (i.e., over-dispersed count data), equation 5-1 is then estimated using a negative binomial model. Allison and Waterman (2002) argue that although the fixed effects negative binomial model can deal with unobserved heterogeneity, the estimated results from a fixed effects negative binomial model do not fully control for all time-invariant variables when using mainstream statistical software packages (e.g., Stata). Given this methodological limitation, this study applies a negative binomial regression model with correlated random effects to control for time-invariant unobserved individual heterogeneity. By including means of all time-variant control variables, this model allows for the correlation between unobserved confounders and time-varying confounders in a random-effects setting (Wooldridge, 2005; 2019). Thus, the equation estimated using the correlated random effects negative binomial model takes the following form:

$$DP_{it} = \beta_0 + \beta_1 FL_{i,t} + \beta_2{}' X_{i,t} + \beta_3 \overline{FL}_i + \beta_4{}' \overline{X_{i,t}} + \beta_3{}' Z_i + c_i + \eta_t + u_{it} \qquad 5\text{-}2$$

In equation 5-2, all the variables and components of error term are the same as those in equation 5-1, with the exception of $\overline{FL_{it}}$ and $\overline{X_{it}}$, which respectively denote the mean values

of individual *i*'s financial literacy score and the mean values of all time-varying confounders across waves. Once again, for hypothesis 1 to hold, β_1 is expected to be negative and significant in equation 1.

Control variables

A set of covariates that might affect depressive symptoms are considered in regression models. The control variables are mainly identified following prior literature on the financial literacy and mental health relationship (e.g., Kadoya, et al., 2016; 2017; 2018) and those on social and economic determinants of depression (e.g., Fastame et al., 2019). These control variables include age, gender, educational attainment, race, region, marital status, employment status, and health condition.

Specifically, age is defined as age in years at the beginning of the interview, which is a continuous variable. Gender is defined as a dummy where "1" indicates male and "0" female. Race/ethnicity is grouped into three types: white or Caucasian American, Black or African American and other races. Educational level is characterised by four categories: lower than high school, high school, some college, and college and higher. Employment status is categorised into four types: employed (including full-time employed and part-time employed), unemployed, retired (including fully retired and partially retired), and out of labour market. Regional areas (North-eastern, Midwestern, Southern, Western and other regions) are included as controls to adjust for the potential influence of the geographical area on both mental health and financial literacy. The models also control for respondents' marital status, which includes five categories: married, married (spouse absent), cohabitating, separated or divorced, widowed and never married. Finally, to control for the possible influences of overall health on mental health, the respondent's health condition is included as a control variable. The health condition is categorised into three groups: no disease, one to two diseases and more than two

diseases. Household income and wealth are considered as control variables in the multivariate analyses. Definitions of all variables used in this study are listed in Table 5-2.

Table 5-2 Variables and definitions

Variables		Definitions
Depressive symptoms		Depressive symptoms are measured using a score on the Centre for Epidemiologic Studies Depression (CESD) scale. The CESD-8 score is the sum of eight indicators measuring whether the respondent experienced the following sentiments all or most of the time: depression, everything is an effort, sleep is restless, felt alone, felt sad, could not get going, felt unhappy and not enjoyed life.
Financial literacy		1. The total number of correct answers to the three numeracy questions related to percentage calculation, lottery division, and compound interes. 2. The total number of correct answers to the Big Three questions, including the interest rates calculation, the understanding of inflation as well as risk and returns. This measurement of financial literacy is applied in the robustness check.
Age		Respondents' age at the beginning of the interview
Male		Dummy variable equal to 1 if the respondent is male, and 0 otherwise.
Race		
	White American/ Caucasian	Dummy variable equals to 1 if the respondent is White American/ Caucasian, and 0 otherwise.
	African American	Dummy variable equal to 1 if the respondent is African American, and 0 otherwise.
	Otherwise	Dummy variable equal to 1 if the respondent belongs to other ethnicities, and 0 otherwise.
Residence		
	Northeast	Dummy variable equal to 1 if the respondent is living in the Northeast region, and 0 otherwise.
	Midwest	Dummy variable equal to 1 if the respondent is living in the Midwest region, and 0 otherwise.
	South	Dummy variable equal to 1 if the respondent is living in the South region, and 0 otherwise.
	West	Dummy variable equal to 1 if the respondent is living in the West region, and 0 otherwise.

Table 5-2 Continued

Variables	Definitions
Marital status	
Married or partnered	Dummy variable equal to 1 if the respondent is married or partnered, and 0 otherwise.
Separated (or divorced)	Dummy variable equal to 1 if the respondent is separated or divorced, and 0 otherwise.
Widowed	Dummy variable equal to 1 if the respondent is widowed, and 0 otherwise.
Never married	Dummy variable equal to 1 if the respondent never married, and 0 otherwise.
Education	
Lower than high school	Dummy variable equal to 1 if the education attainment is lower than high school, and 0 otherwise.
High school	Dummy variable equal to 1 if the education attainment is high school, and 0 otherwise.
Some college	Dummy variable equal to 1 if the education attainment is some college, and 0 otherwise.
College and higher	Dummy variable equal to 1 if the education attainment is college and higher, and 0 otherwise.
Employment	
Employed	Dummy variable equal to 1 if the respondent is currently working, and 0 otherwise.
Retired	Dummy variable equal to 1 if the respondent is fully or partially retired, and 0 otherwise.
Unemployed	Dummy variable equal to 1 if the respondent is not working, and 0 otherwise.
Out of labour market/disabled	Dummy variable equal to 1 if the respondent is out of labour market, and 0 otherwise.

Table 5-2 Continued

Variables	Definitions
Health condition	
No disease	Dummy variable equal to 1 if the respondent has no disease, and 0 otherwise.
Has one or two diseases	Dummy variable equal to 1 if the respondent has one or two diseases, and 0 otherwise.
Has three or more diseases	Dummy variable equal to 1 if the respondent has three or more diseases, and 0 otherwise.
Income	Natural logarithm of the total income of all resident family members. Income includes before-tax income from earnings, unemployment benefits, workers' compensation, Supplemental Security Income (SSI), public assistance, veterans' benefits, social security, pension and retirement income, interest, dividends, rents, royalties, income from estates and trusts, educational assistance, alimony, child support, assistance from outside the household, and other sources.
Wealth	Natural logarithm of the total net wealth, which is defined as total assets (including financial assets and non-financial assets) minus total debt (including mortgages, other home loans, and other debt (e.g., credit card debt)).
Debt status	Dummy variable equal to 1 if the respondent has any household debt, while 0 if the respondent has no household debt.

Taking indebtedness into account

The results from the last chapter show that, in Chinese adults, the relationship between financial literacy and depressive symptoms is stronger among indebted people than their non-indebted counterpaprts. In this chapter, the same hypothesis (see section 4.3 in Chapter IV for the second hypothesis H_2) is tested to investigate if there is the heterogeneity of the financial literacy and depression relationship by debt status among U.S. adults. To realise this, the interaction term of financial literacy and debt is included in Equations 5-1 and 5-2.

Mediation analyses

Structural Equation Modelling (SEM) in the mediation analysis

The mediation analyses are applied in this study to test for the second hypothesis. The two most frequently used methods to examine the mediation model includes a multiple regression and SEM. Initially, mediation analysis is estimated through a series of standard regression models along with ad hoc methods to test for the indirect effects, namely, the stepwise approach (Baron and Kenny; 1986, Kenny, 2016). This study uses the SEM instead of the stepwise approach to conduct the mediation analysis considering the following advantages of SEM. First, SEM allows for relationships between all variables in mediation analyses to be tested at a single framework, which is especially useful and efficient when the mediation model is complicated (MacKinnon, 2007). SEM simplifies the testing process of any mediation hypotheses, and can be applied to testing complicated mediation analysis containing multiple independent variables, multiple mediators and/or dependent variables.

Second, within the SEM framework, one can take into account the temporal orders of the studied variables and make the most of the longitudinal data, which may not be easily realised by a stepwise mediation analysis. Additionally, there is a clear distinction between dependent and independent variables in a standard regression model. However, in a SEM, a dependent variable in one model can potentially be considered as an independent variable in other parts of the SEM model system (Bollen, 1989; Gunzler et al., 2013). In other words, SEM allows to take into account the reciprocal role a variable plays in the model, which will enable better causal inferences.

Finally, it is easy to conduct missing data techniques to deal with incomplete data (e.g., full-information maximum likelihood) in SEM; while the listwise deletion is usually used for missing data in standard regression (Allison, 2003; Enders and Bandalos, 2001). Approaches

like full information maximum likelihood can lead to less biased parameter estimates and standard errors when handling missing data than the conventional methods such as list-wise deletion and pairwise deletion (Allison, 2003; Enders and Bandalos, 2001).

Longitudinal Mediation Analyses

This study applies autoregressive cross-lagged mediation analyses within the SEM framework to test for the relationships between the independent variable financial literacy (*FL*), the mediating variables income (*I*) and wealth (*W*) and the outcome variable depressive symptoms (*DEP*). The reasons for using the SEM approach are above. The mediation models are constructed and conducted initially following previous literature (Turnes and Ernst, 2016; MacKinnon, 2008). This study expands the most frequently used three-waves model with a single mediator in previous research into a four-wave model with two mediators. Hence, the models consider four-time points (corresponding to waves 6, 8, 10, and 12 of the HRS) for *FL*, *I*, *W*, and *DEP*. Hereafter, the four waves are referred to as T1, T2, T3 and T4, respectively. Figure 5-1 depicts the structure of the mediation models.

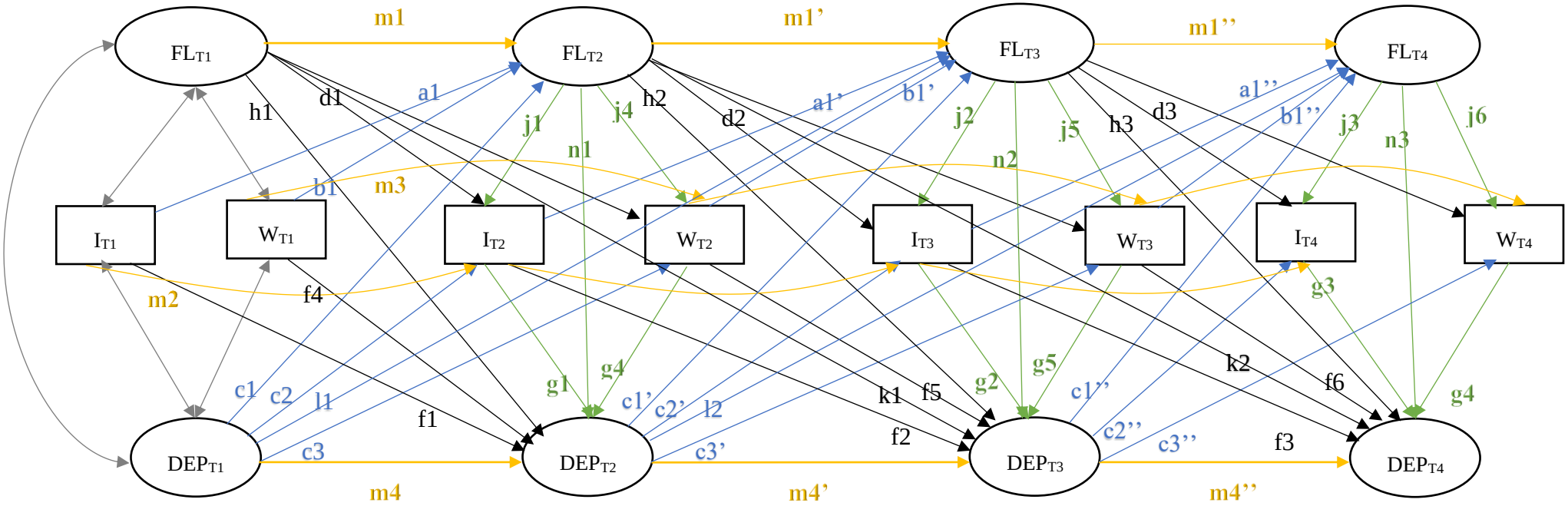


Figure 5-1. Visual representation of the cross-lagged longitudinal mediation model of financial literacy, household income, household wealth and depressive symptoms

Notes: FL= Financial literacy. I = Income. W = Wealth. DEP = Depressive symptoms. T1 to T4: time points. Boxes are observed variables; circles are latent variables; one-headed arrows denote regression results (the arrow points from a predictor to an outcome); and two-headed arrows denote correlations.

Equations 5-3 to 5-14 describe the relationships among variables in the mediation analyses:

$$FL_{T2} = m_1 FL_{T1} + a_1 I_{T1} + b_1 W_{T1} + c_1 DEP_{T1} + \beta_1{}' C_{T2} \quad 5\text{-}3$$

$$FL_{T3} = m_1{}' FL_{T2} + a_1{}' I_{T2} + b_1{}' W_{T2} + c_1{}' DEP_{T2} + l_1 DEP_{T1} + \beta_2{}' C_{T3} \quad 5\text{-}4$$

$$FL_{T4} = m_1{}'' FL_{T3} + a_1{}'' I_{T3} + b_1{}'' W_{T3} + c1'' DEP_{T3} + l_2 DEP_{T2} + \beta_3{}' C_{T4} \quad 5\text{-}5$$

$$I_{T2} = d_1 FL_{T1} + j_1 FL_{T2} + m_2 I_{T1} + c_2 DEP_{T1} + \beta_4{}' C_{T2} \quad 5\text{-}6$$

$$I_{T3} = d_2 FL_{T2} + j_2 FL_{T3} + m_2{}' I_{T2} + c_2{}' DEP_{T2} + \beta_5{}' C_{T3} \quad 5\text{-}7$$

$$I_{T4} = d_3 FL_{T3} + j_3 FL_{T4} + m_2{}'' I_{T3} + c_2{}'' DEP_{T3} + \beta_6{}' C_{T4} \quad 5\text{-}8$$

$$W_{T2} = d_4 FL_{T1} + j_4 FL_{T2} + m_3 W_{T1} + c_3 DEP_{T1} + \beta_7{}' C_{T2} \quad 5\text{-}9$$

$$W_{T3} = d_5 FL_{T2} + j_5 FL_{T3} + m_3{}' W_{T2} + c_3{}' DEP_{T2} + \beta_8{}' C_{T3} \quad 5\text{-}10$$

$$W_{T4} = d_6 FL_{T3} + j_6 FL_{T4} + m_3{}'' W_{T3} + c_3{}'' DEP_{T3} + \beta_9{}' C_{T4} \quad 5\text{-}11$$

$$DEP_{T2} = h_1 FL_{T1} + n_1 FL_{T2} + f_1 I_{T1} + f_4 W_{T1} + g_1 I_{T2} + g_4 W_{T2} + m_4 DEP_{T1} + \beta_{10}{}' C_{T2} \quad 5\text{-}12$$

$$DEP_{T3} = k_1 FL_{T2} + h_2 FL_{T2} + n_2 FL_{T3} + f_2 I_{T2} + f_5 W_{T2} + g_2 I_{T3} + g_5 W_{T3} + m_4{}' DEP_{T2} + \beta_{11}{}' C_{T3} \quad 5\text{-}13$$

$$DEP_{T4} = k_2 FL_{T2} + h_3 FL_{T3} + n_3 FL_{T4} + f_3 I_{T3} + f_6 W_{T3} + g_3 I_{T4} + g_6 W_{T4} + m_4{}'' DEP_{T3} + \beta_{12}{}' C_{T4} \quad 5\text{-}14$$

The vector C_{Ti} includes a set of covariates evaluated at time T_i that might affect household finances and/or depressive symptoms in addition to financial literacy. They include age, gender, educational attainment, race, region, marital status, employment status, and health condition, and are selected following previous literature (e.g., Kadoya et al., 2016; 2018; Fastame et al.,

2019). For consistency, the control variables are the same as those used in the panel regression models.

Four main aspects can be highlighted when constructing the autoregressive cross-lagged longitudinal mediation models. First, the models take into account the autoregressive paths, that is, the stability of inter-individual differences. This is important as the data in this study are targeted at middle-aged and older adults. Many of these older people's characteristics (e.g., educational attainment, employment status, basic numerical ability, mental health) are relatively stable within individuals across different waves. In other words, there are close relationships between variables measured at time T and those measured at time T+1. To capture this, FL_T, I_T and W_T and DEP_T are respectively expressed as a function of FL_{T-1}, I_{T-1} and W_{T-1} and DEP_{T-1}. The autoregressive relationships are denoted by $m*$ in the above equations and Figure 5-1 (orange lines).

Second, the models consider the cross-lagged relationships to test the extent to which prior values of one variable relate to subsequent values of other variables of interest. Specifically, to capture the cross-lagged direct and indirect effects of financial literacy on depressive symptoms, two regressions are considered. First, the mediator, I_T (or W_T) is regressed on FL_{T-1}, controlling for FL_T , DEP_{T-1}, I_{T-1} (or W_{T-1}) and confounding variables. These paths are denoted by $d*$ in the equations and Figure 5-1. Following this, I regress DEP_{T+1} on the two mediators I_T and W_T and on FL_T, controlling for FL_{T+1}, I_{T+1}, W_{T+1}, DEP_T and confounding variables (as denoted by $f*$ and $h*$). The estimated coefficients can be used to estimate the indirect effects of financial literacy on depressive symptoms. For example, in Figure 5-1, the indirect effect of FL_{T1} on DEP_{T3} operated through I_{T2} (or W_{T2}) can be calculated as *d1*f2 (or d4*f5).* The total temporal indirect effect is calculated as the sum of all indirect pathways between FL_{T1} and DEP_{T3}.

Third, the models consider contemporaneous relationships between financial literacy and income/wealth; income/wealth and depressive symptoms; as well as financial literacy and

depressive symptoms. These are respectively denoted by paths "j*", "g*" and "n*", and are depicted with green lines in Figure 5-1.

Fourth, the reversed relationships are included (see Figure 5-1). These are included since the literature suggests that there might be bidirectional relationships between financial literacy and depression, on the one hand, and between depression and people's financial situation, on the other (Lusardi and Mitchell, 2014; Lund et al., 2018b; Jin et al., 2020). As such, in the mediation models, the effects of DEP_{T-1} on NUM_T are examined. Similarly, the effects of DEP_{T-1} on I_T and W_T are also considered. The relevant paths are denoted by "c*" both in the models and in Figure 5-1. Paths representing the reverse effects of I_{T-1} and W_{T-1} on NUM_T are also considered and respectively indicated by "a*" and "b*". All "a*", "b*", and "c*" paths are depicted with blue lines in Figure 5-1.

Bias-corrected bootstrapped confidence intervals are calculated for all estimates of direct and indirect effects in the mediation analyses. Following Kline (2005), the fitness of the models to the data are also evaluated and reported using four indexes: the root-mean-square error of approximation (RMSEA); the Tucker Lewis Index (TLI); the comparative fit index (CFI); and the Standardised Root Mean Squared Residual (SRMR). Statistical analyses are conducted using Stata/SE version 15.1 and Mplus version 8.7. In Mplus, SEM provides built-in missing data techniques to deal with incomplete data, for example, full-information maximum likelihood (FIML, Allison, 2003; Enders and Bandalos, 2001). This study uses FIML to handle missing data within model estimations as it has been shown to outperform listwise deletion, providing less biased or unbiased parameter estimates and standard errors when data are not missing randomly (Enders and Bandalos, 2001). This method has been commonly used in previous studies applying SEM to undertake mediation analysis (e.g., Prentice et al., 2017; Melendez-Torres et al., 2021).

5.4. Results

5.4.1. Descriptive statistics

The distribution of responses to financial literacy is displayed in Tables 5-3a and 5-3b, which is based on the pooled sample used in this study. Table 5-3a shows the proportion of correct, incorrect, unknown and refuse answers to three questions. Over half of the respondents (66.64%) provide the correct answers to questions related to the percentage calculation. 39.72% of respondents are able to do the calculation on lottery division. Regarding the most difficult question related to the calculation on compound interest, around 10.77% of respondents are correct. The distribution of the number of correct, incorrect answers to the three questions is reported in Table 5-3b. The overall financial literacy level of the respondents is not high. In Table 5-3b, only less than 6.26% of respondents provide correct answers to all the three questions; while 26.74% of the respondents answer all the three questions incorrectly. The majority of the respondents have at least one correct answer.

Table 5-3 The distribution of responses to financial literacy

Table 5-3a *Percentage of respondents to financial literacy questions*

	Correct	Incorrect	Unknown	Refuse
Q1: Percentage Calculation	66.64%	23.16%	8.19%	_
Q2: Lottery Division	39.72%	41.35%	18.93%	_
Q3: Compound Interest	10.77%	84.28%	4.95%	_

Table 5-3b *Distribution of the number of correct answers to financial literacy questions*

Proportions	All (Three)	One	Two	Zero
Correct	6. 26%	36.89%	29.75%	26.74%

Notes: Data in table 5-3s are calculated using the waves 6,8, 10, and 12 of the HRS. Numeracy is used to measure financial literacy in this chapter. The exact wording of the basic financial knowledge questions is displayed in Appendix C.1.

Tables 5-4 reports the descriptive statistics for the studied variables based on both pooled data and data from each wave. The average scores of financial literacy of the respondents range between 1.15 and 1.20 out of 3.00 across the four waves considered. The means of CESD-8 scores of the respondents range between 1.52 and 1.57 out of 8.00 across waves. The average household income and wealth in pooled data are 51398.77 U.S. dollars and 338073.30 U.S. dollars, respectively.

The mean age of the respondents is 66.49 (SD=10.79) . 42% of the respondents are males. Over half of the respondents are married or partnered. 17% of respondents do not have any disease, while the majority of them have at least one disease. Over half of the respondents are retired and 32% have either full time or part-time jobs.

Table 5-4 Descriptive statistics for variables

	Pooled data T=74,572	**Wave 6 (2004) N=16,824**	**Wave 8 (2006) N=16,782**	**Wave 10 (2010) N=19,843**	**Wave 12 (2014) N=21,123**
Key Variables	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*
Financial literacy[a]	1.17 (0.90)	1.20 (0.90)	1.19 (0.91)	1.15 (0.89)	1.16 (0.89)
Depressive symptoms (CESD scores)	1.54 (2.03)	1.56 (2.00)	1.52 (2.00)	1.52 (2.03)	1.57 (2.06)
Total family income (USD)	51398.77 (57584.25)	53297.15 (60197.13)	51458.13 (57522.71)	49841.16 (54512.35)	51582.13 (60180.35)
Log of household income	10.24 (1.56)	10.34 (1.37)	10.34 (1.25)	10.18 (1.69)	10.15 (1.77)
Total family wealth (USD)	338073.30 (581809.80)	352535.90 (567522.90)	420680.30 (685514.20)	309719.60 (547950.60)	287569.20 (523703.70)
Log of household wealth	9.95(5.64)	10.73 (4.56)	10.78 (4.74)	9.37 (6.32)	9.21 (6.20)
Age	66.49 (10.79)	66.79 (10.68)	68.20 (10.25)	65.96 (10.93)	65.39 (10.97)
Male	0.42 (0.49)	0.41 (0.49)	0.41 (0.49)	0.42 (0.49)	0.42 (0.49)
Education					
Lower than high school	0.20 (0.40)	0.23 (0.42)	0.21 (0.41)	0.19 (0.39)	0.17 (0.37)
High school	0.34 (0.47)	0.35 (0.48)	0.36 (0.48)	0.34 (0.47)	0.33 (0.47)
Some colleges	0.24 (0.43)	0.22 (0.41)	0.22 (0.41)	0.25 (0.43)	0.26 (0.44)
College and higher	0.22 (0.41)	0.21 (0.40)	0.21 (0.41)	0.22 (0.42)	0.24 (0.43)

Table 5-4 Continued

	Pooled data T=74,572	**Wave 6 (2004) N=16,824**	**Wave 8 (2006) N=16,782**	**Wave 10 (2010) N=19,843**	**Wave 12 (2014) N=21,123**
Control Variables	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*
Race					
White/Caucasian	0.75 (0.43)	0.81 (0.39)	0.81 (0.39)	0.73 (0.45)	0.68 (0.47)
Black/African American	0.18 (0.38)	0.14 (0.35)	0.14 (0.35)	0.19 (0.40)	0.21 (0.41)
Others	0.03 (0.26)	0.05 (0.21)	0.05 (0.21)	0.08 (0.27)	0.11 (0.31)
Residence					
Northeast	0.15 (0.36)	0.16 (0.37)	0.15 (0.36)	0.15 (0.36)	0.15 (0.35)
Midwest	0.24 (0.43)	0.26 (0.44)	0.26 (0.44)	0.23 (0.42)	0.21 (0.41)
South	0.41 (0.49)	0.39 (0.49)	0.40 (0.49)	0.42 (0.49)	0.43 (0.49)
West	0.20 (0.40)	0.19 (0.39)	0.19 (0.39)	0.20 (0.40)	0.21 (0.41)
Others	0.002 (0.04)	0.001 (0.03)	0.002 (0.05)	0.002 (0.04)	0.002 (0.04)
Marital status					
Married/Partnered	0.63 (0.48)	0.64 (0.48)	0.65 (0.48)	0.64 (0.48)	0.61 (0.49)
Separated/Divorced	0.14 (0.35)	0.12 (0.33)	0.12 (0.32)	0.14 (0.35)	0.16 (0.37)
Widowed	0.18 (0.38)	0.20 (0.40)	0.21 (0.40)	0.17 (0.37)	0.16 (0.36)
Never married	0.05 (0.21)	0.03 (0.18)	0.03 (0.17)	0.05 (0.22)	0.07 (0.25)
Employment status					
Employed	0.32 (0.47)	0.31 (0.46)	0.27 (0.44)	0.33 (0.47)	0.36 (0.48)
Unemployed	0.03 (0.16)	0.02 (0.13)	0.01 (0.11)	0.04 (0.16)	0.03 (0.16)
Retired	0.56 (0.50)	0.53 (0.40)	0.61 (0.49)	0.55 (0.50)	0.54 (0.50)
Disabled/ Not in labour	0.10 (0.30)	0.15 (0.35)	0.11 (0.31)	0.08 (0.27)	0.07 (0.26)

Table 5-4 Continued

	Pooled data T=74,572	**Wave 6 (2004) N=16,824**	**Wave 8 (2006) N=16,782**	**Wave 10 (2010) N=19,843**	**Wave 12 (2014) N=21,123**
Control Variables	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*
Health status					
No disease	0.17 (0.37)	0.20 (0.40)	0.15 (0.36)	0.16 (0.37)	0.15 (0.36)
One to two diseases	0.49 (0.50)	0.53 (0.50)	0.51 (0.50)	0.49 (0.50)	0.48 (0.50)
More than two diseases	0.36 (0.47)	0.27 (0.44)	0.34 (0.47)	0.34 (0.47)	0.37 (0.48)
Having debt	0.52 (0.50)	0.48 (0.50)	0.51 (0.50)	0.55 (0.50)	0.54 (0.50)

Notes: a. financial literacy is proxied by numeracy in Table 5-4. Data in Table 5-4 are calculated using waves 6, 8, 10, and 12 of the HRS. N indicates the number of individuals. T indicates the number of observations. Variable means are listed with standard errors in parentheses.

5.4.2. Multivariable Regression Analysis

Table 5-5 reports the estimates of Equation 5-1 obtained using the fixed effects linear regression (Models 1a and 1b) and correlated random effects negative binomial regression models (Models 2a and 2b)[6]. Models 1a and 2a are the bivariable regression of CESD-8 scores on financial literacy scores, which controls for year dummies and all the time-unvarying covariates. Models 1b and 2b regress CESD-8 scores on financial literacy controlling for age, gender, residence, marital status, health, educational attainment, employment status, household income, household wealth, region dummies, year dummies and all the time-unvarying covariates.

As reported in Table 5-5, there is a significant negative association between financial literacy and depression levels. For instance, the coefficient associated with financial literacy in Model 1a shows that for one unit increase in financial literacy scores, CESD-8 scores would be 0.024 points lower ($p < 0.05$). After controlling for demographic, social and economic characteristics, health status and all the time-unvarying covariates, the association between financial literacy and depression levels remains significant with a coefficient of -0.020 ($p < 0.1$) (Model 1b). The magnitude of the relationship between financial literacy and depression is roughly six percentages of the association between being unemployed and depression, or one-fifth that of the link between having multiple diseases and depression. Models 1b also shows significant negative associations between income and depression (ß= - 0.017, p<0.01), as well as between wealth and depression (ß= - 0.011, p<0.01). Overall, these results support the first hypothesis that, when holding other factors constant, higher levels of financial literacy are associated with lower depression levels.

[6] The obtained results using the fixed effects linear regression and correlated random effects negative binomial regression models without taking health status into account are displayed in Appendix C.3.

Table 5-5 Financial literacy and depressive symptoms: fixed effects and correlated random effects estimates

	Fixed effect linear regression		Correlated random effects negative binomial regression	
	Model 1a	Model 1b	Model 2a	Model 2b
Financial literacy[a]	-0.024**	-0.020*	-0.018**	-0.016*
	(0.012)	(0.012)	(0.008)	(0.008)
Log of income		-0.017**		-0.007**
		(0.007)		(0.004)
Log of wealth		-0.011***		-0.005***
		(-0.002)		(0.001)
Age		0.007		0.006
		(0.013)		(0.008)
Male		-		-0.052***
		-		(0.014)
Education (reference group: Lower than high school)				
High school		-		-0.118***
		-		(0.018)
Some colleges		-		-0.174***
		-		(0.020)
College and higher		-		-0.325***
		-		(0.023)
Race (reference group: White or Caucasian)				
Black/African American		-		-0.063***
		-		(0.017)
Others		-		0.075***
		-		(0.024)

Table 5-5 Continued

	Fixed effect linear regression		Correlated random effects negative binomial regression	
	Model 1a	Model 1b	Model 2a	Model 2b
Marital status (reference group: Being married)				
Separated/Divorced		0.340***		0.204***
		(0.055)		(0.027)
Widowed		0.539***		0.328***
		(0.040)		(0.021)
Never married		0.300***		0.210***
		(0.128)		(0.059)
Employment status (reference group: Employed)				
Unemployed		0.328***		0.193***
		(0.057)		(0.031)
Retired		0.061**		0.047***
		(0.026)		(0.018)
Not in labour market/ Disabled		0.257**		0.135***
		(0.041)		(0.022)

Table 5-5 Continued

	Fixed effect linear regression		Correlated random effects negative binomial regression	
	Model 1a	Model 1b	Model 2a	Model 2b
Region (reference group: Northeast)				
Midwest		0.022		0.043
		(0.136)		(0.085)
South		-0.207**		-0.130**
		(0.100)		(0.066)
West		-0.162		-0.116
		(0.145)		(0.090)
Others		0.073		0.069
		(0.413)		(0.187)
Health condition (reference group: Having no disease)				
Having one to two diseases		0.057*		0.053**
		(0.031)		(0.027)
Having more than two diseases		0.200***		0.144***
		(0.043)		(0.033)

Notes: a. financial literacy is proxied by numeracy in Table 5-5. Data in Table 5-5 are calculated using waves 6, 8, 10, and 12 of HRS. Number of observations is 74,572. The number of individuals is 31,088. Marginal effects are reported in Models 2a and 2b. Models 1a and 2a are regressions of CESD-8 scores on financial literacy scores controlling for year dummies and all the time-unvarying covariates. Models 1b and 2b are regressions of CESD-8 scores on financial literacy, controlling for age, gender, race, marital status, health, educational attainment, employment status, region dummies and year dummies, household income and wealth, and all the time-unvarying covariates. Robust standard errors in parentheses for Models 1a and 1b. Standard errors in parentheses for Models 2a and 2b. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

The estimated parameters associated with other control variables such as age, gender, educational attainment, race, marital status, employment status, and health condition are significant and consistent in different regression models (Models 1b and 2b). The observed relationships between depressive symptoms and those control variables are in line with prior literature (WHO, 2014; Assari, 2017; Lund et al., 2018a). Specifically, depression is significantly lower among males and minority ethnicity, which is consistent with Girgus and Yang (2015), WHO (2014) and (Assari, 2017). Marital status is a strong predictor of mental health. Compared to the married respondents, those who are separated or divorced never married, or widowed all show significantly higher depression levels, which support previous literature which links marital status to mental health (Bulloch et al., 2017). Employment status is also a strong predictor of depression. Compared to the employed respondents (either full-time work or part-time work), those who are unemployed, retired, or out of the labour market tend to have higher CESD-8 scores. This is in line with recent research which investigates the employment status and depression (e.g., Amiri, 2021). Consistent with Bisschop et al. (2004) and Clarke et al. (2009), there is a strong positive relationship between having one or more diseases and increased depressive symptoms. Education is also a significant predictor of depressive symptoms and higher educational attainment is negatively associated with depression scores, which is in agreement with Zivin et al. (2010) and Assari (2017)'s.

5.4.3. Moderating effect of debt

The results of the relationship between financial literacy and depressive symptoms by debt status (i.e., indebted group vs non-indebted group) are reported in Table 5-6. There is a significant and negative relationship between financial literacy and depressive symptoms in all models. When debt status is taken into consideration, the link between financial literacy and depressive symptoms is slightly stronger than that observed in Table 5-5, where the interaction term between financial literacy and debt status is not included. However, the results in Table

5-6 show that the interaction term between total numeracy score and having household debt is insignificant. This might suggest that there are no significant differences regarding the financial literacy and depression relationship between the indebted and debt-free respondents.

Table 5-6 Heterogeneity: The moderate role of Debt status

	Fixed effect linear regression		Correlated random effects negative binomial regression	
	Model 1a	Model 1b	Model 2a	Model 2b
Financial literacy[a]	-0.033**	-0.029**	-0.018**	-0.016*
	(0.015)	(0.015)	(0.008)	(0.008)
Having debt	0.027	0.026	0.036***	0.033**
	(0.030)	(0.030)	(0.013)	(0.014)
Financial literacy * Having debt	0.018	0.017	0.018	0.020
	(0.018)	(0.018)	(0.012)	(0.013)
Log of income		-0.017**		-0.007**
		(0.007)		(0.004)
Log of wealth		-0.011***		-0.005***
		(0.002)		(0.001)
Age		0.008		0.007
		(0.013)		(0.008)
Male		-		-0.052***
		-		(0.014)
Education (reference group: Lower than high school)				
High school		-		-0.120***
		-		(0.018)
Some colleges		-		-0.180***
		-		(0.020)
College and higher		-		-0.332***
		-		(0.024)

Table 5-6 Continued

	Fixed effect linear regression		Correlated random effects negative binomial regression	
	Model 1a	Model 1b	Model 2a	Model 2b
Race (reference group: White or Caucasian)				
Black/African American		-		-0.063***
		-		(0.017)
Others		-		0.078***
		-		(0.024)
Marital status (reference group: Being married)				
Separated/Divorced		0.344***		0.207***
		(0.055)		(0.028)
Widowed		0.541***		0.330***
		(0.040)		(0.021)
Never married		0.305**		0.213***
		(0.128)		(0.059)
Employment status (reference group: Employed)				
Unemployed		0.329***		0.193***
		(0.057)		(0.031)
Retired		0.062**		0.048***
		(0.026)		(0.018)
Not in labour market/ Disabled		0.258***		0.136***
		(0.041)		(0.022)

Table 5-6 Continued

	Fixed effect linear regression		Correlated random effects negative binomial regression	
	Model 1a	Model 1b	Model 2a	Model 2b
Region (reference group: Northeast)				
Midwest		0.020		0.040
		(0.137)		(0.085)
South		-0.210**		-0.131**
		(0.100)		(0.066)
West		-0.165		-0.119
		(0.145)		(0.090)
Others		0.073		0.068
		(0.412)		(0.187)
Health condition (reference group: Having no disease)				
Having one to two diseases		0.058*		0.053**
		(0.031)		(0.027)
Having more than two diseases		0.200***		0.144***
		(0.043)		(0.033)

Notes: a. financial literacy is proxied by numeracy in Table 5-6. Data in Table 5-6 are calculated using waves 6, 8, 10, and 12 of HRS. Number of observations is 74,572. Number of individuals is 31,088. Marginal effects are reported in Models 2a and 2b. Models 1a and 2a are regressions of CESD-8 scores on financial literacy scores controlling for year dummies and all the time-unvarying covariates. Models 1b and 2b are regressions of CESD-8 scores on financial literacy, controlling for age, gender, race, marital status, health, educational attainment, employment status, region dummies and year dummies, household income and wealth, and all the time-unvarying covariates. Robust standard errors in parentheses for Models 1a and 1b. Standard errors in parentheses for Models 2a and 2b. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

5.4.4. Longitudinal Mediation Analyses

Figure 5-2 reports the key estimated results of the autoregressive cross-lagged mediation models on financial literacy, household income, household wealth and depressive symptoms (more details are reported in Appendix C.4). The estimated mediation models have an acceptable fit [RMSEA = 0.048 (95% CIs: 0.047, 0.048); CFI = 0.804; TLI = 0.768; SRMR=0.77]. In line with the steps of the model construction, the results on auto-regressive paths (orange lines), cross-lagged paths (black lines), cross-sectional paths (green lines) and paths representing the reverse effects (blue lines) are discussed hereafter.

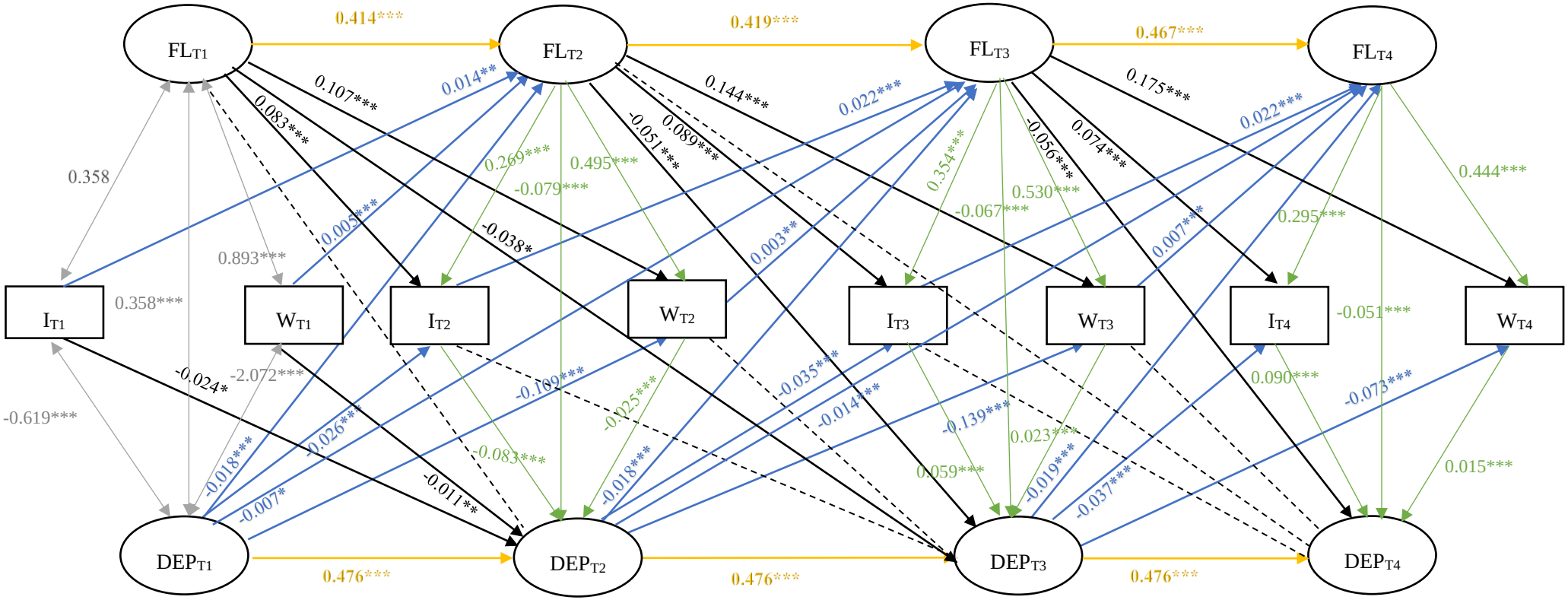


Figure 5-2 Results of autoregressive cross-lagged longitudinal mediation models on financial literacy, household wealth and depressive symptoms

Notes: (Independent variable=FL) FL: Financial literacy. (Mediators=I&W) I: Income; W: Wealth. (Dependent variable=DEP) DEP: Depressive symptoms. T1 to T4: time points. Boxes are observed variables; circles are latent variables; one-headed arrows denote regression results (arrow points from predictor to outcome); two-headed arrows denote correlations. The solid lines denote the significant relationships, and the dashed lines, the insignificant ones. The mediation analyses are conducted using data from the HRS waves 6, 8, 10, and 12. The number of individuals (observations) is 11,369 (45,476). Control variables include age, gender, race, region, education, marital status, employment status and health condition. The control variables and their estimated coefficients are not displayed in Figure 5-2 for simplicity. *p < 0.10, **p < 0.05, ***p < 0.01.

First, estimates of all autoregressive paths of financial literacy, household income, household wealth and depressive symptoms indicate positive associations between measures of each variable at time T and time T+1. For example, as shown in Figure 5-2, the associations between FL_{T1} and FL_{T2}; FL_{T2} and FL_{T3}; FL_{T3} and FL_{T4} are all positive and fluctuate around 0.45.

Second, FL_T is positively associated with both I_{T+1} and W_{T+1}. The cross-lagged association between FL_T and W_{T+1} is stronger than that between FL_T and I_{T+1}. However, there are no associations between either I_{T+1} or W_{T+1} and the outcome variable DEP_{T+2}. For example, at T3, the estimate of the relationship between FL_2 and I_{T3} is 0.089 ($p<0.01$), whilst the estimate of the link between FL_2 and W_{T3} is 0.144 ($p<0.01$). Furthermore, the association between both I_{T3} and W_{T3} and DEP_{T4} is insignificant. There is, however, a direct negative association between FL_{T3} and DEP_{T4}. In summary, no evidence of a longitudinal mediated effect between FL_T and DEP_{T+2} operating through I_{T+1} or W_{T+1} is found, while a direct negative association between FL_T and DEP_{T+1} is observed.

Third, are negatively and significant direct contemporaneous associations between financial literacy and depressive symptoms and indirect associations between the two through household income and household wealth at all times. The mediating effects of household income are larger than those of household wealth. For example, the estimates on the associations among financial literacy, household income and wealth and depressive symptoms at T2 show that: FL_{T2} is positively and significantly associated with I_{T2} and W_{T2}. ($\beta= 0.269$, $p<0.01$; $\beta= 0.495$, $p<0.01$); both I_{T2} and W_{T2} are negatively and significantly associated with depressive symptoms at the same time point (i.e., DEP_{T2}) ($\beta= - 0.083$, $p<0.01$; $\beta= - 0.025$, $p<0.01$). Therefore, in the link between FL_{T2} and DEP_{T2}, the mediating effects through I_{T3} and W_{T3} are $\beta= 0.269 * (-0.083) = - 0.022$ ($p<0.01$) and $\beta = 0.495 * (-0.025) = - 0.012$ ($p<0.01$), respectively. There is also a significant direct link between FL_{T2} and DEP_{T2} after considering the indirect links through I_{T2} and W_{T2} ($\beta = - 0.079$, $p<0.01$). Approximately, the mediating

effects of household income and household wealth account for 19% and 11% of the total contemporaneous relationship (i.e., the sum of the indirect and direct associations) between FL_{T2} and DEP_{T2}.

Fourth, there is a total reverse indirect effect (sum of all indirect pathways) of depressive symptoms on financial literacy, mediated by both household income and household wealth. In other words, in all temporal indirect pathways examined, there are indirect associations between DEP_T and FL_{T+2}, mediated by both I_{T+1} and W_{T+1}. For example, DEP_{T2} is negatively and significantly associated with both I_{T3} and W_{T3} (-0.035, p<0.01; -0.139, p<0.01), and I_{T3} and W_{T4} are positively and significantly associated with FL_{T4} (0.022, p<0.01; 0.007, p<0.01). The mediating effects through I_{T3} and W_{T3} are -0.035 * 0.022 = -0.001 (p<0.01) and -0.139 *0.007 = -0.001 (p<0.01), respectively. Moreover, there are also direct negative associations between DEP_T and FL_{T+1}. However, for all time periods, the magnitude of the direct relationship between DEP_T and FL_{T+1} is smaller than that between FL_T and DEP_{T+1}. For example, the direct relationship between DEP_{T3} and FL_{T4} is -0.019 (p<0.01); while the direct relationship between FL_{T3} and DEP_{T4} is -0.056 (p<0.01).

Most control variables in the mediation model are significantly associated with depressive symptoms (not shown in figures). For example, males, those who have higher educational levels, and those who are healthier are less likely to report depression symptoms.

5.5. Discussion

5.5.1. Statement of principal findings in relation to other studies

This study provides the first longitudinal investigation of the relationship between financial literacy and depressive symptoms and the economic pathways underlying this relationship. The analysis in this study is based in U.S. adults aged 50 and older. As hypothesised, the findings in this study reveal a negative association between financial literacy and depressive symptoms

in both cross-lagged mediation analyses and standard multivariate panel analyses. This study extends previous cross-sectional research by providing the first longitudinal analysis of the relationship between financial literacy and mental health and its underlying economic mechanisms.

From the longitudinal mediation analyses, an important finding is that financial literacy is associated with current depressive symptoms and directly predicts depressive symptoms four years later. Although there are cross-lagged reversing relationships from depressive symptoms to financial literacy, the magnitudes of all reversing relationships are smaller than the relationships from financial literacy to future depressive symptoms. This might imply that influence of financial literacy on depressive symptoms plays a more predominant role than the reverse effect of depressive symptoms on financial literacy in the relationship between the two.

This study also shows that financial literacy is consistently and positively associated with household income and wealth in the future. Moreover, the positive influence of financial literacy on household finances and mental well-being can last for a long period of time (at least up to 4 years). In fact, the cross-lagged relationship between financial literacy and household income/wealth are bidirectional, suggesting that financial literacy and household income and wealth can enhance each other over time. These findings are in line with previous evidence suggesting that financial literacy and financial outcomes are endogenous to each other (Delavande et al., 2008; Lusardi and Mithchell, 2014). Specifically, financial literacy and income or wealth are strongly associated with each other over the life cycle. Financial literacy is associated with better performance and outcomes in retirement planning and financial markets, a lower likelihood of having costly borrowing and thus more income and wealth (Lusardi and Mitchell, 2007a; 2007b; 2011a; 2011b). Simultaneously, people with higher income and wealth are more likely to invest in financial education, which in turn further improve financial literacy levels; while those with lower incomes may find it too costly and do

not have the same incentives to do so (Delavande et al., 2008; Wagner, 2019). Financial literacy acquirement and household finances (income and wealth) constitute a virtuous circle, which jointly benefit the current mental health condition. The findings here thus highlight the importance of financial literacy for both financial and mental well-being.

This study shows that household income and household wealth are negatively associated with the current depressive symptoms. These findings are in line with previous research about income or wealth and mental health outcomes showing that income and wealth are associated with a higher possibility of showing depression at a given time point (Osafo Hounkpatin et al. 2015). However, this study finds no relationship between current household income or wealth and future depressive symptoms. By contrast, previous research on household finances and depression applying the cross-lagged model find that worse economic status (measured by an asset index) is significantly associated with more depressive symptoms two years later (Lund and Cois, 2018b). The differences in findings between this study's and theirs might be attributed to the different time intervals between the measurement points. Evidence also shows that the psychological impact of the previous stressful financial situation diminishes over time (Mirowsky and Ross, 2001; Sareen et al., 2011; Richardson et al., 2016). Therefore, it is very likely that in this study, the time interval between any two measurement points (i.e., 4 years) might be too long to capture any impact of the current financial situation on future depressive symptoms, since this impact might be immediate or short-term. This study thus suggests that further research on the topic apply data with a shorter time interval between the two measurements points, where available.

Overall, although there is no evidence of the cross-lagged impact of household income or wealth on future depressive symptoms, the findings in this study provide some evidence in support of the second and third hypotheses. First, the direct association between financial literacy and depressive symptoms implies that people with higher levels of financial literacy

are less likely to have depressive symptoms both at the time in which financial literacy is measured and four years later. This might be because they are more confident in their financial management abilities and feel a better sense of control over their financial situation. Second, the indirect link between financial literacy and depressive symptoms operating through household finances implies that higher levels of financial literacy allow individuals and households to accumulate more income and net wealth, which is linked to less depressive symptoms cross-sectionally.

Unexpectedly, this chapter finds no significant difference in financial literacy-depressive symptoms association by different debt statuses (i.e., have debt versus no debt). This is inconsistent with that of chapter V. Chapter V finds that the negative association between financial knowledge and depression was stronger among Chinese adults with debt than those without any debt. As hypothesised, compared to those without any debt, the buffering effect of financial literacy on depressive symptoms was expected to be stronger among people with household debt. This is because financial literacy has been found to be related to better debt management (Lusardi and de Bassa Scheresberg, 2013; Lusardi and Tufano, 2015). However, this U.S.-based chapter does not provide supportive evidence to the fourth hypothesis. The variations in findings between this chapter and chapter V might partially be explained by the following reasons. In addition to the well-studied positive impact of financial literacy on debt-related outcomes (refer to Chapter 2-Background of financial literacy for more details), financial literacy might also have negative effects on individuals with financial stress. Specifically, indebted people with more financial literacy are more likely to realise the costs of taking loans and thus concern about their debt stress than those with no or low financial literacy, which is harmful to the former's mental health. Furthermore, individuals with higher financial literacy tend to expect a better financial situation, for example, a low debt level or no debt. For those who have debt stress but a high level of financial literacy, failure to meet their financial

expectation might lead to an increase in depressive symptoms. From these perspectives, having financial literacy might intensify experiences of debt stress in the indebted people. Thus, the overall effects of financial literacy on mental health outcomes are unclear among indebted adults. Another potential reason for no difference in such a relationship between indebted individuals and those who have not debt might be due to the measurement of financial literacy. The financial literacy in this study is constructed by three numeracy questions including percentage calculation, lottery dividends, and interest rates calculation. It did not capture the literacy-related to debt, namely, debt literacy, for example, fundamental concepts related to debt (Lusardi and Tufano, 2015). Additionally, the three numeracy questions measure the most basic financial numeracy, which cannot reflect the understanding of different levels of difficulty of financial literacy of an individual. Therefore, the measure of financial literacy used in this study does not show the effect of financial literacy on debt status.

5.5.2. Strengths

This study has several strengths. The existing research on the relationship between financial literacy and mental health outcomes is mostly cross-sectional. This study extends this literature by providing the first longitudinal examination of the association between financial literacy and depressive symptoms and a stronger causal assertion that low financial literacy might be a predictive factor against future depression in U.S. adults aged 50 and over. Second, the available studies are all based on relatively small samples that can only represent a specific group of the population (Bennett et al., 2012). By contrast, this study is based on a large and representative sample of middle aged and older U.S. adults. Third, this study is, to the best of my knowledge, the first study to provide an analysis of potential economic pathways underlying this association. Cross-lagged longitudinal mediation analyses are used here, contributing to a more fine-grained and thorough view of the links between financial literacy, household income and wealth, and depression. For instance, by considering the temporal

ordering of the variables, this method helps us to examine the mediation effects whilst, at the same time, accounting for potential reverse causation. Additionally, the mediation models include previous values of the dependent variable, as well as of all key variables to alleviate concerns about potential unmeasured confounders that can drive the relationship between financial literacy and mental health (Cole and Maxwell, 2003).

5.5.3. Limitations

However, several limitations should be noted when interpreting the results of this study, which need to be improved in the future research. First, as this study uses longitudinal data, there might be bias in the estimates arising from missing data. This study applies FIML in the mediation analyses to deal with missing data, which is believed to outperform many traditional approaches, such as pairwise deletion and listwise deletion (Ender and Bandalos, 2001). However, this may not completely eliminate the bias due to missing data.

Second, in a cross-lagged longitudinal mediation model, the identification of the optimum time interval between the measurement of the factors is a challenge (Newsom, 2015; Cole and Maxwell, 2003; Selig and Preacher, 2009). This study is constrained by only using a four-year time interval between each measurement point since the data on numeracy (proxy for financial literacy) are collected by design in every second wave (three or four years) in HRS (Bugliari et al., 2019). The four-year time period may not be the optimum length of time to capture the impact of financial literacy on household income/wealth, and depressive symptoms. The long time interval (i.e., four years) might be one of the reasons why the cross-lagged effect of household finances on depressive symptoms cannot be observed. The contemporaneous relationship between variables that is highlighted in the mediation analysis might capture the short-term relationships among the variables., Future research using data collected with more appropriate time intervals is necessary.

Third, most of data in this study are self-reported, which might result in biased estimates due to the influence of personal traits (e.g., overconfidence), social norms or social desirability, and so on. Therefore, the future research might be benefit from applying the research procedure that can correct for measurement errors (Saris and Revilla, 2016).

Finally, financial literacy might be related to mental health through other mechanisms since both household income and wealth cannot fully mediate this relationship. For instance, people with high financial literacy also tend to spend more on services related to better health and to adopt less unhealthy behaviours like smoking (Zheng et al., 2021), which may, in turn, enhance mental health. In this regard, health expenditure and health behaviours might also operate as mediators in the financial literacy and mental health relationship. Therefore, future research might be interested in exploring other potential mechanisms.

5.5.4. Implications for policymakers

The findings suggest that financial literacy can be targeted when developing interventions aimed at improving not only financial, but also mental well-being among middle-aged and older adults. At the same time, experiencing depressive symptoms may be a predictor of declining financial literacy in the future. This suggests that mental health support services may help reduce the risk of financial literacy decline as people age. In summary, intervention on financial literacy should be integrated with interventions on mental health to help late middle aged and older people age better. Moreover, the strategies and interventions aimed at maintaining or improving older people's stock of financial literacy and mental well-being should be introduced early before the vicious cycle between low financial literacy and depression starts happening.

5.6. Conclusion

Using data on a representative sample of middle-aged and older in the U.S., this chapter finds evidence of a protective role of financial literacy on financial and mental well-being. This can be explained considering that people with higher levels of financial literacy tend to have more confidence in daily financial management and better financial outcomes, which are associated with a lower risk of experiencing depressive symptoms. Interventions on financial literacy enhancement among middle-aged and older people might be a useful approach to help enhance financial well-being and reduce the risk of experiencing mental illness. However, more evidence is needed to further our understanding of the causal relationship between financial literacy enhancement and mental health and verify the validity and generalisability of the findings of this study under different settings.

Chapter VI: Financial Shocks, Depression, and the Moderating Role of Financial Literacy

The findings from the previous two chapters showed that financial literacy was related to mental health either directly or indirectly through its interaction with household income and wealth. In another stream of evidence, financial shocks were linked with an increased risk of experiencing poorer mental health outcomes. Meanwhile, having a higher level of financial literacy was shown to improve an individual's financial cushion when faced with financial shocks and made individuals more able to cope with financial shocks (Lusardi, 2019; Swift et al., 2020). Therefore, it is possible that financial literacy may play a role in mitigating the effect of financial shocks on mental health. However, the question as to what role financial literacy might play in a person's mental health when they experience financial shocks has not yet been investigated in the existing literature. The topic presented in this chapter, therefore, aims to fill this research gap and to address the final research question: How does a person's financial literacy influence their mental health when confronted by major financial shocks? This study examines the moderating effect of financial literacy on the association between financial shocks and depression using longitudinal data collected from the Health and Retirement Study over an 18-year period. This study furthers our understanding of the relationship between financial literacy and mental health by being the first of its kind to provide evidence of the moderating effect of financial literacy on the relationship between financial shocks and mental health outcomes.

This chapter is organised as follows. Section 6.1 presents the introduction. Section 6.2 provides a review of the literature on household financial shocks and mental health outcomes, as well as the potential role that financial literacy might play in the association between the two. Section 6.3 describes the data, variables and the statistical method used for the analysis.

Sections 6.4 and 6.5 report the empirical results and the robustness check, followed by a brief discussion and conclusion in sections 6.6 and 6.7.

6.1. Introduction

Financial shocks, which are common and often unforeseen in households, are defined in this study as the experience arising from a decline in income or wealth. Financial shocks may be caused by financial losses resulting from life events, such as getting divorced or becoming widowed, the occurrence of a new disease or injury, a job loss, or taking on new responsibilities (e.g., caring responsibilities) (McKnight, 2019). Experiencing financial shocks is common in U.S. households, particularly among certain vulnerable subgroups, such as those with a lower socioeconomic status and older adults (Bufe et al., 2022). Experiencing financial shocks (e.g., job loss) can place individuals at an increased risk of drifting into material or financial hardship and experiencing psychological stress, an effect which has been shown to be associated with poorer mental health outcomes (Andreeva et al., 2015; Swift et al., 2020). Moreover, the mental health impacts of financial shocks among vulnerable subgroups are also disproportionately high (Van Hal, 2015).

Having a good level of financial resilience is critical for mental health when an individual or a household is confronted with financial shocks, given the evidence of the associations between financial shocks and worsening mental health. Financial resilience means the ability to withstand and recover from financial shocks stemming from life events. Financial resilience is comprised of access to, and demand for, factors such as financial resources (i.e., income), social and community resources (e.g., social support), and human capital (e.g., financial skills) (O'Neill and Xiao, 2006; 2011). Studies suggest that social and community resources (e.g., social security and Medicare in the U.S.) can help to increase financial resilience among older adults, which might act as a buffer against the negative health and psychological effects of financial shocks (O'Neill and Xiao, 2011; Riumallo-Herl et al., 2014). However, social and community resources may not be available or may not be sufficient for protecting some people from the effects of financial shocks. In fact, evidence has shown that people can still be affected

mentally by unpredictable financial shocks, even when they have access to generous social welfare (Norström and Grönqvist, 2015). Therefore, research into other factors that can contribute to financial resilience, and which can mitigate the negative effects of financial shocks on mental well-being, is needed.

Financial literacy, as a type of human capital, is regarded as another resource that can enhance financial resilience in addition to social capital. Financial literacy can help to improve financial resilience by increasing financial resources, by reducing financial fragility, and by enhancing an individual's coping ability when faced with a financial shock (Lusardi, 2019; Lusardi et al., 2021). Specifically, financial literacy is strongly related to higher levels of household income or wealth accumulation and, thus, to a greater quantity of financial resources (Klapper et al., 2013; see section 2.5.5 in Chapter II). In addition to this, financial literacy has been linked with a lower likelihood of reporting financial fragility (Lusardi et al., 2021). Higher levels of financial literacy are also related to greater ability to cope with financial shocks. This may be because those with a higher level of financial literacy can react faster to a changing financial environment, are less likely to be affected by an external economic shock as they tend to be more confident with respect to finances, and are more effective at allocating and managing household financial resources (Klapper et al., 2013; Chhatwani and Mishra, 2021). Therefore, the harmful effects of negative financial shocks on mental health may be lessened among those with higher financial literacy levels.

Scholars have widely investigated financial literacy and the role of financial literacy in protecting people against financial shocks, as well as the association between financial shocks and mental health outcomes. However, based on existing evidence, the understanding of the influence of financial literacy on the associations between financial shocks and mental health is, at best, limited. To fill this research gap and to further our understanding of the effect of financial literacy on mental well-being based on the previous chapters, this chapter investigates

the final research question of the PhD thesis: To what extent can financial literacy influence the relationship between financial shocks and mental well-being? This research question is particularly critical when examined in relation to older adults, who are especially vulnerable to unexpected large financial shocks. It can be difficult for many older people to regain their financial losses, and financial shocks may substantially reduce the financial resources available to them and permanently alter the financial situations of their later life (Lusardi and Mitchell, 2013). Moreover, older people are at an increased risk of cognitive decline as they age, which can lead to a decline in their level of literacy (including financial literacy) and poorer financial decision-making (Finke et al., 2017). This means that many older people may not be able to cope with major financial shocks or to protect themselves against a stressful financial situation (Lusardi and Mitchell, 2013). These factors, individually or as a combination, can magnify the negative consequences of financial shocks among this population.

This study uses data from the Health and Retirement Study (HRS) to perform the empirical investigation. The HRS collects detailed information from a representative sample of U.S. households aged 50 and over regarding their demographic, social and economic situations, financial literacy, and cognitive abilities. This dataset allows for a longitudinal analysis of the relationships between financial shocks and mental health. This study mainly focuses on financial shocks (i.e., income shocks, wealth shocks, and job losses faced by households) at the household level. A job loss can result in income shocks to an individual or a household, which can be one of the worst financial shocks and has a significant effect upon mental well-being (Andreeva et al., 2015). Therefore, in addition to income shocks and wealth shocks, this study also provides evidence related to job losses.

6.2. Literature Review and Hypotheses

6.2.1. Financial shocks and mental health

Financial shocks, such as substantial losses of income or wealth and job loss, have been connected with poorer mental health and a higher risk of depression (McInerney et al., 2013; Andreeva et al., 2015). Many studies investigating the health impacts of negative financial shocks have either used income shocks, wealth shocks or a life event that can lead to losses of income or wealth, such as job loss. Evidence related to income shocks have shown that negative shocks to household income and the frequency of income losses are positively associated with the demand in mental health services, as well as depression and/or anxiety symptoms (Prause et al., 2009; Grafova et al., 2020; Hertz-Palmor et al., 2021). Moreover, individuals with fewer financial resources are more likely to experience income shocks and can be affected by income shocks to a greater extent (Hannagan and Morduch, 2015; Hill et al., 2017). The causal effect of income shocks on mental health outcomes has been investigated in several experimental studies, where positive income shocks are investigated prominently (Christian et al., 2019). Their findings show that money transfers can reduce the risk of experiencing mental disorders (Christian et al., 2019). This evidence may also provide supportive evidence of a causal effect of negative income shocks on mental health, to a certain extent. According to prospect theory, people tend to value losses more than gains, which means the pain of losses is psychologically more powerful than the pleasure experienced from the same amount of gains (Kahneman and Tversky, 1979). Given this, it is reasonable to believe that negative shocks to income may induce higher levels of psychological stress compared to the same level of positive income shocks.

Regarding the consequences of wealth shocks, previous research has consistently reported a negative impact of household wealth losses on mental health outcomes (Pool et al., 2017;

Schwandt, 2018). For example, Pool et al. (2017) found that a substantial negative shock to net wealth (i.e., a loss of total net worth of 75% or more) was significantly associated with increased odds of depressive symptoms among late middle-aged adults in the U.S.. Some prior studies investigating the health effects of a loss of wealth focused on distinct types of wealth, such as housing wealth and financial wealth. Those studies also provide supportive evidence of the negative impact of financial losses on mental health. For example, evidence has shown that the onset of mortgage problems, or a fall in housing wealth, are associated with increasing levels of depression or psychological distress (Osypuk et al., 2012; Yilmazer et al., 2015). A more recent study by Schwandt (2018), who investigated the health impacts of the interaction of stock holdings with stock market changes, found that unexpected financial wealth shocks lead to poorer mental health, especially among those who hold stocks. These previous studies suggest that a negative shock to household wealth, regardless of the type of wealth in which a loss is suffered, is a risk factor for depression.

Studies consistently show that there is a positive association between job loss and undesirable mental health outcomes, which include the onset of depression (Dew et al., 1992; Riumallo-Herl et al., 2014; Andreeva et al., 2015; Stolove et al., 2017). Moreover, the psychological effect of losing a job is greater than that of income losses (Grafova et al., 2020). There is also supportive evidence for the causal effect of job loss on worse mental health outcomes (e.g., Andreeva et al., 2015; Stolove et al., 2017). In the U.S., for instance, Stolove et al. (2017) investigated the changes in depression severity in response to job loss using latent growth mixture modelling based on a sample of older adults who lost their jobs. According to their study, job loss was related to the emergence of depression, which in turn significantly decreased the probability of the follow-up reemployment (Stolove et al., 2017). Indeed, the effect of job loss or being unemployed on mental health appears to remain or become worse as the duration of unemployment increases. It has been documented that those who are

unemployed for a longer period of time experience an even higher burden from disease and impaired mental health, compared to people who are unemployed only in the short-term (McKee-Ryan et al., 2005; Latsou and Geitona, 2018).

Income shocks or wealth shocks can be related to an increased number of depressive symptoms through several pathways. First, experiencing either income shocks or wealth shocks can generate negative psychological and emotional responses (e.g., fear, anger, sadness), and this may lead to mental health problems, such as stress and depression (Boen and Yang, 2016). Second, losses of either income or wealth can induce a reduction in household financial resources and may even lead to poverty and material hardship for some vulnerable subgroups; an effect which is related to an increased risk of depression (Christelis et al., 2015; Chapter III). Additionally, financial stress caused by financial shocks can also lead to poorer mental health through the increased risk of engaging in unhealthy behaviours, such as smoking and alcohol abuse (Adda et al., 2009; French and Vigne, 2019).

Losing a job or becoming unemployed may lead to poorer mental health for a number of reasons, including but not limited to those discussed above. It has been suggested that losing a job can incur losses of income and induce a financial strain, which can both be related to poorer mental health and more depressive symptoms (Price et al., 2002; Howe et al., 2004; Hetschko et al., 2013; see Chapter III). In addition to these pathways, involuntary job loss may also lead to a change in social status, the loss of social networks and working relationships, a heightened feeling of isolation, poorer self-identity and self-esteem, and a changing role in a society, each of which are related to depression (Dew et al., 1992; Barbaglia et al., 2015, Farré et al., 2018). Additionally, previous research has also demonstrated that job loss is associated with a higher likelihood of having an unhealthy lifestyle and engaging in behaviours such as alcohol use and smoking. Such lifestyle choices can trigger or intensify symptoms related to depression or anxiety (Cabello et al., 2017). A theoretical framework of the effect of financial shocks and

depression is displayed in Figure 6-1. Accordingly, this study proposes the following hypothessis:

H_1: Financial shocks (i.e., income shocks, wealth shocks, and/or job losses) are positively associated with more depressive symptoms.

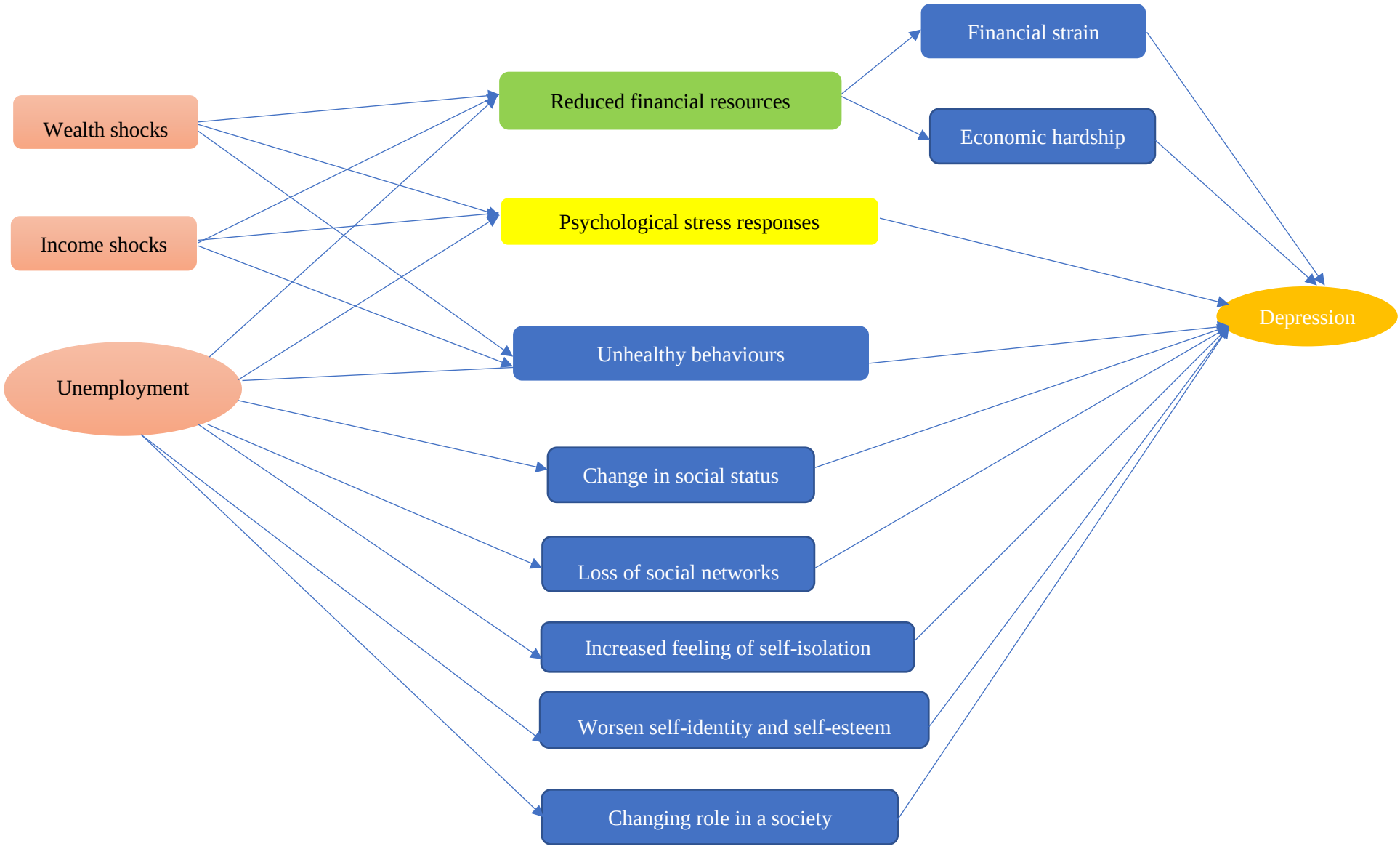


Figure 6-1 Mechanisms underlying the effect of financial shocks and depression

6.2.2. Financial literacy, financial shocks and mental health

Being financially literate might be a protective factor of mental health in face of financial shocks. However, no previous studies have investigated if financial literacy plays a role in the effects of financial shocks on mental health outcomes. The idea of financial literacy encompasses the knowledge and the understanding of financial concepts, the capacity to manage one's own or an organization's financial resources, and the capacity to make financial decisions in different circumstances (Yuesti et al., 2020). As a way of preparing for financial shocks, good financial literacy can help people to effectively manage financial resources and equip people to weather financial shocks better (Yuesti et al., 2020; Philippas and Avdoulas, 2020). An increasing number of studies investigate the association between financial literacy and financial resilience during a crisis, highlighting the importance of financial literacy to get individuals better prepared to withstand financial shocks (Klapper et al., 2013; Guiso and Vivian, 2014; Chhatwani and Mishra, 2021). Financial literacy, therefore, might mitigate the negative effects of financial shocks on mental health. According to the existing evidence, the influence of financial literacy can be considered from two perspectives: first, people with higher financial literacy tend to have more financial resources accumulation; second, more financially literate people tend to have more proactive attitudes towards losses in financial resources and will take timely and effective actions to deal with the consequences of financial shocks and avoid further financial losses.

First, higher financial literacy levels are associated with more financial resources and thus improved financial cushion in face of financial shocks. Both chapter II and many prior studies have documented the consequences of financial literacy. Financially literate individuals or households perform better in day-to-day financial management and tend to have financially savvier behaviours. For example, individuals with higher levels of financial literacy understand better about savings and are thus more likely to save and plan for the future financially (see

section 2.5.1 in Chapter II). They are also more likely to participate in financial markets and investments (see section 2.5.2 in Chapter II). Besides, people with higher financial literacy levels are less likely to have informal borrowing and less likely to have debt problems compared to people with lower levels of financial literacy or debt literacy (see section 2.5.3 in Chapter II). Those financially savvier decisions and behaviours are the main keys to achieving better financial outcomes, such as more disposable income and higher wealth accumulation (see section 2.5.5 in Chapter II). Therefore, financially literate people are prone to have more financial resources, like wealth accumulation, than those who are financially illiterate. Evidence suggests that financial resources such as wealth can potentially act as a coping mechanism to help make ends meet and survive financial shocks (e.g., losing a job) (Hanspal et al., 2020; Chhatwani and Mishra, 2021). Those who lack financial resources may find it difficult to meet unplanned expenses after financial shocks because of the crisis. Conversely, good financial literacy has been associated with higher levels of financial resilience or lower financial fragility (indicated as the ability to prepare for the unexpected expense in the near future, Lusardi et al., 2011), which is a critical component of financial well-being (Lusardi et al., 2011; Yuesti et al., 2020; Lusardi et al., 2021). Financial literacy can positively affect financial well-being and individuals with higher financial literacy levels are better prepared to withstand financial shocks (Lusardi et al., 2021; Yuesti et al., 2020). Therefore, compared to those with low or no financial literacy, respondents with higher financial literacy might be less likely to be affected by financial shocks since they are more likely to be financially prepared and will be less concerned about the negative consequences following a financial shock.

Secondly, good financial literacy equips individuals to apply their financial resources to coping with financial shocks effectively. The difference in financial literacy levels of individuals may lead to different coping strategies with the economic situation when faced with financial shocks. Evidence shows that people with higher financial literacy levels are less likely

to experience negative shocks and are less likely to be affected by financial shocks, since they are better able to deal with financial shocks and can manage the existing financial resources wisely (Klapper et al., 2013; Kurowski, 2021). For example, individuals who are financially literate may be more proactive in managing their finances. Financially literate people also tend to seek out and take advantage of more professional advice to avoid financial mistakes, to get better returns, to deal with reduced income, financial instability, and so on (Bucher-Koenen and Ziegelmeyer, 2011; Guiso and Viviano, 2014; Barrafrem et al., 2020). Conversely, people with low levels of or no financial literacy tend to neglect and avoid relevant financial information, or even ignore making decisions at all in face of financial shocks (Carpena et al., 2011; Barrafrem et al., 2020; Xu et al., 2022). Those people are less likely to timely react to changes in their financial situation and increase the uncertainty of their financial standing.

It might be argued that people with higher financial literacy are more likely to participate in financial markets, and those who holding wealth in financial assets are highly likely to be affected due to the stock market crash during a crisis (Bucher-Koenen and Ziegelmeyer, 2011). However, the findings from empirical research suggest that financially literate investors indeed deal with shocks better than those with lower levels of literacy in the financial market when in faced with financial shocks (Bucher-Koenen and Ziegelmeyer, 2011; Guiso and Viviano, 2014). For example, Guiso and Viviano (2014) found that people with good financial literacy can react promptly to changes in the financial markets and manage their investments. During the financial crisis, high literacy investors were more likely to leave the stock market before the crash than low-literacy investors to avoid financial losses (Guiso and Viviano, 2014). High-literacy investors were also more likely to follow more rational trading strategies in financial markets. Their financial decisions are less likely to be exposed to and misled by biased advice from financial intermediaries (Guiso and Viviano, 2014).

Therefore, this study proposes that the mental health of people with higher financial literacy is less likely to be affected by financial shocks or job losses since they are prone to have more financial resources, better coping strategies and thereby are less concerned about their financial situation. Accordingly, the following research hypothesis is proposed:

H_2: The association between financial shocks and depression is stronger among those who have lower levels of financial literacy.

6.3. Methods

6.3.1. Data

This chapter uses data from the Health and Retirement Study (HRS) to perform the empirical investigation. The HRS is a longitudinal and nationally representative dataset, conducted on a biannual basis since 1992, provides extensive information on households' socioeconomic characteristics, income, and wealth holdings. Details of the HRS dataset are described in Chapter V (see section 5.3). The analysis in this chapter uses data from the waves 5 to 14, which were collected in 2001-2002, 2003-2004, 2005-2006, 2007-2008, 2009-2010, 2011-2012, 2013-2014, 2015-2016, and 2017-2018, respectively. Waves 5 (7, 9, 11, 13) of the HRS is only used once, helping to construct the wave-to-wave changes in income, wealth, and job status between wave 5 and wave 6 (wave 7 and wave 8, wave 9 and wave 10, wave 11 and wave 12, as well as wave 13 and wave 14). Numeracy data are collected every second wave including waves 6, 8, 10, 12 and 14. Therefore, the main results related to income shocks and wealth shocks are based on data from waves 6, 8, 10, 12 and 14, including 74,489 observations. The regression models related to job loss are based on data that includes 30,082 observations who has a job at each baseline wave.

6.3.2. Variables

Depressive symptoms

In this chapter, the outcome variable, depressive symptoms, is measured by the CESD-8 scale. CESD-8 captures eight aspects of feelings of respondents during the past week including “felt depressed,” “feel effortless,” “restless sleep,” “happiness,” “loneliness," “life enjoyment,” “sadness” and “tough get going”. Respondents respond to each item with a “yes” or “no” answer. Two items expressed in the positive direction such as “happiness” and “life enjoyment” are reverse coded to keep consistent with the remaining six questions. The Cronbach’s alpha of the CESD-8 measure varies from 0.81 to 0.83 across waves, indicating an adequate internal consistency (Steffick, 2000). For each respondent, the total CESD-8 score is calculated by summing up any symptoms associated with depression. This leads to the total scores of CESD-8 ranging from 0 to 8 where the higher score indicates more depressive symptoms. The composite score of the outcome variable was also applied in Chapter V.

Financial literacy

Numeracy as a proxy of financial literacy

Similar as the previous chapter, financial literacy is proxied by numeracy in the main analysis in this chapter. This is because the sample size of the respondents of the numeracy questions is larger and more representative than that of the Big Three financial literacy questions, and the power of the study based on a larger sample size would be stronger. Numeracy can be used as a proxy of financial literacy since it contains questions relevant to financial concepts. Besides, a significant positive association between financial literacy and numeracy has been found in chapter V and previous literature (Skagerlund et al., 2018; Nolan and Doorley, 2019). In HRS, numeracy is measured by three numeracy questions relevant to percentage calculation, lottery division and interest rate calculation. The wordings of the three numeracy questions have been listed in Appendix C.1. For each respondent, financial literacy is measured by the total number

of correct answers to the three numeracy questions. Thus, the total score of financial literacy ranges from zero to three, where higher scores indicate higher levels of financial literacy. More details of using numeracy to proxy financial literacy has been illustrated in the Chapter V (refer to section 5.3 in Chapter V for more details).

Financial literacy

In the HRS, the measurement of the basic financial literacy, the Big Three, which is developed by Lusardi and financial literacy questions are firstly introduced in the experimental module in the 2004 HRS (wave 7). The Big Three - the three financial literacy questions that capture the aspects such as simple calculation of interest rates, understanding the inflation and the relationship between risks and returns. Financial literacy questions are included in waves 7, 10, and 13 of HRS with 982, 1,253, 1,216 individuals participating in the module respectively. The detailed content of the three financial literacy questions has been listed in Appendix C.1. The financial literacy score is calculated by summing up all the correct answers to the three financial literacy questions. The total financial literacy score ranges from zero to three, where higher scores indicate higher financial literacy levels. This measure of financial literacy is applied in the robustness check to test if the results are robust to a different measurement of financial literacy.

Financial shocks

Job loss

Regarding the employment status, individuals reported at each interview whether they are: working now, temporarily laid off, unemployed and looking for work, disabled and unable to work, retired, a homemaker, or other. The employment status is re-grouped into four types in this study: employed (including full-time employed and part-time employed), unemployed and looking for work, retired, and out of labour market. The employment status change is constructed by comparing the employment status across two adjacent waves within each

respondent. Thus, job loss in this study is defined as the transition from working status to unemployment between two adjacent waves. In the case of leaving a job/business, the HRS also asks for the reason. Data on the cause of losing a job are used to differentiate between job loss due to a worker's firm or plant closing; job loss due to a lay-off; and job loss due to other reasons. The cause of a job loss is considered since the previous literature suggests that involuntary job loss due to firm closure can reduce bias due to reverse causality between mental health and job loss when examining the effect of job loss and mental health (Riumallo-Herl et al., 2014; Drydakis, 2015). As such, job loss includes three categories: a respondent lost his/her job in the past two years involuntarily, a respondent lost his/her job in the past two years voluntarily, and 0 otherwise.

Income and wealth shocks

The household income growth rate and wealth growth rate are calculated across two adjacent waves within each individual based on equations 6-1 and 6-2, respectively. The values of household income and wealth are adjusted to 2002 dollars using the consumer price index in the U.S. before any variable operations. Then based on the income (wealth) growth rate, three measures of income (wealth) shocks are constructed: small income (wealth) shocks, medium-income (wealth) shocks and large income (wealth) shocks. A small income (wealth) shock of a household income (wealth) is defined as a wave-to-wave drop in the household income (wealth) by 25% and over; a medium-income (wealth) shock is a drop by 50% and over; a large income (wealth) shock is a drop by 75% and over. No particular cut-off value or definition of income shocks of wealth shocks has been established in the existing literature. Previous research has used either 25%, 50%, or 75% cut-off points to define financial shocks (Pool et al., 2017; Christelis et al., 2015). This study applies three different cut-off points: 25%, 50%, or 75%, to study whether the results are sensitivity to the choice of cut-off points.

$$Income\_growth_{it} = {Income_{it} - Income_{it-1}}/{Income_{it-1}} \quad 6\text{-}1$$

$$Wealth\_growth_{it} = {Wealth_{it} - Wealth_{it-1}}/{Wealth_{it-1}} \quad 6\text{-}2$$

Control variables

A set of control variables are chosen based on the associations with financial shocks, financial literacy and depression that are documented in the previous literature[7]. The control variables in models include age, gender, educational attainment, race, marital status, household income, health condition, employment status, regional dummies, and year dummies. The definition of control variables (and other variables) is displayed in Table 6-1.

Table 6-1 Variables and Definitions

Variables	Definitions
Depressive symptoms	Depressive symptoms are measured using a score on the Centre for Epidemiologic Studies Depression (CESD) scale. The CESD score is the sum of eight indicators measuring whether the respondent experienced the following sentiments all or most of the time: depression, everything is an effort, sleep is restless, felt alone, felt sad, could not get going, felt unhappy and not enjoyed life.
Financial literacy	First measurement: proxied by numeracy, which is measured by three numeracy questions related to percentage calculation, lottery division, and compound interest. Second measurement: measured by the Big Three questions, including the interest rates calculation, the understanding of inflation as well as risk and returns. This measurement of financial literacy is applied in the robustness check.

[7] The rationales of selecting the control variables can be found in Chapters IV (section 4.2.4) and V (section 5.3.3).

Table 6-1 Continued

Variables	Definitions
Income shocks	
Negative income large shocks	Dummy variable equal to 1 if income drops by 75% and over; 0 if income drops by less than 75%.
Negative income medium shocks	Dummy variable equal to 1 if income drops by 50% and over; 0 if income drops by less than 50%.
Negative income small shocks	Dummy variable equal to 1 if income drops by 25% and over; 0 if income drops by less than 25%.
Wealth shocks	
Negative wealth large shocks	Dummy variable equal to 1 if wealth drops by 75% and over; 0 if wealth drops by less than 75%.
Negative wealth medium shocks	Dummy variable equal to 1 if wealth drops by 50% and over; 0 if wealth drops by less than 50%.
Negative wealth small shocks	Dummy variable equal to 1 if wealth drops by 25% and over; 0 if wealth drops by less than 25%.
Involuntary job loss	Dummy variable equal to 1 if the employment status changes into the status of unemployed involuntarily; 0 if otherwise.
Voluntary job loss	Dummy variable equal to 1 if the employment status changes into the status of unemployed voluntarily; 0 if otherwise.

Table 6-1 Continued

Variables	Definitions
Age	Respondents' age at the beginning of the interview
Gender	Dummy variable equal to 1 if the respondent is male, and 0 otherwise.
Race	
White American/ Caucasian	Dummy variable equals to 1 if the respondent is White American/ Caucasian, and 0 otherwise.
African American	Dummy variable equal to 1 if the respondent is African American, and 0 otherwise.
Otherwise	Dummy variable equal to 1 if the respondent belongs to other ethnicities, and 0 otherwise.
Residence	
Northeast	Dummy variable equal to 1 if the respondent is living in the Northeast region, and 0 otherwise.
Midwest	Dummy variable equal to 1 if the respondent is living in the Midwest region, and 0 otherwise.
South	Dummy variable equal to 1 if the respondent is living in the South region, and 0 otherwise.
West	Dummy variable equal to 1 if the respondent is living in the West region, and 0 otherwise.
Marital status	
Married or partnered	Dummy variable equal to 1 if the respondent is married or partnered, and 0 otherwise.
Separated (or divorced)	Dummy variable equal to 1 if the respondent is separated or divorced, and 0 otherwise.
Widowed	Dummy variable equal to 1 if the respondent is widowed, and 0 otherwise.
Never married	Dummy variable equal to 1 if the respondent never married, and 0 otherwise.

Table 6-1 Continued

Variables	Definitions
Education	
Lower than high school	Dummy variable equal to 1 if the education attainment is lower than high school, and 0 otherwise.
High school	Dummy variable equal to 1 if the education attainment is high school, and 0 otherwise.
Some college	Dummy variable equal to 1 if the education attainment is some college, and 0 otherwise.
College and higher	Dummy variable equal to 1 if the education attainment is college and higher, and 0 otherwise.
Employment	
Employed	Dummy variable equals to 1 if the respondent is currently working, and 0 otherwise.
Retired	Dummy variable equal to 1 if the respondent is fully or partially retired, and 0 otherwise.
Unemployed	Dummy variable equal to 1 if the respondent is not working, and 0 otherwise.
Out of labour market/disabled	Dummy variable equal to 1 if the respondent is out of labour market, and 0 otherwise.
Health condition	
No disease	Dummy variable equal to 1 if the respondent has no disease, and 0 otherwise.
Has one or two diseases	Dummy variable equal to 1 if the respondent has one or two diseases, and 0 otherwise.
Has three or more diseases	Dummy variable equal to 1 if the respondent has three or more diseases, and 0 otherwise.
Household income	Natural logarithm of the total amount of income of all resident family members.

6.3.3. Analytical methods

Baseline specifications

To test for the effect of financial shocks (i.e., income shocks, wealth shocks, or job losses) on depressive symptoms,the baseline model specification is given by:

$$Y_{it} = \alpha_0 + \beta_1 FS_{it} + \beta_2 \boldsymbol{X_{it}} + \beta_3{}' \boldsymbol{Z_i} + \epsilon_i + c_t + e_{it} \qquad 6\text{-}3$$

where *i* indicates the individual identifier, *t* indicates the time; The dependent variable Y_{it} is depressive symptoms of respondents in the past week, which is measured by the CESD-8 score; FS_{it} denotes financial shocks (i.e., income shocks, wealth shocks and job loss) for the i^{th} individual at time *t*; $\boldsymbol{X_{it}}$ is the matrix of time-varying control variables related to the respondent's demographic, socioeconomic characteristics, and health including age, marital status, employment status, household income, health condition. *Zi* is vector of time-invariant control variables including gender, race, and educational attainment. Definitions and measures of all variables are displayed in Table 6-1. The error term comprises three terms: ϵ_i denotes individual-specified unobserved heterogeneity. it is taken into account by estimating the model using panel data estimators. c_t is a time-specific component, which is taken into account by including year dummies. e_{it} is an idiosyncratic component of the error term. The coefficient β_1 in equations 6-3 captures the association between financial shocks and depressive symptoms independent of the control variables. The estimated coefficients that are relevant to any indicators of financial shocks (i.e., β_1) are expected to be positive and significant.

Moderation Analysis

Then to examine whether the association between financial shocks and mental health is weaker among individuals with higher levels of financial literacy, the following model is estimated:

$$Y_{it} = \alpha_0 + \beta_1 FS_{\boldsymbol{it}} + \beta_2 FL_{it} + \beta_3 FS_{\boldsymbol{it}} * FL_{\boldsymbol{it}} + \beta_4 \boldsymbol{X}_{it} + \beta_5{}' \boldsymbol{Z}_i + \epsilon_i + c_t + e_{it} \qquad 6\text{-}4$$

where FL_{it} is the overall scores of three numeracy questions described in section 6.3.2; FL_{it} * FS_{it} denotes the interaction between financial literacy and different indicators of financial changes for the i^{th} individual at time *t*. Other variables and the components of error term are the same as those in equation 6-3. The coefficient β_3 captures the estimated association between the interaction term of financial shocks and financial literacy and the outcome variable independent of the control variables. For the main hypothesis to hold, the estimated coefficients that are relevant to any indicators of the financial shocks-financial literacy interaction β_3 need to be negative and significant.

Estimation methods

The application of longitudinal data (i.e., HRS) enables this study to apply a panel regression method, as is also used by other studies focusing on the health and mental health effects of financial shocks (Riumallo-Herl et al., 2014; Drydakis, 2015; Ohrnberger et al., 2020). A fixed-effect regression model is used in this chapter to test the multivariable association between financial shocks (i.e., income shocks, wealth shocks, job losses) and depressive symptoms. This aims to address the heterogeneity due to unobserved time-invariant confounders (Greene, 2008). In this study, the fixed-effects model is preferable to the random-effects model since it allows for the correlation between the individual-specific effect and the included independent variables (Greene, 2008). Additionally, the results of the Hausman test also reveal that a fixed effects model is preferred based on this study's sample ($p<0.000$).

Considering the characteristics of the dependent variable (i.e., over-dispersed count data), equations 6-3 and 6-4 can be estimated using a negative binomial model. However, as argued by Allison and Waterman (2002), although using the fixed effects negative binomial model can deal with time-invariant heterogeneity, the estimated results from a fixed effects negative

binomial model do not fully control for all time-invariant variables when using mainstream statistical software packages (e.g., Stata). Given this methodological limitation, this study applies and reports the results from fixed effects poisson regression models and correlated random effects models to produce more robust estimates (Allison and Waterman, 2002). More details of performing a correlated random effects model can be found in Chapter V (section 5. 3). For ease of the result interpretation in terms of the difference in the outcome variable (i.e., the CESD score) between the respondents who experienced financial shocks and those who did not, the incidence rate ratios (IRRs) are presented in this chapter. The IRRs are interpreted as the rate of CESD scores of those who experienced financial shocks to CESD scores of those who did not. An IRR larger (or smaller) than 1.0 indicates more (or fewer) depressive symptoms in those exposed to the factor than in those who are unexposed (e.g., experience fiancial shocks vs not experience financial shocks).

6.4. Results

6.4.1. Descriptive statistics

Prior to regression analysis, summary statistics of the key variables, financial shocks and the CESD-8 score are provided in Table 6-2. The mean CESD-8 scores of the respondents ranged from 1.39 (SD=1.94) to 1.53 (SD= 1.97) across waves, as shown in Table 6-2. About one third of the respondents experience a reduction of 25% or more in household income. The proportions of individuals who experience a decrease in household income by 75% and higher hover around 5% throughout waves. Regarding the wealth shocks, individuals who have seen a 25% or more decrease in household wealth account for almost a third of the respondents. Around 10% of respondents experience a decrease in household wealth at least 75%. Only a small proportion of the respondents who are employed at baseline lose their jobs either voluntarily or involuntarily in each wave. In terms of numeracy, respondents' average

numeracy scores vary from 1.18 to 1.23 out of 3 across waves. The descriptive statistics of control variables based on the observations for the analyses related to financial shocks (or job loss) are displayed in Table 6-3 (or Table 6-4). According to data in Table 6-3, the respondents are all adults aged 50 or higher, and the mean age of the sample is around 68. Males account for around 40% of the sample. Over half of the respondents are married or partnered, have educational levels higher than some colleges, are fully retired or partially retired, and are white Americans. Less than 15% of the sample report having no disease, and most of them have at least one disease.

Table 6-2 Descriptive statistics of variables (for income shocks and wealth shocks)

Variables	**Pooled data**	**Wave 6 (2004)**	**Wave 8 (2006)**	**Wave 10 (2010)**	**Wave 12 (2014)**	**Wave 14 (2016)**
	Mean (SD)	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*
Depressive symptoms	1.48 (1.99)	1.53 (1.97)	1.51 (1.99)	1.39 (1.94)	1.49 (2.02)	1.48 (2.00)
Numeracy	1.18 (0.90)	1.18 (0.90)	1.20 (0.91)	1.15 (0.88)	1.15 (0.89)	1.23 (0.93)
	N (Proportion)	*N (Proportion)*	*N (Proportion)*	*N (Proportion)*	*N (Proportion)*	*N (Proportion)*
Income small shocks						
Decreased by less than 25%	53,632 (0.72)	9,631 (0.72)	11,751 (0.73)	9,531 (0.70)	12,133 (0.74)	10,660 (0.71)
Decreased by 25% and larger	20,857 (0.28)	3,746 (0.28)	4,346 (0.27)	4,085 (0.30)	4,263 (0.26)	4,354 (0.29)
Income medium shocks						
Decreased by less than 50%	64,060 (0.86)	11,638 (0.87)	14,004 (0.87)	11,573 (0.85)	14,265 (0.87)	12,612 (0.84)
Decreased by 50% and larger	10,428 (0.14)	1,739 (0.13)	2,093 (0.13)	2,042 (0.15)	2,131 (0.13)	2,402 (0.16)
Income large shocks						
Decreased by less than 75%	70,765 (0.95)	12,842 (0.96)	15,453 (0.96)	12,798 (0.94)	15,740 (0.96)	13,963 (0.93)
Decreased by 75% and larger	3,724 (0.05)	535 (0.04)	644 (0.04)	817 (0.06)	656 (0.04)	1,051 (0.07)

Table 6-2 Continured

Variables	Pooled data	Wave 6 (2004)	Wave 8 (2006)	Wave 10 (2010)	Wave 12 (2014)	Wave 14 (2016)
	N (Proportion)	*N (Proportion)*	*N (Proportion)*	*N (Proportion)*	*N (Proportion)*	*N (Proportion)*
Wealth small shocks						
Decreased by less than 25%	51,397 (0.69)	9,498 (0.71)	11,751 (0.73)	8,441 (0.62)	11,313 (0.69)	10,510 (0.70)
Decreased by 25% and larger	23,092 (0.31)	3,879 (0.29)	4,346 (0.27)	5,174 (0.38)	5,083 (0.31)	4,504 (0.30)
Wealth medium shocks						
Decreased by less than 50%	60,336 (0.81)	11,370 (0.85)	13,521 (0.84)	10,756 (0.79)	13,117 (0.80)	12,011 (0.80)
Decreased by 50% and larger	14,153 (0.19)	2,007 (0.15)	2,576 (0.16)	2,859 (0.21)	3,279 (0.20)	3,003 (0.20)
Wealth large shocks						
Decreased by less than 75%	65,550 (0.88)	12,173 (0.91)	14,487 (0.90)	11,981 (0.88)	14,265 (0.87)	12,912 (0.86)
Decreased by 75% and larger	8,939 (0.12)	1,204 (0.09)	1,610 (0.10)	1,634 (0.12)	2,131 (0.13)	2,102 (0.14)
Observations[1]	74,489	13,377	16,097	13,615	16,396	15,014
Job loss						
Involuntarily job loss	602 (0.02)	99 (0.02)	65 (0.01)	155 (0.03)	137 (0.02)	67 (0.01)
Voluntarily job loss	301 (0.01)	49 (0.01)	65 (0.01)	52 (0.01)	68 (0.01)	67 (0.01)
No job loss	29,180 (0.97)	4,793 (0.97)	6,357 (0.98)	4,894 (0.95)	6,625 (0.97)	6,539 (0.98)
Observations[2]	30,082	4,941	6,487	5,152	6,830	6,672

Notes: 1. Data are calculated based on waves 6, 8, 10, 12, and 14 of HRS. 2. Data are calculated based on the sample who are employed at each baseline wave (i.e., wave 5, 7, 9, 11, or 13).

Table 6-3 Descriptive statistics of control variables by wave (for income shocks and wealth shocks)

Variables	**Pooled data**	**Wave 6 (2004)**	**Wave 8 (2006)**	**Wave 10 (2010)**	**Wave 12 (2014)**	**Wave 14 (2016)**
	Mean (SD)	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*
Age	68.70 (10.21)	69.60 (9.62)	68.27 (10.24)	70.45 (9.67)	68.23 (10.44)	67.28 (10.61)
	N (Proportion)	*N (Proportion)*	*N (Proportion)*	*N (Proportion)*	*N (Proportion)*	*N (Proportion)*
Gender						
Male	29,796 (0.40)	5,351 (0.40)	6,600 (0.41)	5,446 (0.40)	6,722 (0.41)	6,156 (0.41)
Educational attainment						
Lower than high school	14,153 (0.19)	3,210 (0.24)	3,380 (0.21)	2,587 (0.19)	2,787 (0.17)	2,252 (0.15)
High school	26,071 (0.35)	4,816 (0.36)	5,795 (0.36)	4,901 (0.36)	5,575 (0.34)	4,804 (0.32)
Some colleges	17,877 (0.24)	2,675 (0.20)	3,541 (0.22)	3,131 (0.23)	4,263 (0.26)	4,054 (0.27)
College and higher	17,132 (0.23)	2,542 (0.19)	3,380 (0.21)	3,131 (0.23)	3,935 (0.24)	3,904 (0.26)
Race						
White/Caucasian	57,357 (0.77)	11,237 (0.84)	13,200 (0.82)	11,028 (0.81)	11,805 (0.72)	10,059 (0.67)
Black/African American	12,663 (0.17)	1,739 (0.13)	2,254 (0.14)	1,906 (0.14)	3,115 (0.19)	3,303 (0.22)
Others	4,469 (0.06)	401 (0.03)	644 (0.04)	681 (0.05)	1,312 (0.08)	1,652 (0.11)
Region						
Northeast	11,173 (0.15)	2,140 (0.16)	2,576 (0.16)	2,042 (0.15)	2,459 (0.15)	2,102 (0.14)
Midwest	17,877 (0.24)	3,478 (0.26)	4,185 (0.26)	3,540 (0.26)	3,771 (0.23)	3,153 (0.21)
South	30,540 (0.41)	5,351 (0.40)	6,439 (0.4)	5,446 (0.40)	6,722 (0.41)	6,456 (0.43)
West	14,898 (0.20)	2,408 (0.18)	3,058 (0.19)	2,587 (0.19)	3,443 (0.21)	3,303 (0.22)
Others	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)

Table 6-3 Continued

Variables	Pooled data	Wave 6 (2004)	Wave 8 (2006)	Wave 10 (2010)	Wave 12 (2014)	Wave 14 (2016)
	N (Proportion)	*N (Proportion)*	*N (Proportion)*	*N (Proportion)*	*N (Proportion)*	*N (Proportion)*
Marital status						
Married/Partnered	46,928 (0.63)	8,428 (0.63)	10,463 (0.65)	8,577 (0.63)	10,166 (0.62)	9,159 (0.61)
Separated/Divorced	9,684 (0.13)	1,338 (0.10)	1,771 (0.11)	1,634 (0.12)	2,295 (0.14)	2,402 (0.16)
Widowed	14,898 (0.20)	3,210 (0.24)	3,380 (0.21)	2,995 (0.22)	3,115 (0.19)	2,402 (0.16)
Never married	2,980 (0.04)	401 (0.03)	483 (0.03)	408 (0.03)	820 (0.05)	1,051 (0.07)
Employment status						
Employed	26,071 (0.35)	4,147 (0.31)	5,795 (0.36)	4,221 (0.31)	6,067 (0.37)	5,855 (0.39)
Unemployed	1,490 (0.02)	134 (0.01)	161 (0.01)	272 (0.02)	328 (0.02)	300 (0.02)
Retired	40,969 (0.55)	7,090 (0.53)	8,531 (0.53)	8,305 (0.61)	9,182 (0.56)	7,957 (0.53)
Not in the labour market or disabled	5,959 (0.08)	2,007 (0.15)	1,6100 (.10)	817 (0.06)	820 (0.05)	901 (0.06)
Health status						
No disease	9,684 (0.13)	2,140 (0.16)	2,415 (0.15)	1,498 (0.11)	1,968 (0.12)	1,802 (0.12)
One to two diseases	36,500 (0.49)	7,224 (0.54)	8,209 (0.51)	6,671 (0.49)	7,706 (0.47)	6,756 (0.45)
More than two diseases	28,306 (0.38)	4,013 (0.30)	5,473 (0.34)	5,446 (0.40)	6,722 (0.41)	6,456 (0.43)
Observations	74,489	13,377	16,097	13,615	16,396	15,014

Notes: Data in Table 6-3 are calculated based on waves 6, 8, 10, 12, and 14 of HRS.

Table 6-4 Descriptive statistics of control variables (for job loss)

Variables	**Pooled data**	**Wave 6 (2004)**	**Wave 8 (2006)**	**Wave 10 (2010)**	**Wave 12 (2014)**	**Wave 14 (2016)**
	Mean (SD)	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*
Age	62.66 (7.66)	63.51 (7.43)	62.07 (7.76)	64.57 (7.64)	62.32 (7.58)	61.47 (7.50)
	N (Proportion)	*N (Proportion)*	*N (Proportion)*	*N (Proportion)*	*N (Proportion)*	*N (Proportion)*
Gender						
Male	13,838 (0.46)	2,273 (0.46)	2,984 (0.46)	2,370 (0.46)	3,142 (0.46)	3,069 (0.46)
Educational attainment						
Lower than high school	3,610 (0.12)	791 (0.16)	778 (0.12)	567 (0.11)	751 (0.11)	667 (0.10)
High school	9,325 (0.31)	1,680 (0.34)	2,141 (0.33)	1,649 (0.32)	2,049 (0.30)	1,868 (0.28)
Some colleges	8,122 (0.27)	1,136 (0.23)	1,687 (0.26)	1,340 (0.26)	1,912 (0.28)	1,935 (0.29)
College and higher	9,025 (0.30)	1,334 (0.27)	1,881 (0.29)	1,597 (0.31)	2,117 (0.31)	2,202 (0.33)
Race						
White/Caucasian	22,562 (0.75)	4,150 (0.84)	5,254 (0.81)	515 (0.10)	4,781 (0.70)	4,270 (0.64)
Black/African American	5,114 (0.17)	642 (0.13)	843 (0.13))	721 (0.14)	1,366 (0.20)	1,468 (0.22)
Others	2,407 (0.08)	148 (0.03)	389 (0.06	309 (0.06)	683 (0.10)	934 (0.14)
Region						
Northeast	4,512 (0.15)	741 (0.15)	973 (0.15)	721 (0.14)	1,025 (0.15)	867 (0.13)
Midwest	7,220 (0.24)	1,383 (0.28)	1,751 (0.27)	1,391 (0.27)	1,503 (0.22)	1,334 (0.20)
South	12,033 (0.40)	1,927 (0.39)	2,530 (0.39)	2,009 (0.39)	2,732 (0.40)	2,869 (0.43)
West	6,317 (0.21)	889 (0.18)	1,233 (0.19)	1,030 (0.20)	1,571 (0.23)	1,601 (0.24)
Others	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0.00	0.00

Table 6-4 Continued

Variables	Pooled data	Wave 6 (2004)	Wave 8 (2006)	Wave 10 (2010)	Wave 12 (2014)	Wave 14 (2016)
	N (Proportion)	*N (Proportion)*	*N (Proportion)*	*N (Proportion)*	*N (Proportion)*	*N (Proportion)*
Marital status						
Married/Partnered	21,057 (0.70)	3,558 (0.72)	4,736 (0.73)	3,709 (0.72)	4,781 (0.70)	4,537 (0.68)
Separated/Divorced	4,512 (0.15)	642 (0.13)	908 (0.14)	670 (0.13)	1,093 (0.16)	1,201 (0.18)
Widowed	3,008 (0.10)	593 (0.12)	649 (0.10)	567 (0.11)	615 (0.09)	467 (0.07)
Never married	1,504 (0.05)	148 (0.03)	195 (0.03)	206 (0.04)	342 (0.05)	467 (0.07)
Employment status						
Employed	24,066 (0.80)	3,755 (0.76)	5,254 (0.81)	3,864 (0.75)	5,601 (0.82)	5,538 (0.83)
Unemployed	902 (0.03)	99 (0.02)	130 (0.02)	258 (0.05)	137 (0.02)	133 (0.02)
Retired	4,512 (0.15)	939 (0.19)	973 (0.15)	927 (0.18)	956 (0.14)	801 (0.12)
Not in the labour market or disabled	602 (0.02)	148 (0.03)	130 (0.02)	103 (0.02)	137 (0.02)	200 (0.03)
Health status						
No disease	6,618 (0.22)	1,235 (0.25)	1,492 (0.23)	927 (0.18)	1,503 (0.22)	1,401 (0.21)
One to two diseases	16,545 (0.55)	2,816 (0.57)	3,698 (0.57)	2,834 (0.55)	3,688 (0.54)	3,603 (0.54)
More than two diseases	6,919 (0.23)	889 (0.18)	1,297 (0.20)	1,391 (0.27)	1,639 (0.24)	1,668 (0.25)
Observations	30,082	4,941	6,487	5,152	6,830	6,672

Notes: Data in Table 6-4 are calculated based on the sample who are employed at each baseline, that is wave 5, 7, 9, 11, and 13.

6.4.2. Multivariable analysis

Tables 6-5, 6-6 and 6-7 present the estimates of equations 6-3, respectively. Models 1 to 3 show the results from the fixed-effects poisson estimations for the association between different measures of income shocks (wealth shocks in Table 6-6, job loss in Table 6-7) and the CESD-8 score[8]. In Table 6-5, for instance, models 1 to 3 reveal a negative association between income shocks and mental health. In other words, experiencing income shocks is significantly associated with higher depression scores. The rate of the number of depressive symptoms of individuals who experience income shocks in the past two years is 1.034 times (when using 75% as a cut-off value), 1.048 times (when using 50% as a cut-off value), or 1.041 times (when using 25% as a cut-off value) as high as the rate of those who do not experience one.

Table 6-5 Fixed-effect Poisson regression estimates of the relationship between income shocks and depressive symptoms

	Model 1	**Model 2**	**Model 3**
Income large shocks	1.034*		
	(1.85)		
Income medium shocks		1.048***	
		(4.05)	
Income small shocks			1.041***
			(4.52)
Control variables	Yes	Yes	Yes

Notes: The number of observations is 74,489. The number of individuals is 28,990. IRRs are reported in Table 6-5. Data in Table 6-5 are calculated based on waves 6, 8, 10, 12, and 14 of the HRS. Control variables include age, gender, race, marital status, health, educational attainment, employment status, region dummies, year dummies, household income, and all the time-unvarying covariates. t statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

[8] Appendix D.1 reports the estimated results of the fixed-effects poisson regression models without controlling for health status.

Table 6-6 shows a significant positive association between wealth shocks and CESD-8 scores. According to models 1 to 3, experiencing large shocks, medium shocks, or small shocks to household wealth in the past two years is associated with an increase in depression scores by 5.6%, 4.4%, or 3.3%, respectively.

Table 6-6 Fixed-effect Poisson regression estimates of the relationship between wealth shocks and depressive symptoms

	Model 1	**Model 2**	**Model 3**
Wealth large shocks	1.056***		
	(4.22)		
Wealth medium shocks		1.044***	
		(4.18)	
Wealth small shocks			1.033***
			(3.69)
Control variables	Yes	Yes	Yes

Notes: The number of observations is 74,489. The number of individuals is 28,990. IRRs are reported in Table 6-6. Data in Table 6-6 are calculated based on waves 6, 8, 10, 12, and 14 of the HRS. Control variables include age, gender, race, marital status, health, educational attainment, employment status, region dummies, year dummies, household income, and all the time-unvarying covariates. t statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 6-7 presents the results from the fixed-effect Poisson regression estimation for the association between job loss and CESD-8 scores. The estimates show that there is a significant positive association between job loss and depressive symptoms. Specifically, both involuntarily job losses and voluntary job losses are associated with more depressive symptoms significantly, when keeping other factors constant (IRR=1.29, $p<0.01$; IRR=1.153, $p<0.1$).

Table 6-7 Fixed-effect Poisson regression estimates of the relationship between job loss and depressive symptoms

	Model 1
Job loss	
Involuntarily job loss	1.290***
	(4.05)
Voluntarily job loss	1.153*
	(1.88)
Control variables	Yes

Notes: The number of observations is 30,082. The number of individuals is 15,825. IRRs are reported in Table 6-7. Data in Table 6-7 are calculated based on waves 6, 8, 10, 12, and 14 of the HRS. Control variables include age, gender, race, marital status, health, educational attainment, region dummies, year dummies, household income, and all the time-unvarying covariates. t statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Tables 6-8 to 6-10 present the results of the fixed-effect regression models examining the moderating effect of financial literacy (measured by numeracy questions) on the association between financial shocks and depressive symptoms.

In Table 6-8, after adding the interaction term between financial literacy and household income shocks to models, the positive association between income shocks and depressive symptoms becomes insignificant in all models. The estimated coefficients for the interaction terms between financial literacy and household income shocks are larger than one in all models and are significant in most models. The findings reveal that individuals with higher levels of financial literacy have fewer depressive symptoms among those who did not experience income shocks. However, among those who experienced income shocks, having higher levels of financial literacy can become a risk factor for depression as the estimates for the interaction terms between different measures of income shocks and depressive symptoms are consistently larger than one. For example, in model 2, for those who do not experience income shocks, a unit increase in financial literacy score is associated with a decrease in depressive symptoms by 2.5% and the effect of income shocks is insignificantly different from zero. However, for those who experience income shocks, a unit increase in financial literacy score is associated with an increase in depressive symptoms by 1.5% (i.e., [(1.040-1) - (1-0.975)] *100%). The pattern of the income shocks and depression relationship by financial literacy is illustrated in Figures 6-2, which provides more intuitive picture of the findings. They reveal that the marginal effect of experiencing income shocks (as compared to not experiencing income shocks) on depression is larger among those with higher financial literacy levels.

Table 6-8 Fixed-effect Poisson estimates of income shocks on depressive symptoms considering the effect of financial literacy

	Model 1	Model 2	Model 3
Income large shocks	1.004		
	(0.14)		
Income large shocks * Financial literacy	1.037		
	(1.51)		
Income medium shocks		1.009	
		(0.50)	
Income medium shocks * Financial literacy		1.040***	
		(3.04)	
Income small shocks			1.011
			(0.82)
Income small shocks * Financial literacy			1.031***
			(2.98)
Financial literacy	0.980***	0.975***	0.972***
	(-2.86)	(-3.39)	(-3.62)
Control variables	Yes	Yes	Yes

Notes: 1. Financial literacy is proxied by numeracy questions in Table 6-8. The number of observations is 74,489. The number of individuals is 28,990. IRRs are reported in Table 6-8. Data in Table 6-8 are calculated based on waves 6, 8, 10, 12, and 14 of the HRS. Control variables include age, gender, race, marital status, health, educational attainment, employment status, region dummies, year dummies, household income, and all the time-unvarying covariates. t statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 6-9 Fixed-effect Poisson estimates of wealth shocks on depressive symptoms considering the effect of financial literacy

	Model 1	Model 2	Model 3
Wealth large shocks	1.034**		
	(2.05)		
Wealth large shocks * Financial literacy	1.024		
	(1.63)		
Wealth medium shocks		1.037**	
		(2.55)	
Wealth medium shocks * Financial literacy		1.008	
		(0.68)	
Wealth small shocks			1.045***
			(3.50)
Wealth small shocks * Financial literacy			0.987
			(-1.32)
Financial literacy	0.978***	0.980***	0.986*
	(-2.97)	(-2.72)	(-1.82)
Control variables	Yes	Yes	Yes

Notes: 1. Financial literacy is proxied by numeracy questions in Table 6-9. The number of observations is 74,489. The number of individuals is 28,990. IRRs are reported in Table 6-9. Data in Table 6-9 are calculated based on waves 6, 8, 10, 12, and 14 of the HRS. Control variables include age, gender, race, marital status, health, educational attainment, employment status, region dummies, year dummies, household income, and all the time-unvarying covariates. t statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 6-10 Fixed-effect Poisson estimates of job loss on depressive symptoms considering the effect of financial literacy[1]

	Model 1
Job loss	
Involuntarily job loss	1.097
	(0.87)
Voluntarily job loss	0.877
	(-1.11)
Job loss * Financial literacy	
Involuntarily job loss * Financial literacy	1.152*
	(1.85)
Voluntarily job loss * Financial literacy	1.307**
	(3.07)
Financial literacy	0.979
	(-1.42)
Control variables	Yes
Observations: 30,082	

Notes: 1. Financial literacy is proxied by numeracy questions in Table 6-10. The number of observations is 30,082. The number of individuals is 15,825. IRRs are reported in Table 6-10. Data in Table 6-10 are calculated based on waves 6, 8, 10, 12, and 14 of the HRS. Control variables include age, gender, race, marital status, health, educational attainment, region dummies, year dummies, household income, and all the time-unvarying covariates. t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

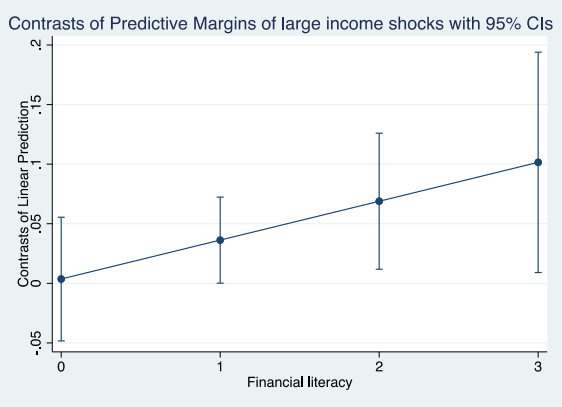


Figure 6-2a

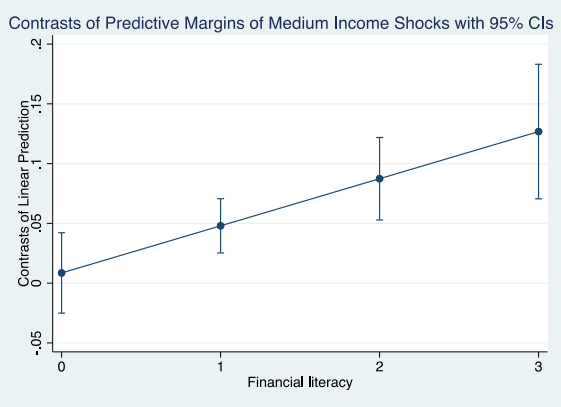


Figure 6-2b

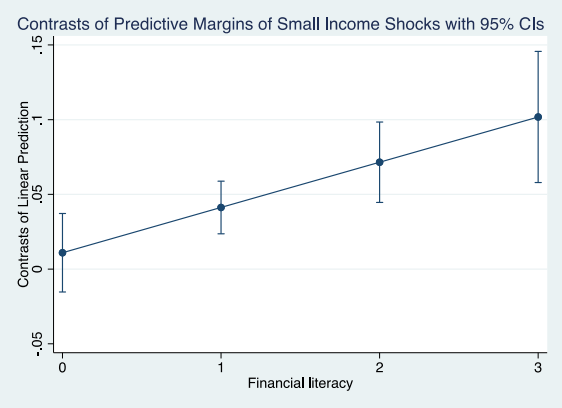


Figure 6-2c

Figure 6-2 The effect of income shocks on depressive symptoms by financial literacy

Note: Figures 6-2 display the contrasts of predictive margins of income shocks when using different cut-off points (Figures 6-2a, 6-2b, and 6-2c use a cut-off of 75%, 50%, and 25%, respectively).

In Table 6-9, after adding the interaction term between financial literacy and each meaurement of household wealth shocks based on the models displayed in Table 6-6, the positive association between wealth shocks and depressive symptoms still holds. The estimated coefficient associated with the interaction term between financial literacy and household income shocks are insignificant in all models. It shows that regardless of the definition of wealth shocks, the joint effect of financial literacy and financial shocks is not statistically different from the sum of both effects individually. Besides, financial literacy per se is significantly associated with fewer depressive symptoms. For instance, according to model 1, a unit increase in financial literacy score is associated with lower depression scores by 2.2%. The findings suggest that individuals with higher levels of financial literacy have fewer depressive symptoms and such a negative association between financial literacy and depressive severity holds among individuals who experience wealth shocks and among those do not. Figures 6-3a to 6-3c display the contrasts of predictive margins of financial shocks. The figures show that the pattern of the marginal effect of experiencing wealth shocks (as compared to not experiencing wealth shocks) on depression by financial literacy levels is inconsistent. The marginal effects of experiencing large and medium wealth shocks on depression are stronger among those with higher financial literacy levels. Nevertheless, the marginal effects of experiencing small wealth shocks (i.e., when using a cut-off of 25%) on depression shows a decreasing trend as the financial literac level increases.

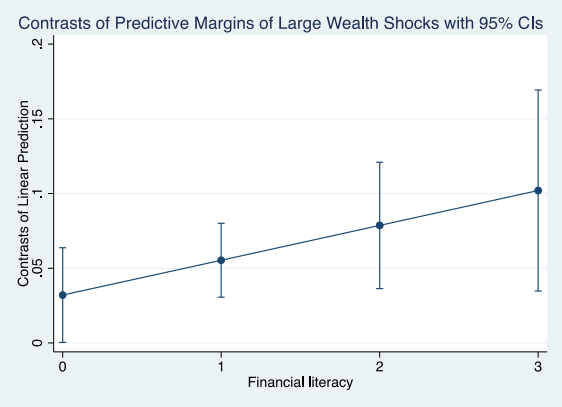


Figure 3a

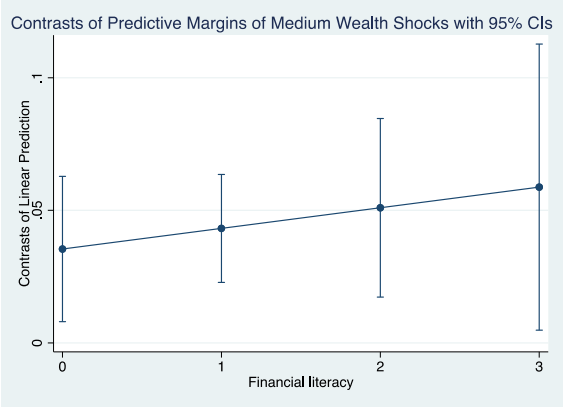


Figure 3b

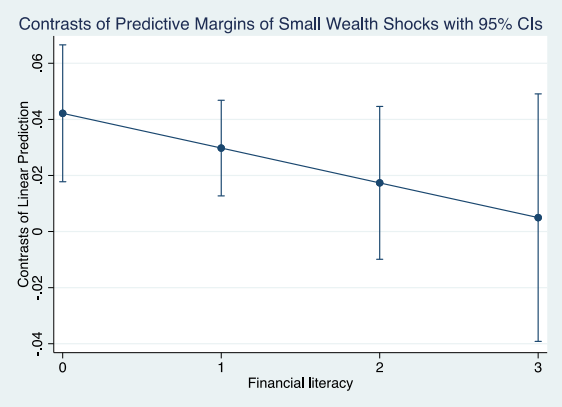


Figure 3c

Figure 6-3 The effect of wealth shocks on depressive symptoms by financial literacy

Note: Figures 6-2 display the contrasts of predictive margins of wealth shocks when using different cut-off points (Figures 6-2a, 6-2b, and 6-2c use a cut-off of 75%, 50%, and 25%, respectively).

The results reported in Table 6-10 reveal that the magnitude of the association between job loss and depressive symptoms vary with financial literacy levels. The estimated coefficient for the interaction term between financial literacy and job loss is significant and larger than one. The results show that the association between voluntary job loss and depression severity is moderated by financial literacy levels. For example, among individuals who experience the voluntary job loss, a unit increase in financial literacy score is associated with an increase in depressive symptoms by 28.6% (i.e., [(1.307-1) - (1-0.979)] *100%). The similar results are also observed in Figure 6-4, which shows that the marginal effect of experiencing either involuntary job loss or voluntary job loss (as compared to not experiencing unemployment shocks) on depression rises as financial literacy increases.

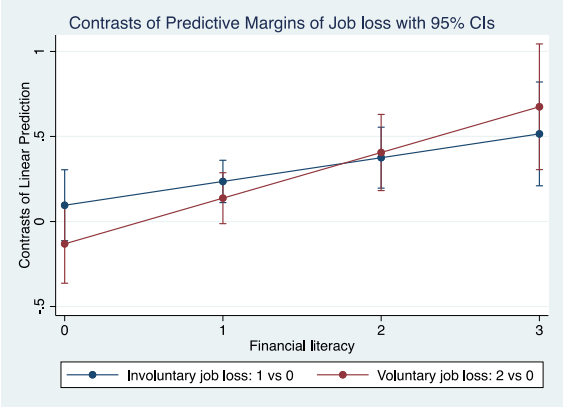


Figure 6-4 The effect of job loss on depressive symptoms by financial literacy

6.5. Robustness check

6.5.1. Robustness check I

In the first robustness check, financial literacy is measured by the "Big Three" financial literacy questions as described in section 6.3.2. The results are reported in Tables 6-8, 6-9 and 6-10. The first robustness check is conducted using data from waves 7, 10 and 13 since only data from waves 7, 10 and 13 included information on the Big Three questions to measure financial literacy.The sample size for income shocks and wealth shocks is 3,451. The results from the robustness check do not provide supportive evidence to the main findings from Tables 6-11 to 6-12. As in Tables 6-11 and 6-12, the estimates of the interaction terms between financial literacy and either household income shocks or wealth shocks are insignificant in all models. The results show that the financial literacy level does not significantly moderate the association between either income shocks or wealth shocks and depressive symptoms. This first robustness check is only conducted for the association related to income shocks and wealth shocks while not for that related to job loss since the sample size for the latter (i.e., 213 observations in total, where the sample of involuntary job loss and voluntary job loss are 30 and 11, respectively) is too small to get the results from the fixed-effects estimation.

Table 6-11 Fixed-effect Poisson estimates of income shocks on depressive symptoms considering the effect of financial literacy[1]

	Model 1	Model 2	Model 3
Income large shocks	1.120		
	(0.26)		
Income large shocks * Financial literacy	0.888		
	(-0.59)		
Income medium shocks		1.411	
		(1.28)	
Income medium shocks * Financial literacy		0.866	
		(-1.18)	
Income small shocks			1.011
			(0.06)
Income small shocks * Financial literacy			1.015
			(0.16)
Financial literacy	0.956	0.971	0.951
	(-0.88)	(-0.56)	(-0.91)
Control variables	Yes	Yes	Yes

Notes: 1. Financial literacy is proxied by the Big Three financial questions. The number of observations is 877. The number of individuals is 428. IRRs are reported in Table 6-11. Data in Table 6-11 are calculated based on waves 7, 10 and 13 of the HRS. Control variables include age, gender, race, marital status, health, educational attainment, employment status, region dummies, year dummies, household income, and all the time-unvarying covariates. t statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 6-12 Fixed-effect Poisson estimates of wealth shocks on depressive symptoms considering the effect of financial literacy[1]

	Model 1	Model 2	Model 3
Wealth large shocks	1.14		
	(0.54)		
Wealth large shocks * Financial literacy	0.916		
	(-0.67)		
Wealth medium shocks		0.950	
		(-0.26)	
Wealth medium shocks * Financial literacy		1.05	
		(0.53)	
Wealth small shocks			0.928
			(-0.46)
Wealth small shocks * Financial literacy			1.047
			(0.58)
Financial literacy	0.968	0.947	0.941
	(-0.60)	(-0.96)	(-0.99)
Control variables	Yes	Yes	Yes

Notes: 1. Financial literacy is proxied by the Big Three financial questions. The number of observations is 877. The number of individuals is 428. IRRs are reported in Table 6-12. Data in Table 6-12 are calculated based on waves 7, 10 and 13 of the HRS. Control variables include age, gender, race, marital status, health, educational attainment, employment status, region dummies, year dummies, household income, and all the time-unvarying covariates. t statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

6.5.2. Robustness check II

The second robustness check aims to test if the main results displayed in section 6.4.2 are robust when applying a different regression model. To realise this, the association between financial shocks, job loss, financial literacy and depressive symptoms is tested using a correlated random effects negative binomial regression model. A detailed description of this estimation method has been discussed in the previous chapter (see section 5.2 in Chapter V). The results of the robustness check II are reported in Tables 6-13, 6-14 and 6-15. The results from the correlated random effect negative binomial regression are mostly similar to those observed in section 4.2, suggesting that the main findings are robust to applying a different regression method.

Table 6-13 Correlated random effects negative binomial estimates of income shocks on depressive symptoms considering the effect of financial literacy[1]

	Model 1	Model 2	Model 3
Income large shocks	1.008		
	(0.27)		
Income large shocks * Financial literacy	1.043*		
	(1.74)		
Income medium shocks		1.018	
		(0.90)	
Income medium shocks * Financial literacy		1.041***	
		(2.67)	
Income small shocks			1.019
			(1.26)
Income small shocks * Financial literacy			1.030**
			(2.52)
Financial literacy	0.979***	0.974***	0.972***
	(-2.57)	(-3.06)	(-3.18)
Control variables	Yes	Yes	Yes
Observations: 74,489			

Notes: 1. Financial literacy is proxied by numeracy questions in Table 6-13. The number of observations is 74,489. The number of individuals is 28,990. IRRs are reported in Table 6-13. Data in Table 6-13 are calculated based on waves 6, 8, 10, 12, and 14 of the HRS. Control variables include age, gender, race, marital status, health, educational attainment, employment status, region dummies, year dummies, household income, and all the time-unvarying covariates. t statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 6-14 Correlated random effects negative binomial estimates of income shocks on depressive symptoms considering the effect of financial literacy[1]

	Model 1	Model 2	Model 3
Wealth large shocks	1.034*		
	(1.78)		
Wealth large shocks * Financial literacy	1.031		
	(1.84)		
Wealth medium shocks		1.036**	
		(2.16)	
Wealth medium shocks * Financial literacy		1.012	
		(0.89)	
Wealth small shocks			1.043***
			(2.64)
Wealth small shocks * Financial literacy			0.992
			(-0.67)
Financial literacy	0.976***	0.977**	0.983*
	(-2.84)	(-2.67)	(-1.83)
Control variables	Yes	Yes	Yes
Observations: 74,489			

Notes: 1. Financial literacy is proxied by numeracy questions in Table 6-14. The number of observations is 74,489. The number of individuals is 28,990. IRRs are reported in Table 6-14. Data in Table 6-14 are calculated based on waves 6, 8, 10, 12, and 14 of the HRS. Control variables include age, gender, race, marital status, health, educational attainment, employment status, region dummies, year dummies, household income, and all the time-unvarying covariates. t statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 6-15 Correlated random effects negative binomial estimates of indicators of job loss on depressive symptoms considering the effect of financial literacy[1]

	Model 1
Job loss	
Involuntarily job loss	1.100
	(0.77)
Voluntarily job loss	0.863
	(-1.04)
Job loss* Financial literacy	
Involuntarily job loss * Financial literacy	1.136
	(1.46)
Voluntarily job loss* Financial literacy	1.324***
	(2.73)
Financial literacy	0.980
	(-1.12)
Control variables	Yes

Notes: 1. Financial literacy is proxied by numeracy questions in Table 6-15. The number of observations is 30,082. The number of individuals is 15,825. IRRs are reported in Table 6-15. Data in Table 6-15 are calculated based on waves 6, 8, 10, 12, and 14 of the HRS. Control variables include age, gender, race, marital status, health, educational attainment, region dummies, year dummies, household income, and all the time-unvarying covariates. t statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

6.6. Discussion

6.6.1. Findings and interpretation

In previous studies, financial literacy was showed to be critical to the accumulation of financial resources as well as a greater financial and mental well-being. On the other hand, more recent studies also link financial literacy to a better coping ability towards unexpected financial shocks, suggesting that financial literacy may play a role in individuals' financial and mental well-being when they experience financial shocks. However, it is still unclear if financial literacy can protect people's mental health when they experience financial shocks at the individual or household level. This chapter produces fresh evidence of the moderating effect of financial

literacy on the relationship between financial shocks and depression. The findings in this study suggest that financial literacy indeeed has a nuanced relationship with mental health. One of interesting findings in this study is that the association between income shocks or job loss and depressive symptoms is stronger among those with higher levels of financial literacy, suggesting a potential negative psychological impact of being financially literate when people confronting with financial shocks. The findings in this chapter further our understanding regarding the effect of financial literacy on mental health by showing that having higher levels of financial literacy can not only be regarded as a protective factor of mental health but also impose more depressive symptoms among those who experience financial shocks.

As the baseline specification, this study found the positive associations between financial shocks and depression. Specifically, after considering a range of control variables and all time-invariant confounders, both income shocks and wealth shocks were associated with elevated depressive symptoms. Besides, this study also found that both involuntary job loss and voluntary job loss were associated with increased depressive symptoms. The findings here are in line with previous studies conducted in the U.S., who also found that wealth shocks, income losses, and job loss or unemployment can negatively affect mental health outcomes (Dew et al., 1992; Dooley et al. 2000; Pool et al., 2017; Schwandt, 2018; Stauder, 2019).

It has been widely shown that individuals with higher levels of financial literacy are also more likely to have (i) more financial resources such as higher income and greater wealth accumulation, and (ii) better financial coping abilities, both of which constitute to better financial resilience of individuals or households when confronted with financial shocks. Given this, it is expected that the negative effects of financial shocks on mental health may be mitigated by financial literacy. However, contrary to my expectation, the results showed that the association between income shocks, voluntary job loss and depressive symptoms was stronger among those with higher levels of financial literacy. The contradictory findings might

be explained from a behavioural economics perspective. Specifically, financially literate people tend to have a heightened focus on and pay more attention to their financial situation including the consequence of financial shocks (Carpena et al., 2011; Barrafrem et al., 2020; Xu et al., 2022). Meanwhile, people might have been inculcated with the belief or the expectation that higher levels of financial literacy means being better able to manage financial issues and thus have more advantaged financial situation, as they are suggested so by either academia or non-academia. This might in turn induce higher financial expectations and aspirations of their financial situation, reflecting a higher reference point against which an income shock is evaluated (Kahneman and Tversky, 1979; Golman and Loewenstein, 2012; Dewi et al., 2020). Higher reference points due to financial literacy can constitute a widened gap between desired financial outcomes and the actual realities of financial shocks, thereby disproportionally eroding one's mental health. Therefore, the findings here might indicate that financial literacy can impose hidden psychological costs to middle-aged and older people when facing income shocks or job loss.

Meanwhile, the study also showed that financial literacy levels per se was negatively associated with depressive symptoms among those who did not experience financial shocks, in other words, individuals with higher levels of financial literacy tended to have lower likelihood of experiencing depressive symptoms. This finding supports those obtained from the previous chapters, where the negative effect of financial literacy on depressive symptoms was observed. However, after considering the interaction term between financial shocks and financial literacy, the overall effect of financial literacy on mental health becomes inconclusive since the magnitude of the net effect of financial literacy on mental health may be sensitive to many factors such as the severity, the type of financial shocks and financial literacy levels. For example, this study found that financial literacy was negatively associated with depressive symptoms for those who experienced wealth shocks; while the overall effect of financial

literacy on depressive symptoms was positive, in other words, having higher levels of financial literacy might be harmful to the mental health of those who experienced income shocks.

An increasing number of scholars highlight that financial literacy can help reduce financial fragility and build up financial resilience, especially during the financial downturn when people are facing the increased risk of financial shocks (Guiso and Viviano, 2014; Lusardi et al., 2021; Chhatwani and Mishra, 2021). Additionally, a large body of evidence shows that financial literacy can have positive effects on financial outcomes such as higher household income and wealth accumulation, as also found in the previous chapter. The negative association between financial literacy and depressive symptoms is in line with this previous literature. However, this study also found that financial literacy can induce negative effects on mental health for those who experienced income shocks or voluntary job loss. Further research is therefore needed to investigate: how does financial literacy impact mental health? This knowledge will be informative to the trade-off between the negative effect and positive effect of enhancing financial literacy under different conditions.

The findings observed in the robustness check where a different measurement of financial literacy was applied were inconsistent with the main findings. There is no significant difference in the association between financial literacy and depression by financial literacy levels when financial literacy was measured by the Big Three financial questions. The difference between the main results and the results from the robustness check might be due to several reasons. First, the findings are sensitive to the measure of financial literacy. Since the results of robustness check where the financial literacy is measured through the "Big Three" are different from the main results in this study where financial literacy is measured through a proxy of numeracy questions. The two measures may have captured the different aspects of financial literacy. The "Big Three" questions measure an individual's ability to calculate interest rates, to understand money inflation and the relation between risks and returns. The three numeracy questions focus

on an individual's ability to understand and calculate percentages, the division of lottery and interest rates. Second, the robustness check and the main regressions are based on different samples. The robustness check is conducted using since only these three waves (i.e., waves 7, 10 and 13) having the information of the "Big Three" financial literacy questions. However, the key regressions are performed using data from five waves including HRS waves 6, 8, 10, 12, and 14. The sample used in the first robustness check is not a subsample of that in the key regressions since the majority respondents who answered the Big Three financial literacy questions did not answer the numeracy questions.

6.6.2. Strengths

To the best of my knowledge, this study is the first to explore the role of financial literacy in shaping the associations between financial shocks and mental health outcomes. Previous research has exclusively focused on the effects of financial shocks on mental health as well as various consequences of having good levels of financial literacy. Besides, the findings of the previous chapters have shown that financial literacy is associated with less depressive symptoms through the increased level of financial resources, which can contribute to a better financial resilience. This study expands upon our current understanding on financial shocks, financial literacy and mental health by providing the evidence about whether having higher levels of financially literacy can mitigate or further erode the harmful impacts of financial shocks on mental health when facing financial shocks.

Besides, this study considers different types of financial shocks including income shocks, wealth shocks and job loss, respectively. Furthermore, regarding income shocks and wealth shocks), different definitions of shocks (i.e., using cut-off points of 25%, 50% and 75%) are considered regarding the possibility that the effects of a financial shock can vary depends on how is the financial shock defined. Additionally, this study differentiates the involuntary job loss from voluntary job loss. The differentiation between voluntary job losses and involuntary

job losses is necessary in this study. Because it is expected that the effect of involuntary job loss on mental health is different from that of leaving a job voluntarily. For example, there is evidence showing that involuntary job losses may be harmful to mental health while voluntary job losses may have positive effects on mental health (Mandal and Roe, 2007). Besides, differentiating involuntary job loss from voluntary job loss can also reduce the potential reverse causality that runs from the outcome variable to job loss.

Finally, the use of HRS dataset is another strength of this study. The HRS dataset provides a sufficient and representative sample of middle-aged and older people in the U.S.. Using fixed-effect models and correlated random effect models based on the panel data enables to control for all time-invariant confounders including those are unobserved time-invariant confounders.

6.6.3. Limitations

Despite the strengths discussed above, this study is subject to several limitations. First, no particular cut-off value has been established in the literature to be used to indicate a negative shock to income (or wealth). However, this study investigates income shocks (or wealth shocks) applying a range of potential cut-off values the 25% cut-off, the 50% cut-off and the 75% cut-off, respectively, which to some degree can reduce the risk of misclassification since different cut-off values are considered.

Besides, the measurement of financial literacy may not be the best reflection of an individual's financial literacy level. A high score on the financial literacy questions, especially when financial literacy is inadequately defined, does not necessarily reflect better financial decisions and behaviours in reality. In this study, financial literacy is measured in two ways: through questions on numeracy as a proxy for financial literacy and through the "Big Three" financial questions, involving an individual's understanding of interest rates, inflation, and risk diversification. Nevertheless, both measures may not capture many other aspects of financial

literacy and are not able to distinguish between different levels of financial literacy, though it is suggested that the "Big Three" financial questions proposed by Lusardi and Mitchell (2009) is one of the most representative measurements of financial literacy (Rieger, 2020).

This study focuses on the associations between financial literacy, financial shocks and depressive symptoms among people aged 50 and over. Therefore, the findings in this study are generalisable to this age group. The wealth accumulation is usually higher among individuals who are approaching or in the early stage of retirement compared to younger adults. These people are more likely to have sufficient financial resources to mitigate the negative effects of financial shocks, which can swamp the importance of financial literacy in coping with financial shocks. As a result, the effect of financial literacy on the effects of financial shocks on mental health may have been underestimated. On the other hand, younger and early middle-aged cohorts tend to have less wealth accumulation compared to those who aged 50 and over, according to the life-cycle hypothesis in economics (Shefrin and Thaler, 1988). Therefore, the effect of financial literacy in shaping the consequences of negative financial shocks on mental health may be more salient among younger and early middle-aged cohorts. Future research might be benefit from looking at the relevant research question among these populations.

Although this study finds that financial literacy can significantly moderate the effect of financial shocks on mental health, it does not provide the most direct evidence about whether financial literacy affects coping abilities (e.g., financial decisions in response to the financial shock) during a financial shock. Future research may look at the mechanisms underlying the effects of financial literacy on mental health outcomes resulted from financial shocks, for example, the difference in coping ability in more details. This knowledge can be informative to understanding how financial literacy functions in protecting mental health when confronted with financial shocks.

6.7. Conclusion

In conclusion, this study finds that experiencing financial shocks is positively associated with depressive symptoms and that higher levels of financial literacy actually exacerbates this association. Individuals with higher levels of financial literacy were found to have fewer depressive symptoms, which supports the previous evidence arguing that maintaining financial literacy can be critical to individuals' mental health when getting older. However, it is also observed that higher levels of financial literacy are positively associated with *more* depressive symptoms at times of experiencing financial shocks or life events related to financial shocks such as job loss. As shown in this chapter, the positive association between income shocks and depressive symptoms is *stronger* among those with higher financial literacy levels. Given the positive effects of financial literacy on both financial and mental well-being, policymakers and educators may want to increase support and investments in financial education aimed at improving financial literacy levels of populations. However, the findings in this study highlight that it is equally important to understand why financial literacy make the psychological effect of financial shocks worse and whether there is anything practical that can be done about this. For example, when people are experiencing substantial financial losses due to major life events, financial support and emotional support might be a more efficient way of supporting people's mental well-being, especially for individuals with higher levels of financial literacy and financial aspirations. More future research that investigates how financial literacy can possibility influence the effect of financial shocks on mental health in different research contexts is needed to better guide the policy.

Chapter VII: Discussion

Chapter VII moves on to a discussion of the thesis work overall. The chapter starts by summarising the key findings of the PhD research. Section 7.2 brings together and compares the findings from each chapter of the PhD thesis and interprets the overall findings of the research. Section 7.3 focuses on the practical implications inferred from the findings. This is followed by sections 7.4 and 7.5 where a discussion on the limitations and suggestions for future research are presented. Section 7.6 concludes.

7.1. Summary of the key findings

This PhD research has empirically investigated the relationship between financial literacy and depression and explored its underlying mechanisms from an economic perspective by dealing with the six research objectives outlined in Chapter I (section 1.2).

I began by addressing the first two research objectives in the literature review chapters, which provided a theoretical foundation for the empirical research that follows. Specifically, Chapter II conceptualised financial literacy and reviewed the evidence on the relationship between financial literacy on one side, and financial outcomes and mental health outcomes on the other. In Chapter II, I found that higher levels of financial literacy are associated with various financial outcomes including better financial decisions, higher levels of income and wealth accumulation, and improved financial and mental well-being. In Chapter III, I found that the indicators of financial stress are associated with a higher risk of depression or a greater number of depressive symptoms. This relationship between the two can be explained by social causation, social selection, psychological stress and/or social comparison hypotheses.

Findings from the two literature reviews suggested a potential link between financial literacy and depression, and identified the research gaps within the existing literature. Despite some evidence existing on the association between financial literacy and anxiety or psychological well-being, the association between financial literacy and depression is not well-understood. In this PhD research thesis, I conducted a series of empirical studies aiming to explore the nature of the relationship between financial literacy and mental well-being. Using data taken from two rich longitudinal datasets, the CFPS and the HRS, I examined the relationship between financial literacy and depression in both Chinese adults and the U.S. adults. Table 7.1 summaries the key information relating to the research gaps, research questions, dataset, key findings, and the contributions of each empirical chapter.

Overall, I found that, after considering demographics, socioeconomic characteristics and health conditions, there was a negative and significant cross-sectional association between financial literacy and depressive symptoms in Chinese adults (as in Chapter IV). Such a cross-sectional and negative association between financial literacy and depression was confirmed by the longitudinal study on the U.S. sample (see Chapter V), where the intertemporal interaction between the two and its underlying pathways were the major emphases. In addition to a direct contemporary association between financial literacy and depressive symptoms, there was an indirect contemporary association between the two that was operated through household income and household wealth. Through the panel analysis in Chapter V, I documented that the negative relationship between financial literacy and depression symptoms remained, even after an additional adjustment for time dummies and all of the time-invariant confounders. Additionally, the cross-lagged panel mediation analysis suggested that there was a cross-lagged relationship between financial literacy and depressive symptoms. Specifically, financial literacy at the baseline was associated with higher levels of household income and wealth, as well as depressive symptoms four years later. Moreover, the reverse pathways were statistically supported, suggesting a bidirectional cross-lagged relationship between depressive symptoms and financial literacy.

I then discovered that the effect of financial literacy on mental health can be complex after examining the moderating effect of financial literacy on the association between financial shocks and depression in the U.S. adults in Chapter VI. I found that, after adjusting for a range of control variables, negative shocks to household income (or household wealth) and involuntary job loss were associated with elevated depressive symptoms. Consistent with the findings from the previous chapters, I found that individuals with higher levels of financial literacy who did not experience major financial shocks tended to have fewer depressive symptoms. However, contrary to my expectation, I also discovered that, among people who

experienced income shocks and job losses, having higher levels of financial literacy intensified the negative mental health effect of experiencing either income shocks or job loss.

Table 7-1 A summary table of the three empirical studies

Empirical studies	Research Gaps	Research Questions	Dataset	Key findings	Secondary findings	Key contribution to knowledge
Chapter IV	Only a handful of studies have examined the relationship between financial literacy and mental health. The existing evidence has mostly focused on one aspect of financial literacy (i.e., financial knowledge), in high-income settings and in older adults. The relationship between different dimensions of financial literacy and depression in a low- and middle-income setting in adults is yet to be investigated.	Does a relationship exist between financial literacy and mental well-being among Chinese adults aged 18 and over?	The analyses are based on data from the 2014 wave of the China Family Panel Studies.	1. All three components of financial literacy: basic financial knowledge, financial behaviours and financial attitudes, are statistically and significantly associated with mental health (when measured by the symptoms related to depression and anxiety) after controlling for demographics, social factors, and health status. 2. After further considering household economic indicators, the relationship between basic financial knowledge and mental health becomes insignificant; while the relationship associated with financial attitudes or financial behaviours remains significant.	1. The negative association between financial knowledge and depression is stronger among respondents with debt than those without any debt. 2. There are no significant differences in the association related to financial attitudes or financial behaviours between adults with debt and those with no debt.	It provides the first empirical evidence of the relationship between financial literacy and mental health outcomes in a middle-income setting.
Chapter V	The existing empirical studies on the relationship between financial literacy and mental health outcomes are mostly cross-sectional. It is unclear if the relationship between financial literacy and mental health outcomes holds over time. Additionally, the potential mechanism underlying this relationship has not yet been investigated.	Does the relationship between financial literacy and depression hold over time? What are potential economic pathways underlying the relationship between financial literacy and depression?	The key analyses are based on data from waves 6, 8, 10, and 12 of the Health Retirement Study.	Panel analysis: There is a negative association between financial literacy and depressive symptoms. Yet, the magnitude of the association declines after adjusting for demographic, social and economic factors, and health status. Mediation analysis: 1. Negative and direct relationship between current financial literacy and future depressive symptoms. 2. Positive relationship between current income or wealth and future financial literacy, as well as between current financial literacy and future income and wealth. 3. No evidence of the cross-lagged impact of household income or wealth on depressive symptoms. 4. Income and wealth mediate the relationship between financial literacy and depressive symptoms cross-sectionally.	No significant differences in the association between financial literacy and depression between adults with debt and those with no debt.	It provides the first longitudinal evidence of the relationship between financial literacy and depression and the economic pathways underlying this association between the two, thus contributing to better causal inferences.

Table 7-1 Continued

Empirical studies	Research Gaps	Research Questions	Dataset	Key findings	Secondary findings	Key contribution to knowledge
Chapter VI	Financial shocks have been widely considered to negatively affect mental well-being. In another stream of studies, financial literacy has been linked to higher financial resilience and a greater ability to cope with financial shocks. However, it is unclear whether financial shocks have different impacts on mental well-being among people with different financial literacy levels.	Does financial literacy moderate the relationship between financial shocks and mental well-being?	The analyses are based on data from waves 5 to 14 of the Health Retirement Study.	1. There are positive associations between income shocks, wealth shocks, job loss and depression. 2. The association between income shocks or job loss and depressive symptoms is stronger among those with higher levels of financial literacy.	Null	It expands upon the current understanding of financial shocks, financial literacy and mental health by providing fresh evidence about whether having higher levels of financial literacy can mitigate or further erode the harmful impacts of financial shocks on mental health.

7.2. Interpretation and comparison of findings

7.2.1. The relationship between financial literacy and depression

The common aim that the three empirical studies shared was an attempt to understand the relationship between financial literacy and mental well-being. As anticipated, the findings based on Chinese adults supported the study's hypothesis of a negative relationship between financial literacy and depressive symptoms, after controlling for demographic, social and economic factors and health status. The negative relationship between financial literacy and depressive symptoms was further confirmed by the panel analysis based on data from the U.S. in Chapter V. The results indicate that people with higher financial literacy levels are less likely to experience depressive symptoms. These findings are in line with the existing literature, which shows that higher financial literacy levels are associated with lower anxiety levels in adults aged between 40 and 65 in Japan (Kadoya and Khan, 2017), less depressive symptoms and loneliness in older adults in the U.S. (Bennett et al., 2012), and, more broadly, improved health outcomes in Chinese adults (Zheng et al., 2021).

7.2.2. The underlying economic pathways

A closer look at the mechanisms underpinning the relationship between financial literacy and depression was provided in Chapter V, allowing for a better understanding of how financial literacy can be related to depression. The results indicate that more financially literate individuals may be better at accumulating financial resources, such as income and wealth, by making more value-maximising financial decisions and managing their finances effectively, which, in turn is associated with a decreased risk of experiencing the symptoms of depression. On the one hand, I observed that baseline financial literacy was positively and significantly associated with the follow-up household income and wealth, which lasted for up to four years. These findings support the predictions of the microeconomic models of saving and

consumption simulated by Delavande et al. (2008) and Jappelli and Padula (2013b), which is then calibrated by Lusardi and Mitchell (2014). In these models, financial literacy is seen as a form of investment in human capital. Both Lusardi and Mitchell's (2014) and Jappelli and Padula's (2013b) theoretical models suggest that financial literacy and wealth are endogenous to each other and are strongly associated with each other over one's life cycle, which is in line with my findings. Specifically, the stock of financial literacy and the additional financial knowledge acquired can influence income or wealth accumulation. This may be because people who are more financially literate are more likely to undertake value-maximising financial decisions and engage in more effective financial management. For instance, they are also more likely to participate in financial markets, be better at detecting financial fraud, better able to cope with financial shocks and emergencies (Engels et al., 2020; also see Chapters II and VI), and be less likely to engage in costly borrowing strategies. As a result, they are more likely to accumulate income and wealth (see Chapter II). At the same time, people with higher levels of income and wealth will also care more about improving their financial knowledge and will be more incentivised to invest in financial education in order to maintain and improve their financial literacy levels. The cost of acquiring additional financial knowledge for those who are already financially literate will be low, whereas such a cost will be higher for those who lack financial knowledge or knowledge in general (Delavande et al., 2008). Thus, people with fewer financial resources, who usually also have low levels of financial literacy, may find it too costly (e.g., time-consuming, money consuming, effort consuming) to invest in financial knowledge (Wagner, 2019; Lusardi and Mitchell, 2014). Both financial literacy (regarded as a specific type of human capital) and household finances (income and wealth) constitute a virtuous circle, and the combination of these two elements contributes significantly to an individual's financial and mental well-being.

In addition to this finding, I also observed that household income and wealth were negatively associated with depressive symptoms in the same time interval. This finding is in line with the findings from my systematic review chapter and with the existing literature on the various indicators of financial stress and mental health outcomes, which show that a lack of financial resources can be a risk factor for depression at a given point in time (e.g., Osafo Hounkpatin et al. 2015). The reasoning behind this can be explained by hypotheses such as the social causation theory and the social comparison theory (see section 3.4.2 in Chapter III for more detail). According to social causation theory, people with a lower level of income and wealth are also more likely to have poor living conditions and nutrition status, worse health and quality of life, limited access to medical, health and many other services, and are less able to deal with unexpected financial shocks (Jin et al., 2020; Lund and Cois, 2018b). According to the social comparison theory, an upward social comparison against a particular reference group and concerns about one's uncertain future situation can have adverse effects on a person's mental health and can cause psychological stress (Verduyn et al., 2017; Staufenbiel et al., 2013). Therefore, low levels of income and wealth accumulation can lead to a higher likelihood of experiencing financial strain and higher levels of financial insecurity.

I found no evidence of an association between baseline household income and wealth and depressive symptoms four years later. This finding is in contrast with the existing literature. Previous research studies on household finances and depression that apply the cross-lagged model find that a worse economic status (measured by an asset index) is significantly associated with an increased number of depressive symptoms two years later (Lund and Cois, 2018b). The differences between my findings and those of these studies may be attributed to the different time intervals between the measurement points. Indeed, there is evidence that the psychological impact of a previous stressful financial situation diminishes over time (Richardson et al., 2016; Sareen et al., 2011; Mirowsky and Ross, 2001). Therefore, it is highly

likely that in my study, the time interval between any two measurement points (i.e., four years) may be too long to capture any impact of the current financial situation on future depressive symptoms, which themselves may be immediate or short-term.

In addition to the indirect relationship between financial literacy and depressive symptoms that are operated through household income and wealth, a direct relationship between financial literacy and depressive symptoms was also observed in my analysis. This is in line with the study's hypothesis (in Chapter V) and can be explained from a psychological perspective: more financially literate individuals may be more confident in their financial management abilities and feel more in control over their financial situation, which is, in turn, related to better mental well-being (Taylor et al., 2011; Orth and Robins, 2013).

However, since the analysis based on Chinese adults is cross-sectional (constrained by the dataset that is available), the direction of the relationship between financial knowledge, financial behaviour, financial attitudes, and depression remains unclear in Chapter IV. It is likely that the reverse effect, that is, the effect of depression on financial literacy, also plays an underlying role in the relationship between financial literacy and depression. I was able to examine such a reverse effect of depressive symptoms on financial literacy in Chapter V, where a longitudinal analysis was applied and the temporal relationship between financial literacy and depressive symptoms was tested using a cross-lagged panel model. The reverse effect of depressive symptoms on financial literacy was observed in Chapter V (based on the U.S. sample), which demonstrated that baseline depressive symptoms were negatively and significantly associated with follow-up household income and wealth. This, in turn, was associated with future financial literacy levels. These findings indicate that depressive symptoms may lead to decreased financial literacy levels among late-middle-aged and older adults. This can be explained when considering that emotions such as depression, anxiety, fear, and happiness have the potential to induce psychological biases and to distort the cognitive

process (Griffiths, 1994; Khresna Brahmana et al., 2012). It has also been shown that mental disorders are associated with reduced cognitive functions (Gotlib and Joormann, 2010). Therefore, depressive symptoms may negatively affect financial literacy levels and lead to irrational financial decision making, unwise financial behaviours and an impaired financial capacity (Bradley et al., 1999; Eysenck, 2001; Mackin and Arean, 2009). In addition, the reduced cognitive ability may speed up the deprecation of human capital, including financial literacy, and hinder an individual's ability to acquire additional financial literacy. Furthermore, individuals with mental illnesses are more prone to engage in irrational spending, have less self-control and, thus, spend more money (Ridley et al., 2020). These behaviours are related to lower levels of wealth accumulation. People with less financial resources are also less likely to invest in personal financial literacy improvement (Lusardi and Mitchell, 2014; Hasting et al., 2013).

7.2.3. A disadvantage of being financially literate

To further our understanding of the relationship between financial literacy and mental health, Chapter VI explored the extent to which financial literacy can affect individuals' mental health when a person is confronted with financial shocks. To this end, I investigated the moderating effect of financial literacy on the relationship between financial shocks and depression. The findings in Chapter VI produce fresh evidence suggesting the existence of a potential hidden psychological cost of being more financially literate. Contrary to the study's hypothesis, the relationship between financial shocks and depressive symptoms were, in fact, found to be intensified among those individuals with higher financial literacy levels. I explained this finding by noting that individuals with a high level of financial knowledge may feel that they fail to achieve their own financial goals, which may, in turn, intensify the relationship between financial shocks and depressive symptoms. Specifically, financially literate people tend to have a heightened focus on and pay more attention to their financial circumstances. They may also

believe that higher levels of financial literacy are associated with a better ability to manage one's financial issues which should, thus, provide them with a better financial situation. This may, in turn, lead to heightened financial aspirations in individuals with higher financial literacy levels, reflecting a higher reference point against which a financial shock is evaluated (Kahneman and Tversky, 1979; Dewi et al., 2020). This higher reference point that occurs due to higher financial literacy can constitute a widened gap between desired financial outcomes and financial losses, thus, disproportionally eroding people's mental health. In addition, more ambitious financial goals that come to exist due to higher financial literacy have also been shown to make people feel less in control of their financial circumstances (McKenzie et al., 2021).

7.2.4. Taking indebtedness into consideration

In Chapter IV, however, I observed a stronger association between financial knowledge and depressive symptoms among respondents with debt compared to those without debt. This seems to contradict the finding in Chapter VI which shows that the psychological stress of financial shocks was stronger among those who have higher financial literacy levels. This apparent contradiction can be explained through the fact that, unlike experiencing a financial shock, a rising level of debt does not necessarily bring financial stress to individuals and households, especially among those are financially literate. In fact, as documented in the systematic review chapter, holding debt can lead to mental health problems only when people perceive debt as a stressor or when debt becomes excessive and problematic (see Chapter III). By contrast, financial shocks are more likely to happen suddenly and unexpectedly. The psychological stress stemming from sudden financial shocks may prohibit individuals from making rational financial decisions and adopting financially shrewd behaviours, even if they have a basic level of financial literacy (Khresna Brahmana et al., 2012). This may, in turn, lead to further financial strains.

In summary, this PhD research has revealed that having higher levels of financial literacy can have both a positive and negative influence on mental health. On the one hand, higher financial literacy levels were found to be associated with better mental health, possibly because financially literate people tend to feel more in control of their financial situation and have higher levels of personal and social confidence in their day-to-day financial management ability, characteristics which are related to having fewer depressive symptoms. At the same time, higher levels of financial literacy were found to be indirectly related to a lower risk of depressive symptoms through having more financial resources, such as income and wealth accumulation. On the other hand, higher financial literacy levels were also found to intensify the negative effects of financial shocks (such as income shocks and job loss) on mental health. This may be because people experiencing a shock feel that they fail to achieve their own financial goals. This may induce them to feel demotivated, frustrated, and, ultimately, to experience depressive feelings. The gap between personal financial ambitions and unresolved financial stress is larger among more financially literate people since they tend to have higher financial aspirations.

7.3. Implications

The findings of this study have the following implications.

7.3.1. Implications for the assessment of financial literacy programmes

First, an increasing number of scholars advocate the use of programmes aimed at improving financial literacy. The economic evaluation of financial literacy programmes is needed to guide financial educational strategies by identifying the most effective programmes. However, as stated in previous chapters, most researchers focus on the economic importance of financial literacy; the mental health effects of financial literacy have been largely overlooked. Therefore, the economic evaluation of a financial literacy programme could easily ignore the potential changes in respondents' psychological well-being due to changes in their financial literacy

levels. Financial literacy programmes can be effective in many ways and across a range of disciplines (OECD/INFE, 2013). The findings in this PhD research and in previous literature suggest that the effect of improving financial literacy on mental health should be also taken into account when evaluating a financial literacy programme. The economic outcomes that can integrate the mental health effects of the endowment of financial literacy will contribute to a more comprehensive assessment of financial literacy programmes. Further research is needed to carefully identify the psychological costs and benefits of specific financial literacy programmes or training.

7.3.2. The potential benefits of improving financial literacy

The average level of financial literacy in many countries in the present day is still low. As a result, a lack of financial literacy is undermining the mental well-being of adults of different ages. Some individuals and households suffer from financial stress or even poverty due to a lack of financial resources, and it is a lack of financial literacy has been found to be one of the barriers to achieving financial well-being (Ouattara and Zhang, 2020). These facts underline the need for interventions and strategies that can enhance financial literacy. My findings show that higher financial literacy levels were associated with better financial outcomes, such as higher levels of income and wealth and a lower risk of experiencing depression. Such results indicate that interventions and strategies aimed at improving financial literacy or maintaining a good financial literacy level will not only have positive effects on financial well-being, but also have the potential to prevent mental disorders among adults. Both policymakers and educators should emphasise the notion that enhancing financial literacy and achieving financial success can also help people to achieve better mental health. Additionally, the findings in my study and in the extant literature suggest the existence of the effects of mental disorders, such as depression, on both financial well-being and financial literacy. Based upon this, I would also expect that the improved mental well-being that stems from enhanced financial literacy, in turn,

would further improve a person's financial well-being and their stock of financial literacy. Therefore, the interventions and strategies aimed at improving financial literacy have the potential to help individuals in poverty and those with mental illness to break the vicious cycle of poverty and mental illness.

Investments in interventions aimed at improving financial literacy will have potential benefits for multiple stakeholders. For example, from the perspective of individuals or households, a higher level of financial literacy will ensure financial well-being and more successful wealth accumulation through better saving and investment decisions, more financially astute behaviours, such as retirement planning, and a higher likelihood of participating in financial markets and appropriately managing one's debt. Financial well-being will, in turn, contribute to improved mental well-being and greater overall well-being in the long run. From the perspective of the financial sectors, higher financial literacy levels will induce more and better-quality participation in financial markets, and will therefore increase the utilisation of financial products and services. In addition, more financially literate participants in financial markets are likely to exhibit more rational and well-informed financial decisions and behaviours, which are believed to increase market transparency and efficiency. In the long run, this will contribute to stability, sustainability, and the development of the global economy (Krechovská et al., 2015; OECD/GFLEC, 2018). Finally, the health sector would benefit from a reduced burden related to mental ill-health, for example, through decreased healthcare costs and healthcare services utilisation.

7.3.3. Implications for the design of anti-poverty programmes

The findings in this PhD thesis have implications for the design of anti-poverty programmes. A meta-analysis shows that the effect of cash transfer (i.e., "direct payments made to people in poverty", McGuire et al., 2020, p.1) on well-being is mild and declines over time (McGuire et al., 2020). Additionally, cash transfer on its own cannot endow people with better financial

management abilities, which is crucial for the achievement of lifelong financial and mental well-being. Effective financial management, in the long run, requires people to have a certain level of financial literacy. My empirical findings showed that financial literacy was related to financial situation and depressive symptoms for up to four years. These findings suggest that, compared to pure money endowment, enhancing both financial resources and financial literacy appears to be a more sustainable way to help improve the financial and mental well-being of people in poverty. In fact, experimental evidence has shown that multifaceted anti-poverty programmes integrating both money endowment and financial education are effective for people in poverty and have an effect on financial outcomes, not only in the short run, but also in the long run (Banerjee et al., 2015; 2022). In order to sustainably improve the financial well-being, and thereby the mental well-being, of those in poverty, policymakers could consider improving financial literacy levels as a supplementary approach to providing direct money endowments. Reducing the costs of acquiring financial literacy for those populations will also be important as it may increase an individual's incentive to invest in their own financial literacy.

7.3.4. Implications for the strategy of improving financial literacy

Interventions and strategies aimed at improving financial literacy or maintaining a good financial literacy level have the potential to prevent adverse mental health outcomes among late-middle-aged and older adults by assuring financial well-being among these populations. Given this, the key problem then becomes how to help people to sustain and acquire additional financial literacy effectively. Financial education is one of the strategies for improving financial literacy levels, given the general belief that financial literacy is a consequence of financial education programmes. However, existing evidence suggests that the benefits of financial education are highly heterogeneous. For example, there is evidence arguing that the passive acquisition of specialist financial literacy skills in a school classroom has little impact on, for example, saving decisions (Cole and Shastry, 2009). Furthermore, financial education

has been reported to be less effective for low-income people and those in low- and lower-middle-income economies (Kaiser and Menkhoff, 2017). Thus, establishing an effective way to improve financial literacy crucially depends on offering financial literacy programmes or training that is appropriate for the target audience and which is offered to people at the right time (Kaiser and Menkhoff, 2017). Moreover, as indicated in my findings, people with higher levels of financial literacy may feel worse or more depressed when faced with financial shocks. It is thus equally important that the intervention design is based on a better understanding as to why financial literacy causes the psychological effect of financial shocks to be worse and whether there is anything practical that can be done to resolve this.

In this PhD research, I found only a moderate effect of financial literacy on mental health. In fact, this research is not the first to show a limited influence of financial literacy. In a study focused on a group of university students, West et al. (2021) also found that levels of financial literacy did not play an important role in financial well-being, which itself is believed to be a determinant of good mental health. Although it is believed that a higher level of financial knowledge is associated with an increased probability of adopting more financially literate behaviours and achieving better financial outcomes, a higher level of financial knowledge does not necessarily mean that an individual will adopt financially literate attitudes and behaviours (Hilgert et al., 2003). In fact, the achievement of one's financial goals can be shaped by many factors other than financial literacy, such as time preferences, risk preferences, self-control, the expectation of future financial security, and perceived financial capability (DellaVigna, 2009; Huston, 2010). Additionally, to realise the financial well-being of a population, other factors such as social safety net benefits, equal access to education and work, and access to financial services may be more important than understanding basic financial concepts (e.g., compound interest, inflation, risk and returns) (Lusardi and Mitchell, 2014). Research in behavioural economics suggests that making changes to the financial environment where people make

financial decisions (e.g., taking measures to frame people's choices in such a way as to nudge them to choose healthier options) may be particularly effective for encouraging more financially shrewd behaviours. This change in behaviours would then lead to an improvement in people's overall financial well-being (Thaler and Sunstein, 2008; OECD/INFE, 2013).

7.4. Limitations

This section will briefly summarise the limitations of both the systematic review study and the three empirical chapters. More specific strengths and limitations regarding particular analyses are highlighted in the discussion section of each chapter.

7.4.1. Literature review

In the systematic review chapter, a comprehensive search was conducted to capture the studies which examine the association between various indicators of financial stress and depressive symptoms or depression. This systematic review is the first study to bring together observational evidence, and the inclusion of longitudinal evidence has allowed for a better understanding of the temporal association between financial stress and depression. However, there was substantial heterogeneity in the studies included regarding the measurements and definitions of exposure (i.e., financial stress) and the outcome variable (i.e., depression), targeted populations, methodologies, and so on. Therefore, a narrative review, instead of a meta-analysis, was conducted as a meta-analysis on the reviewed studies was not feasible (see Chapter III for more detail). A further limitation was that, over the past three years, many new studies which focus on the social and economic determinants of depression were published. The systematic review was updated in 2019 and all the conclusions and judgements were made based on evidence published no later than 2019. The findings on the relationship between financial stress and depression inferred from the systematic review may be affected by new research.

7.4.2. Methodological limitations in the empirical research

Measurement issues

A limitation shared by all the empirical studies of this PhD research as a result of data limitations is the measurement of financial literacy. There is no consensus on how to measure financial literacy, since financial literacy is a complex construct and accurately measuring financial literacy is difficult (Ouachani et al., 2020; Hung et al., 2009). The measures of financial literacy vary substantially. Some only include financial numeracy or financial knowledge, where others integrate more practical experience such as the ability to apply financial knowledge, the confidence to use financial knowledge and effective decision-making (OECD/INFE, 2018). In Chapters V and VI, I use three numeracy questions to proxy financial literacy. This approach has also been used in other studies to proxy financial literacy (e.g., Gousia, 2016). However, it has been argued that the measurement of financial literacy using only a limited number of questions, for example, the three questions used in Chapter V, is restrictive (Ouachani et al., 2020). Increasing the number of questions to be asked when measuring financial literacy has been recommended as a way of integrating other dimensions (e.g., borrowing, insurance) as well as helping to establish the sophistication level of a person's financial literacy (Ouachani et al., 2020). Therefore, the measurement of financial literacy used in this PhD research only serves as a starting point for assessing financial literacy levels. A more comprehensive measurement of financial literacy was applied in Chapter IV covering three dimensions: financial knowledge, financial behaviour and financial attitudes. Financial knowledge was further stratified into basic financial knowledge and advanced financial knowledge. However, the measurement of financial literacy was only included in one wave of the survey. As a result, only a cross-sectional analysis was feasible at the time of conducting the research within Chapter IV.

Additionally, due to differences in datasets, the measurements used for the key independent variable, financial literacy, and the outcome variable, the depressive symptoms, are different between Chapter IV and Chapters V and VI. Furthermore, the Chinese sample used in Chapter IV included adults aged 18 and over, while the U.S. sample used in Chapters V and VI included adults aged 50 and over. The divergence in the variable measurements and the sample population may have influenced the empirical results and constrained the comparability of empirical findings regarding the association between financial literacy and depression. Nevertheless, similar regression models (e.g., the negative binomial regression) were applied in all empirical calculations, which may, to some extent, offset the lost comparability due to the heterogeneity in measurements.

Challenges for causal inference

While all empirical analyses carefully control for factors that can constitute confounding influences on the observed relationships, the findings cannot be interpreted causally. For example, in Chapter IV, I have controlled for a wide range of demographic variables, social and economic factors and health. Yet, I was unable to adjust for the confounding effects of unobservable variables, for example, personal traits, self-control, and ability. In Chapters V and VI, in addition to the control variables used in Chapter IV, I was able to control for time-invariant unobserved confounders using panel analysis methods, such as fixed effects and correlated random effects models. Nevertheless, it was still not feasible to control for all time-varying unobserved confounders. As a result, the limited usage of control variables might be linked to a potential confounding issue and the estimates may suffer from omitted variable bias.

Furthermore, I was unable to make causal inferences on the influence of financial literacy on mental health as there may be reverse causality. For instance, in Chapter IV, a higher level of financial literacy may induce better mental health. Conversely, a lack of financial literacy may lead to depressive symptoms. Yet, as mentioned earlier, since the analysis is cross-

sectional, the direction of the relationship between financial literacy and depression is still unclear. The bidirectional relationship between financial literacy and depression has been highlighted in the analysis based on the U.S. adults (see Chapter V). Therefore, it is likely that the reverse effect, that is, the effect of depression on financial literacy also plays an underlying role in the relationship between financial literacy and depression. However, it is unfeasible to explore the direction of the relationship between financial literacy and depression in the Chinese sample at this stage due to data limitations. In this regard, the results should be interpreted cautiously as they do not allow for the inference of causality.

Limitations on time window in the cross-lagged panel model

The cross-lagged longitudinal mediation analysis used in Chapter V has the benefit of explicitly modelling the temporal association between financial literacy and follow-up household income and wealth, as well as the association between household income and wealth and follow-up depressive symptoms at predetermined time intervals. However, the identification of the optimal time interval between measurements of these factors is a challenge (Cole and Maxwell, 2003; Selig and Preacher, 2009; Newsom, 2015). This study was constrained by only using the four-year time interval between each measurement point since the data on the key independent variables were collected by design in every second wave (i.e., every three or four years) in the HRS (Bugliari et al., 2019). The four-year time period may not be the optimal length of time interval for capturing the impact of financial literacy on household income and resources, and therefore, depressive symptoms. The long length of the time interval may be one of the explanations for the absence of a cross-lagged influence of household finances on depressive symptoms. Additionally, I was unable to draw a conclusion regarding the length of time taken for financial literacy to affect depressive symptoms by increasing household income or other financial resources.

7.5. Suggestions for future research

Based on the entirety of this PhD study and its findings, I suggest several key areas which may benefit from future research on financial literacy and mental well-being.

7.5.1. Measurement of financial literacy

Applying a more precise and comprehensive measurement of financial literacy would allow for more accurate estimates of the effect of financial literacy on mental health. In Chapters VI and VII, financial literacy was measured in two ways: using questions on numeracy as a proxy for financial literacy, and through the "Big Three" financial questions, involving an individual's understanding of interest rates, inflation, and risk diversification. However, both measures may not capture many other aspects of financial literacy and are not able to distinguish between the different difficulty levels of the financial literacy questions. Additionally, financial decision making is a result of many factors. Thus, a high score on the financial literacy questions, especially when financial literacy is inadequately defined, may not necessarily reflect an individual's financial capability in reality. Therefore, it will be crucial for future research to use a more comprehensive measurement of financial literacy, where available. For example, the measurement used in Chapter IV combines three dimensions of financial literacy, namely financial knowledge, financial attitudes, and behaviours (OECD/INFE, 2018).

7.5.2. Other mechanisms for the mediation analysis

This PhD study has investigated how the relationship between financial literacy and depression is operated through financial factors such as household income and wealth. This provides a legitimate perspective for understanding the possible mechanisms through which financial literacy is linked to mental health outcomes. Yet, financial literacy may be related to mental health through other mechanisms, since both household income and wealth cannot fully

mediate this relationship. For instance, people with a high level of financial literacy also tend to spend more on services related to better health and engage in fewer unhealthy behaviours such as smoking (Zheng et al., 2021), which may, in turn, enhance their level of mental health. In this regard, health expenditure and health behaviours may also operate as mediators in the relationship between financial literacy and mental health. Therefore, in terms of future research, exploring other potential mechanisms would be beneficial for a better understanding as to how financial literacy affects mental health outcomes and vice versa. However, this requires the support of data with more detailed information on personal or household finances, health, and lifestyles.

7.5.3. Different mental health outcomes

Future research might investigate the bi-directional relationship between financial literacy and other mental health conditions in addition to depression. This PhD thesis has mainly focused on depression. This is reasonable as depression is a major contributor to the health burden of disease and is a leading cause of disability globally (Friedrich, 2017; WHO, 2021). However, financial literacy may interact with other mental health disorders in different ways, since issues related to finance can affect different types of mental disorders differently (Burns, 2015). Therefore, future research might investigate if the relationship between financial literacy and mental health is conditional on the types and levels of severity of the mental health conditions.

7.5.4. Research method for better causal inference

As discussed in section 7.4, although the results on a bi-directional relationship between financial literacy and depressive symptoms in this PhD research are promising, the causal relationship between financial literacy and depression cannot be fully inferred as there may be confounders that have not been considered. Additional longitudinal studies or randomised experimental work is still needed to provide more robust evidence for causal inference. For

example, the analysis in Chapter IV based on the 2014 wave of the CFPS could be expanded into a panel analysis, should relevant new data become available. This would allow for the investigation of both contemporaneous and temporal relationships between financial literacy and mental health. To reach a more robust causal inference, other control variables relevant to possibly pre-existing disorders, such as social status, life events, lifestyle, and self-control may also be considered, subject to data availability. Additionally, experimental studies like natural or quasi-experiments or randomised control trials may be used to better determine the causality in the relationship between financial literacy or financial education and mental health. However, experimental studies are often expensive to implement and difficult to perform with large nationally representative samples. In this case, econometrical tools (i.e., quasi-experimental methods such as propensity score matching, instrumental variable analysis and difference-in-differences) could be applied to mimic the intuition behind the experimental study in order to produce causal inferences from observational studies (Dague and Lahey, 2018).

7.5.5. Research in other contexts

As social, economic, and cultural characteristics vary across countries, the relationship between financial literacy and mental health can be different depending on where a study is focused. For example, evidence shows that financial literacy is less likely to affect people who are living in a country where the social welfare system is generous (Jappelli and Padula, 2013b). Therefore, future research might re-assess the complex relationship between financial literacy and mental health in different country contexts to provide more specific evidence for policymakers that can target different social, economic, and cultural contexts.

Additionally, in Chapter V, the two mediators, household income and wealth, were measured using aggregate values without differentiating between the various types of income and wealth (e.g., without differentiating financial assets from housing assets). However, it is likely that the mechanisms underlying the relationship between financial literacy and mental

health may be different between high-income countries and low- and middle-income countries. For example, a study conducted in a low- and middle-income country context showed that there was no relationship between financial literacy and stock market participation (Akpene Akakpo et al., 2022), while this relationship was often observed in high-income countries (e.g., the U.S., the Netherlands) with more developed financial markets (Van Rooij et al., 2011). Considering this, financial literacy may be more likely to affect people's mental health through financial assets in an economy with more developed markets where people have access to a wide range of financial products and services. However, this effect is more likely to operate through housing assets in an economy with less developed financial markets where fewer people participate in the stock market. Therefore, it is crucial for future research to consider the potential difference in mechanisms according to the specific context of the study.

7.6. Conclusion

Financial literacy is a type of human capital, which plays an important role in financial decision making and a life cycle optimisation of the financial resource allocation. Being financially literate is strongly associated with higher levels of income and wealth accumulation and, thus, higher financial resilience, which is believed to be one of the key determinants of mental well-being. This PhD research was conducted with the aim of investigating the relationship between financial literacy and mental health, specifically, depression, in both the high-income country context and the low- and middle-income country context. As it is the first to investigate a number of innovative angles on this topic, this PhD research provides unique evidence of the interplay between financial literacy and mental well-being. The research found that people with higher financial literacy levels are less likely to experience depressive symptoms and that this may occur through having more financial resources, such as higher income or greater wealth accumulation. However, having higher financial literacy can also influence mental well-being negatively by magnifying the harmful effects of financial shocks on mental health, possibly

due to higher financial aspirations among those with higher financial literacy levels. The benefits of financial education and the endowment of financial literacy across disciplines have been increasingly highlighted by scholars. Compared to the economic effects of acquiring or improving one's financial literacy, the psychological costs and benefits of being financially literate tend to be neglected. It is equally crucial for scholars and policymakers to emphasise the psychological effects of improving financial literacy when implementing financial education programmes aimed at improving a population's financial literacy. Overall, this PhD research provides insights into how policymakers might enhance financial and mental well-being in a more sustainable way, for example, by enhancing financial literacy. To better support policy-making, more future research is required to examine the causal impact of enhancing financial literacy on mental well-being in different study settings.

Supplementary material

Appendix A.1 Sample search in PsycINFO

Database: PsycINFO as an example

Search Strategy:

Financial variables

1. income.mp.
2. (debt* or indebt* or loan* or mortgage*).mp.
3. wealth.mp.
4. asset*.mp.
5. financ*.mp.
6. (economic situation* or economic stat* or economic condition* or economic position* or economic hardship* or economic str* or economic difficul*).mp.
7. (financial situation* or financial stat* or financial condition* or financial position* or financial str* or financial hardship* or financial satisf* or financial difficult*).mp.
8. (poverty or deprivation).mp.
9. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8

Individual and/or household

10. (household* or family). mp.
11. (individual* or personal).mp.
12. 10 or 11

Depression

13. depress*.mp.
14. depressive disorder*.mp.
15. depressive symptom*.mp.

16. depressed mood*.mp.

17. mood disorder*.mp.

18. affective disorder*.mp.

19. dysthymia*.mp.

20. 13 or 14 or 15 or 16 or 17 or 18 or 19

Study types

21. (observational or cross-sectional or longitudinal or cohort or panel or retrospective or prospective or survey or questionnaire).mp.

The combination of all terms

22. 9 and 12 and 20 and 21

23. limit 22 to English

Appendix A.2 Data extraction form

A. Characteristics of studies

1. Title
2. Year
3. Authors
5. Journal name
6. Aim of the study
7. Countries

B. Data collection information

1. Study type
2. Did the study use primary or secondary data?
3. Data source and dates
4. Response Rate
5. Was information for non-responders described?
6. Level of Study (national level or city level or town level or area level or others)
7. Eligibility criteria for participants?
8. Ethical approval

C. Population description

1. Sample Size
2. Age group
3. Mean/Median age of the participants
4. Gender structure

D. Exposures

1. Any exposures related to household/personal finances
2. Objective measures or subjective measures

3. The measure of related exposures

4. Exposure's categories

5. Definition of exposures

6. The validity of the measure of exposures (Cronbach's alpha or correlation coefficient etc)

E. Outcomes

1. Study outcomes related to depressive symptoms/ depression/depressive disorder)

2. Measures of depression

3. Definition of depression

4. Cut-off points/ thresholds of depression if applicable

5. The validity of the measure of outcome (Cronbach's alpha or correlation coefficient etc.)

F. Data and analyses

1. Statistical methods

2. Confounders controlled

3. Adjust for reverse causality or not? And how did the authors deal with it?

4. Subgroup analyses

5. Robustness check

G. Main results (household finances and depress* relationships only)

1. Unadjusted results

2. Results after adjusting for confounders if applicable

3. Results after adjusting for reverse causality if applicable

I. Notes

Appendix A.3 Quality assessment tool following Glonti et al. (2015)

1. Study design

(**Q1**) The study design is:

1. Experimental
    i. Individual-randomised
    ii. Group-randomised
    iii. Non-randomised
2. Observational
    i. Cross-sectional
    ii. Longitudinal (also natural experiment or pre-post tests)
    iii. Case-control
3. Any other method or did not state method (i.e. pre-post test without control group)

(**Q2**) Was this an intervention study?

Yes – proceed

No – go to question 7

(**Q3**) Is the intervention of interest clearly described?

1. Yes
2. No

(**Q4**) Were (groups of) subjects randomized into intervention groups?

1. Yes
2. No
3. Not applicable

(**Q5**) Was the intervention assignment concealed from participants and caregivers until recruitment was completed?

1. Yes
2. No
3. Can't tell

(**Q6**) Was (were) the intervention or exposure status of participants concealed from the outcome assessors?

1. Yes
2. No
3. Can't tell

(**Q7**) Were power/sample size calculations conducted?

1. Yes, details of calculation provided
2. Yes, no details were provided
3. Not reported or post hoc computation
4. Not applicable (using an existing database and referring to design article*

Rating study design: **Strong:** Q1 is 1

Moderate: Q1 is 2

Weak: Q1 is 3

Rating blinding: **Strong:** Q5 and Q6 are 1

Moderate: Q5 or Q6 is 1**; or** Q5 or Q6 are 3

Weak: Q5 and Q6 are 2; **or** Q5 and Q6 are 3

(no rate is given when the study is not an intervention study)

If the study is using data from a large existing database such as HSE, NHANES, BRFSS etc, often the authors refer to the design paper of the original study and no information in the present article is being described about power calculations, the validity of tools, etc.

2. Selection bias

(**Q8**) Is the spectrum of individuals selected to participate likely to be representative of the wider population who experience the intervention/exposure/situation?

1. Very likely
2. Somewhat likely
3. Not likely (selected group of users e.g., volunteers)
4. Can´t tell (no information provided)
5. Not applicable (using an existing database and authors refer to design article)

(**Q9**) Were inclusion/exclusion criteria specified and the number of exclusions reported?

1. Criteria and number of exclusions reported
2. Criteria or number of exclusions not reported
3. Criteria and number not reported

Rating: **Strong:** Q8 is 1

Moderate: Q8 is 2

Weak: Q8 is 3 or 4

No rating: Q8 is 5

3. Withdrawals and drop-outs

(**Q10**) Were withdrawals and drop-outs reported in terms of numbers and reasons per group?

1. Numbers and reasons provided
2. Numbers but no reasons provided
3. Can't tell (if longitudinal data)
4. Not applicable (if cross-sectional data or if using an existing database and authors refer to design article)

Rating: **Strong:** Q10 is 1

Moderate: Q10 is 2

Weak: Q10 is 3

No rating: Q10 is 4

4. Confounders

(**Q11**) Were analyses appropriately adjusted for confounders?

1. For most confounders
2. For some confounders
3. No or can't tell

The following are examples of confounders: race, sex, marital status/family, age, SES (income or class), education, health status, pre-intervention score on the outcome measure. Considering the study design, were appropriate methods for controlling confounding variables and limiting potential biases used? Confounding can be addressed by the appropriate use of randomization, restriction, matching, stratification, or multivariable methods. Sometimes the use of a single method may be inadequate. Some biases can be limited by the institution of data collection or study procedures that support the validity of the study (e.g. training and/or blinding of interviewers or observers, interviewers and observers are different from interventions' implementers etc). For example: if between-group differences persist after randomization or matching, statistical control should also have been used.

Rating: **Strong:** Q11 is 1

Moderate: Q11 is 2

Weak: Q11 is 3

5. Data collection

(**Q12**) Were the validity, reliability or appropriateness of the data collection tools discussed?

1. Both validity and reliability were discussed
2. a. Validity or reliability were discussed

b. A national dataset was used and authors provided adequate information to find information on validity and reliability

3. None of them was discussed

Rating: **Strong:** Q12 is 1

Moderate: Q12 is 2

Weak: Q12 is 3

6. Data analysis

(**Q13**) Were appropriate statistical analyses conducted (including correction for multiple tests where applicable)?

1. a. Statistical methods were described and were appropriate and comprehensive – sophisticated approach

   b. Statistical methods were described and were appropriate and comprehensive –a simple approach
2. Statistical methods were described and less appropriate
3. No description of statistical methods or inappropriate methods

Rating: **Strong:** Q13 is 1

Moderate: Q13 is 2

Weak: Q13 is 3

7. Reporting

(**Q14**) Are the hypothesis/aim/objective of the study clearly described?

1. Yes
2. No

(**Q15**) Are the main outcomes to be measured clearly described?

1. Yes

2. No

(**Q16**) Are the main findings clearly described?

1. Yes
2. No

(**Q17**) Have actual probability values been reported

(i.e. p=0.345 instead of p>0.05; same goes for t-values, 95%CIs etc)?

1. Yes
2. No

Rating: **Strong:** Q14 and Q17 are 1

Moderate: Q14 or Q17 are 1

Weak: Q14 and Q17 are 2

Studies can have between six and eight component ratings. The overall rating for each study is determined by assessing the component ratings.

If seven ratings have been given;

Strong will be attributed to those with no weak ratings and at least four strong ratings;

Moderate will be given to those with one weak rating or fewer than four strong ratings;

Weak will be attributed to those with two or more weak ratings.

If six ratings have been given;

Strong will be attributed to those with no weak ratings and at least three strong ratings;

Moderate will be given to those with one weak rating or fewer than three strong ratings;

Weak will be attributed to those with two or more weak ratings.

If five ratings have been given;

Strong will be attributed to those with no weak ratings and at least two strong ratings;

Moderate will be given to those with one weak rating or fewer than two strong ratings;

Weak will be attributed to those with two or more weak ratings.

If four ratings have been given;

Strong will be attributed to those with no weak ratings and at least two strong ratings;

Moderate will be given to those with one weak rating or fewer than two strong ratings;

Weak will be attributed to those with two or more weak ratings.

The final decision of both reviewers will be: **strong, moderate, or weak**.

Appendix A.4 Basic characteristics data extraction

Study ID	Study type	Level of Study (national level or city level or town level or area level or others)	Years	Countries	Data source	Population	Exposures	Depression measure
Asebedo and Wilmarth, 2017	Longitudinal	National representative	2012, 2014	USA	The HRS	8,366 observations, aged 50 and over	Financial strain and financial stress	CESD-8
Alley et al., 2011	Longitudinal	National representative	2006-2008	USA	The HRS	2474 individuals, aged 50 and over	Mortgage delinquency	CESD-8
Berger et al., 2016	Longitudinal	National representative	1987/1989, 1992/1994	USA	The NSFH	8,457–8,516 individuals per dataset, aged between 21 and 65 years of age	Debt occurrence and debt amount; financial debt occurrence and financial debt amount; housing debt occurrence and housing debt amount	CESD-12
Boe et al, 2017	Cross-sectional	International level	2014	Europe	The ESS, round 7.	18,401 respondents, aged 25–75	Financial difficulties in childhood	CESD-8
Boey and Chiu, 2005	Cross-sectional	Regional level	1997/1998	China	A primary study conducted in Hong Kong	1,034 individuals, aged 70 and over	Financial status: income and perceived income sufficiency	GDS-15
Bridges and Disney, 2010	Longitudinal	National representative	1999-2005	UK	The FACS	1999 sample: 4,549 sample and 2001 sample: 8,062 sample, aged 16 and over	Objective debt variables, subjective debt problem, subjective financial stress	Self-reported depression
Butterworth et al., 2009	Longitudinal	Community level	2003/2005	South-east Australia	The PATH Through Life Study	6,715 persons, aged 24-68	Financial hardship in wave 2, and subjective financial difficulty in wave 1	GDS-9
Butterworth et al., 2012	Cross-sectional	National representative	2007	Australian	The NSMHWB	8,840 respondents, aged among 16 and 85	Household income and financial hardship	ICD-10

Study ID	Study type	Level of Study (national level or city level or town level or area level or others)	Years	Countries	Data source	Population	Exposures	Depression measure
Chen et al., 2016	Cross-sectional	National representative	2012	China	The CFPS	8,636 rural registered individuals in China, aged above 45 years.	Pension enrolment and pension income	CESD-20
Cheung and Chou, 2017	Cross-sectional	City level	2015	China	A cross-sectional survey of older persons in Hong Kong	1,959 persons aged 65 or over.	Income poverty and material deprivation	GDS-15
Chi and Chou, 2000	Longitudinal	City level	1992-1995	China	A two-wave longitudinal survey of older persons in Hong Kong	554 older persons aged 70 and over at baseline.	Financial strain	CESD-20
Drentea and Reynolds, 2012	Longitudinal	County level	2000/2001-2004/2006	USA	The Miami Disability study	1,463 Miami-Dade County residents of adults	Occurrence of debt, credit card debt, and debt stress	CESD-20
Drentea and Reynolds, 2015	Longitudinal	County level	2000/2001-2004/2006	USA	The Miami Disability study	1,463 Miami-Dade County residents of adults	Occurrence of debt and economic hardship	CESD-20
Ellaway et al., 2016	Repeated Cross-sectional	Regional level	1997 and 2010	UK	The THAW 2010	2,092 individuals aged 17 to 95 years.	Material assets	HADS depression.
Gathergood and John, 2012	Longitudinal	National representative	From 1991 to 2008 (18 waves)	UK	The BHPS	10,000 individuals aged 16 and over.	The occurrence of problem debt and debt stress	GHQ-12 depression
Gillen et al., 2017	Cross-sectional	National representative	2006	USA	The HRS	5,383 individuals aged 51 years and over	Debt occurrence, financial assistance from family, public assistance	CESD-8
Hiilamo and Grundy, 2018	Longitudinal	National representative	2003/2004, 2006/2007, 2011, 2013, 2015	Belgium, France, Germany	The SHARE	31,409 individuals aged 50 and over	Financial debt amount and housing debt amount	CESD-12

Study ID	Study type	Level of Study (national level or city level or town level or area level or others)	Years	Countries	Data source	Population	Exposures	Depression measure
Hojman, 2016	Longitudinal	National representative	2002, 2004, 2006, 2009	Chilean	The SPS	14,463 individuals. Over 18 years old.	Financial service ratio, mortgage arrears (MA), and over-indebtedness (OI)	CESD-8
Jo et al., 2011	Cross-sectional	Regional level	2006/2007	Korea	A survey conducted from November 2006 to November 2007 in two regions located in Seoul.	966 and 992 in the A 'Gu' and B 'Gu', respectively, Adults.	Economic status	CESD-20
Kim et al., 2016	Longitudinal	National representative	2010 to 2013	Korea	The KOWEPS	9,645 individuals without depressive symptoms from South Korea, aged 20 and above.	Childhood economic status, current economic status (household income)	CESD-11
Krause et al., 1991	Cross-sectional	Both are national representative	USA: 1986; JAPAN: 1987	USA, Japan	The US. Data: the Americans' Changing Lives Survey; Japanese Data: a random-probability survey conducted in Japan.	US: 1,523 individuals; Japan: 1,517 individuals; older adults aged 60 and over	Financial strain	CESD-6
Krause et al., 1998	Cross-sectional	City level	1991	China	1991 Survey of Health and Living Conditions of the Aged in Wuhan City.	2,749 individuals, aged 60 and over	Financial strain, received economic support, anticipated economic support.	CESD-6

Study ID	Study type	Level of Study (national level or city level or town level or area level or others)	Years	Countries	Data source	Population	Exposures	Depression measure
Leung and Lau, 2014	Longitudinal	National representative	From 1992 to 2008 (9 waves)	USA	The HRS	30,548 individuals, aged 50 and over	Mortgage loan to house value	CESD-8
Lorant et al., 2007	Longitudinal	Regional level	From 1992 to 1999 (8 waves)	Belgian	The Belgian Household Panel Survey	11,909 individuals aged 16 and over	Subjective financial strain, poverty, deprivation, and income	A modified version of the global depression scale of HDL
Lund and Cois, 2018	Longitudinal	National representative	2008-2012	South Africa	The NIDS	11,440 individuals who were 15 years of age or older at the time of the first interview (2008)	Material assets	CESD-10
Martikainen et al., 2003	Cross-sectional	City level	1997/1999	UK	The Whitehall II study	7,162 office staffs from London; aged 35–55	Income and wealth	GHQ depression
Mirowsky et al., 2001	Longitudinal	National representative	1995 and 1998	USA	The ASOC	2,592 households, aged 18 or over	Economic hardship	CESD-7
Osafo Hounkpatin et al., 2015	Longitudinal	National representative	Income: 1992 and 2003; Wealth: 2004 and 2008	UK	Income: the WLS; Wealth: the ELSA.	WLS: time1: 6,494 individuals & time 2: 4,812 individuals; ELSA: wave 1: 1,1264 individuals & wave 4: 6,425 individuals; Aged 50 and above.	Income and wealth	CESD
Pool et al., 2017	Longitudinal	National representative	1992-2012	USA	The HRS	19,281 late middle-aged adults, aged 51 to 64 years	Negative wealth shock	CESD-8
Pu et al., 2011	Longitudinal	City level	1996, 1999, 2003	China	The SHLS	2,387 the middle age and elderly in Taiwan; aged 60 and above.	Financial satisfaction	CESD-10

Study ID	Study type	Level of Study (national level or city level or town level or area level or others)	Years	Countries	Data source	Population	Exposures	Depression measure
Rautio et al., 2013	Cross-sectional	Hospital districts of Pirkanmaa, Southern Ostrobothnia and Central Finland	2007	Finland	The FIN-D2D	2,819 individuals; aged 45–74 years	Financial satisfaction	BDI-21
Reeves et al., 2016	Repeated cross-sectional	National representative	2009-2013 (4 waves)	UK	The APS	179,037 low-income persons aged between 16 and 69 years who were then renting housing in the private sector.	Reductions in the Housing Benefit (HB)	Self-reported depression
Richardson et al., 2016	Longitudinal	University students/neighbourhood level	2012-2014	UK	A primary longitudinal study conducted on British first-year undergraduate students.	454 first-year British undergraduate students; aged between 17 and 57	Index of financial stress, debt stress, how to perceive student loan	CESD-20
Ross and Huber, 1985	Cross-sectional	National representative	1978	USA	A telephone survey of a national probability sample of the U.S. households	680 wives and 680 husbands; aged 18-65	Economic hardship, family income, wife's and husband's earnings	CESD-16
Sareen et al., 2011	Longitudinal	National representative	2001/2002-2004/2005 (2 waves)	USA	The NESARC	34,653 adults aged 20 and older	Household income	DSM-IV
Sweet et al., 2013	Longitudinal	National representative	2007/2008	USA	The Add Health	8,400 respondents aged between 24 and 32	Financial debt amount, financial debt/asset, subjective relative debt	Wave I: CESD-19; Wave III: CESD-9; Wave IV: CESD-5;
Tran et al., 2018	Cross-sectional	University level/neighbourhood level	2003	USA	The NLSF	1,412 college students	Student loan debt amount and debt stress	CESD-13

Study ID	Study type	Level of Study (national level or city level or town level or area level or others)	Years	Countries	Data source	Population	Exposures	Depression measure
Virtanen et al., 2008	Cross-sectional	National representative	2000/2001	Finland	The Health 2000 Study	3,374 working population, aged 30-64	Income	CIDI (DSM-IV)
Zimmerman and Katon, 2005	Longitudinal	National representative	1979-2004	USA	The NLSY	8,489 young adults aged between 27 and 35	Income	CESD-20
Zurlo et al., 2014	Cross-sectional	Nationally representative	2006	USA	The HRS	5,817 respondents; aged 50 and older	Occurrence of unsecured debt, Amount of unsecured debt	CESD-8

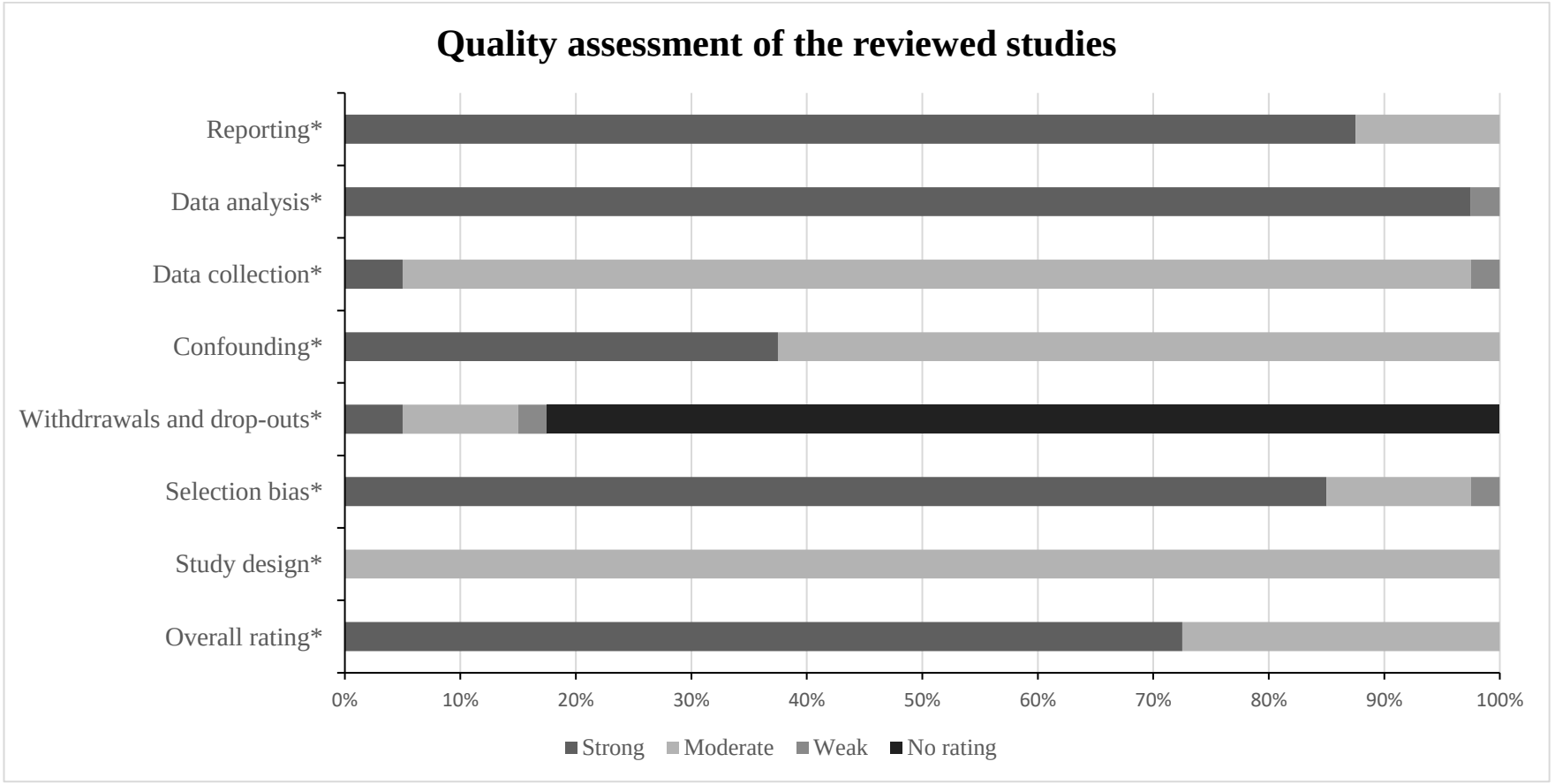
N: No information was reported.

Appendix A.5 Quality assessment form

Study ID	Country	Study design	Selection bias	Withdrawals and drop-outs	Confounding	Data collection	Data analysis	Reporting	Overall rating
Asebedo and Wilmarth, 2017	USA	2	1	N/A	2	2	1	1	1
Alley et al., 2011	USA	2	1	N/A	1	2	1	1	1
Berger et al., 2016	USA	2	1	N/A	1	2	1	1	1
Boe et al, 2017	Europe	2	1	N/A	2	2	1	1	1
Boey and Chiu, 2005	China	2	2	N/A	2	2	1	2	2
Bridges and Disney, 2010	UK	2	1	2	1	2	1	1	1
Butterworth et al., 2009	South-east Australia	2	1	1	2	2	1	1	1
Butterworth et al., 2012	Australian	2	1	N/A	2	2	1	1	1
Chen et al., 2016	China	2	1	N/A	1	2	1	1	1
Cheung and Chou, 2017	China	2	1	N/A	2	2	1	1	1
Chi and Chou, 2000	China	2	1	1	2	1	1	2	1
Drentea and Reynolds, 2012	USA	2	1	2	1	2	3	1	2
Drentea and Reynolds, 2015	USA	2	1	2	1	2	1	1	1
Ellaway et al., 2016	UK	2	2	N/A	2	2	1	1	2
Gathergood and John, 2012	UK	2	1	3	1	2	1	1	2
Gillen et al., 2017	USA	2	1	N/A	1	2	1	1	1
Hiilamo and Grundy, 2018	Belgium, France, Germany	2	1	N/A	1	2	1	1	1
Hojman, 2016	Chilean	2	1	N/A	1	2	1	1	1
Jo et al., 2011	Korea	2	1	N/A	2	3	1	1	2

Study ID	Country	Study design	Selection bias	Withdrawals and drop-outs	Confounding	Data collection	Data analysis	Reporting	Overall rating
Kim et al., 2016	Korea	2	1	N/A	1	2	1	1	1
Krause et al., 1991	USA, Japan	2	1	N/A	2	2	1	2	2
Krause et al., 1998	China	2	3	N/A	2	2	1	2	2
Leung and Lau, 2014	USA	2	1	N/A	1	2	1	1	1
Lorant et al., 2007	Belgian	2	1	N/A	2	2	1	1	1
Lund and Cois, 2018	South Africa	2	1	N/A	2	2	1	1	1
Martikainen et al., 2003	UK	2	1	N/A	2	2	1	1	1
Mirowsky et al., 2001	USA	2	1	N/A	2	2	1	1	1
Osafo Hounkpatin et al., 2015	UK	2	1	2	2	2	1	1	2
Pool et al., 2017	USA	2	1	N/A	1	2	1	1	1
Pu et al., 2011	China	2	1	N/A	2	2	1	1	1
Rautio et al., 2013	Finland	2	2	N/A	2	2	1	1	2
Reeves et al., 2016	UK	2	1	N/A	2	2	1	1	1
Richardson et al., 2016	UK	2	2	N/A	2	2	1	2	2
Ross and Huber, 1985	USA	2	1	N/A	2	1	1	1	1
Sareen et al., 2011	USA	2	1	N/A	2	2	1	1	1
Sweet et al., 2013	USA	2	1	N/A	1	2	1	1	1
Tran et al., 2018	USA	2	1	N/A	2	2	1	1	1
Virtanen et al., 2008	Finland	2	2	N/A	2	2	1	1	2
Zimmerman and Katon, 2005	USA	2	1	N/A	1	2	1	1	1
Zurlo et al., 2014	USA	2	1	N/A	2	2	1	1	1

Appendix A.6 Quality assessment of the reviewed studies



Appendix A.7 Methods and findings extraction form

Study ID	Econometrical methods	Subgroup analysis	Panel analysis	Exposures	Depression measure	Control for	Main findings
Asebedo and Wilmarth, 2017	Ordinal logistic regression model	N	N	Financial strain and financial stress	CESD-8	Objective financial stressors, health and socio-demographic characteristics	Financial strain is associated with reduced mental health. Lower levels of stress about ongoing financial strain reduces the negative relationship between financial strain and mental health.
Alley et al., 2011	Logistic regression model	N	N	Mortgage delinquency	CESD-8	Age, gender, race/ ethnicity, marital status, smoking status, sources of debt, and annual household income, employment, health condition, physical activity level.	Compared with nondelinquent participants, the mortgage-delinquent group were significantly more likely to develop incident depressive symptoms during follow-up.
Berger et al., 2016	Linear regression	N	Fixed effects estimation; Cross-lag structural equation estimation	Debt occurrence and debt amount; financial debt occurrence and financial debt amount; housing debt occurrence and housing debt amount	CESD-12	Time-invariant baseline measures: male, race/ethnicity, the highest level of educational attainment by the respondent's most educated parent Time-varying socioeconomic factors age, marital status, the proportion of household members, respondent education, the logarithm of total household income, working at the time of the interview; total household assets, current health status, and wave indicator.	Household debt is positively associated with greater depressive symptoms. However, this association appears to be driven by short-term (unsecured) debt; little evidence of associations with depressive symptoms for mid- or long-term debt was found.
Boe et al, 2017	Multi-level OLS regression.	Age	N	Financial difficulties in childhood	CESD-8	Age, gender, education, family conflict, highest education in family, Marital status, and social meetings	Financial difficulties in childhood was an influential predictor of depression scores in younger adults for many of the investigated countries.
Boey and Chiu, 2005	Hierarchical multiple regression model	Gender	N	Financial status: income and perceived income sufficiency	GDS-15	Age, education, marital status, physical health	Perceived financial sufficiency was significantly associated with reduced depressive symptoms in both genders. The relationship between objective income and depressive symptoms was not significant.

Study ID	Econometrical methods	Subgroup analysis	Panel analysis	Exposures	Depression measure	Control for	Main findings
Bridges and Disney, 2010	Probit regression & Logistic regression	N	Fixed-effect logistic regression	Objective debt variables, subjective debt problem, subjective financial stress	Self-reported depression	Age, gender, marital status and the number of children, educational qualifications and employment status and current health status	There is a positive association between the probability of reporting depression and self-reported problems of indebtedness and financial stress. Only a weak link exists between objective measures of the financial position of the household and psychological stress.
Butterworth et al., 2009	Logistic regression model	Age (young, middle, old)	N	Financial hardship in wave 2, and subjective financial difficulty in wave 1	GDS-9	Age, gender, marital status, and presence of dependent children (aged under 15) in the household, physical disability, labour-force status, educational attainment, housing tenure, and childhood adverse financial situation	Current financial hardship was strongly and independently associated with depression above the effects of other measures of social and economic position and demographic characteristics. There was no significant difference in the association between hardship and depression across different age groups.
Butterworth et al., 2012	Logistic regression model & Multinomial logistic regression	Age (young, middle, old)	N	Household income and financial hardship	ICD-10	Age, sex, partner status, location	Financial hardship was strongly associated with depression while the association between household income and depression was not significant. Hardship was more strongly associated with current depression than with prior history of depression. The relative effect of hardship was strongest in late adulthood, but the absolute effect of hardship was greatest in middle age.
Chen et al., 2016	Linear regression	Age (45-60 & over 60); income level; educational level; mental health status	N	Pension enrolment and pension income	CESD-20	Age, gender, ethnicity, CCP membership, married or not, year of education, NCMS, chronic disease, total assets, migration ratio, as well as several regional characteristics.	Pension enrolment and pension income significantly decreased depressive symptoms of pensioners aged 60 and above. This effect was more pronounced among individuals eligible to claim pension income, among populations with more financial constraints, and among those with worse baseline mental health.

Study ID	Econometrical methods	Subgroup analysis	Panel analysis	Exposures	Depression measure	Control for	Main findings
Cheung and Chou, 2017	Logistic regression model	N	N	Income poverty and material deprivation	GDS-15	Age, gender, marital status, education level, financial strain, self-rated health, functional disability, poor sleeping quality, protective factors such as social support, engagement in cultural activities a neighbourhood collective efficacy	The association between income and depressive symptoms disappeared once material deprivation was controlled for. When all the covariates were entered, the association of material deprivation with depressive symptoms remained significant but was slightly weaker.
Chi and Chou, 2000	Multiple regression	Gender	N	Financial strain	CESD-20	Age, gender, marital status, years of education, physical health, social support	The elderly persons with higher financial strain reported more depressive symptoms three years later. Financial strain influenced depression equally among men and women.
Drentea and Reynolds, 2012	Logistic regression model	Assets level	N	Occurrence of debt, credit card debt, and debt stress	CESD-20	Income, assets, and homeownership/home value, education, age, race, gender, employment status, health insurance coverage, marital status, physical disability status, children in the household, and prior depression, prior anxiety, prior anger, and health problems up to 25	Being in debt was associated with higher depressive symptomatology, controlling for all the variables in the left cell. The effect of debt on mental health did not vary by level of assets.
Drentea and Reynolds, 2015	Multivariate Generalised Least Squares Regression	N	N	Occurrence of debt and economic hardship	CESD-20	Education, age, race, gender, employment status, health insurance coverage, marital status, physical disability status, presence of dependent children in the household, and prior mental and physical health problems, earlier health problems, the lagged value of the dependent variable as assessed in the first wave of the study, income, assets, and homeownership/home value	Both debt and economic hardship are associated with negative mental health, and the effect of economic hardship more consequential than debts. The influence of hardship is partly mediated by mastery. This is not true of debt.

Study ID	Econometrical methods	Subgroup analysis	Panel analysis	Exposures	Depression measure	Control for	Main findings
Ellaway et al., 2016	Generalised linear model & Logistic regression	N	N	Material assets	HADS depression.	Age, sex, marital status and income or social class	Housing tenure and car ownership are associated with mental health, after taking known correlates (age, sex, social class, income) into account.
Gathergood and John, 2012	Linear regression	N	Fixed-effect linear regression; IV least squares regression	The occurrence of problem debt and debt stress	GHQ-12 depression	Age, gender, marital status, has children, ethnicity, homeowner, regional dummies, education and employment, household income	There is a causal effect of the perceived problem debt on the worsening of psychological health at the household level. There is a sizable social norm effect in the perceived debt-mental health relationship.
Gillen et al., 2017	OLS regression model	N	N	Debt occurrence, financial assistance from family, public assistance	CESD-8	Age, education, race, marital status, health status, education, gender, employment status, income, and wealth	(As an aggregated measure, financial constraints were positively associated with depression in mid-age and in late life). Having any type of debt (including financial debt and mortgage loan) was positively associated with more depressive symptoms. The relationship between the occurrence of debt and depressive symptoms was partially accounted for by perceived control over one's financial circumstances.
Hiilamo and Grundy, 2018	Linear mixed model with random intercepts	Country and gender	Linear mixed model with random intercepts	Financial debt amount and housing debt amount	CESD-12	Education level, employment status, homemaker for women, household gross wealth, physical health status, age (age and age-squared), marital status, housing status, household size, time and country × time interaction dummies.	After adjustment, low or substantial financial debt was associated with a higher number of depressive symptoms in all countries. Housing debt was strongly linked to depressive symptoms for women while the association was weaker for men. Associations between financial debt and depression were also evident in analyses of within-individual changes in depressive symptoms for a longitudinal sub-group.

Study ID	Econometrical methods	Subgroup analysis	Panel analysis	Causal effect	Depression measure	Control for	Main findings
Hojman, 2016	OLS regression model	N	N	N	CESD-8	Socio demographics, family characteristics, health problems, personality traits, assets, personal history, health risk factors, regional dummies	Depressive symptoms are higher for those who persistently have a high debt level, followed by those who transit from moderate to high debt level. Those who transition from over-indebtedness to moderate debt levels have no additional depressive symptoms compared to those with trajectories of moderate debt throughout (never over-indebted). The association between debt and depressive symptoms seems to be driven by non-mortgage debt - primarily consumer credit- or late mortgage payments; secured debt (secured by collateral) per se is not associated with depressive symptoms.
Jo et al., 2011	Multiple logistic regression model	Gender & Income level	N	N	CESD-20	Gender, age, educational status, marital status.	An increase by a million won/month of income significantly reduced the possibility of depressive symptoms. Among males, only the highest average monthly family income showed such a tendency; among females, a higher income level was associated with a lower possibility of depressive symptoms for all income groups.
Kim et al., 2016	Hierarchical logistic regression model	Education	N	N	CESD-11	Age, gender, education level, marital status, employment status, family satisfaction level, perceived health status, and chronic disease status	Low current economic status was associated with a higher likelihood of depressive symptoms. In particular, the low current-low childhood economic status group showed the highest likelihood of depressive symptoms, suggesting the adverse mental health effects of prolonged poverty.

Study ID	Econometrical methods	Subgroup analysis	Panel analysis	Exposures	Depression measure	Control for	Main findings
Krause et al., 1991	Latent variable model	N	N	Financial strain	CESD-6	Age, sex, education	Financial strain tends to erode feelings of control and self-worth in both the U.S. and Japan, and the weakening of these personal resources tends to increase depressive symptoms.
Krause et al., 1998	Hierarchical OLS regression model	N	N	Financial strain, received economic support, anticipated economic support.	CESD-6	Age, sex, education, marital status, urban residence or not, occupational status.	There is a strong relationship between ongoing financia and depression scores for Chinese older people. The rel between financial strain and depressive symptoms beco older adults in China receives more economic support. T relationship becomes weaker as the level of anticipated increases.
Leung and Lau, 2014	Linear regression	Mortgagors vs All homeowners	Fixed-effect estimation & First difference estimation & Fixed effect Instrumental variable estimation & First difference instrumental variable estimation	Mortgage loan to house value	CESD-8	Age, marital status, annual average unemployment rates in the county of residence, year dummies to capture time trends and state dummies to capture persistent health differences across states	Results from pooled OLS estimations show that excessive mortgage indebtedness is associated with a greater number of depressive symptoms. After adjusting for individual-level heterogeneity using panel estimation, these associations become statistically insignificantly different from zero. Using state-level home prices as an instrument variable in a panel IV framework, results show that Panel IV estimations suggest that having a high mortgage loan to home value (LTV), defined as LTV at or above 80 %, leads to more depressive symptoms.

Study ID	Econometrical methods	Subgroup analysis	Panel analysis	Exposures	Depression measure	Control variables	Main findings
Lorant et al., 2007	Conditional logistic regression	N	Fixed effect estimation	Subjective financial strain, poverty, deprivation, and income	A modified version of the global depression scale of HDL	Age, gender, education, employment, civic participation, living with a partner or spouse	1-year increases in material hardship such as financial strain, deprivation and poverty led to an increase in depressive symptoms, and caseness of major depression.
Lund and Cois, 2018	Weighted linear regression	N	Cross-lagged structural equation model	Material assets	CESD-10	Gender, race, age and categorical education	Worse individual economic status at time 1 and 2 were independently associated with worse depression two years later at time 2 respectively. Conversely worse depression at time 1 and time 2 was independently associated with worse economic status at time 2 respectively. In addition, the "effect" of depression on future assets was stronger among people with fewer baseline assets.
Martikainen et al., 2003	Logistic regression	Gender	N	Income and wealth	GHQ depression	Age, health at baseline, employment status, number of economically active adults, number of children and number of all persons in the household, marital status, education, and employment grade	The association between income (especially individual income) and depression can be largely accounted for by health status at baseline and other socioeconomic factors. There is a strong association between household wealth and depression.
Mirowsky et al., 2001	Linear regression	Age & income level	Subsequent and concurrent change model	Economic hardship	CESD-7	Age, sex, race, education, marital status, household income, non-wage household, chronic conditions	Economic hardship is statistically significantly associated with depression in all age groups, and the amount of the relationship is decreases with older age, both cross-sectional and over time.

Study ID	Econometrical methods	Subgroup analysis	Panel analysis	Exposures	Depression measure	Control for	Main findings
Osafo Hounkpatin et al., 2015	Linear regression	N	N	Income and wealth	CESD	Income-depression: gender, age, age squared, household size, level of highest education since high school, marital status, current employment status, and retirement. Wealth-depression: gender, age, age squared, household size, employment status, marital status, educational attainment, tenure, retirement status was used	It is the rank of a person's income or wealth within a social comparison group, rather than income or wealth themselves or their deviations from the mean within a reference group, that is more strongly associated with depressive symptoms.
Pool et al., 2017	Logistic regression model	N	Nested cross-over model within individuals with conditional logistic regression	Negative wealth shock	CESD-8	Cross-over model control for: Time-varying sociodemographic covariates (including marital status, household annual income, current unemployment status, and health insurance status). Panel regression control for both time-varying and Time invariant variables (including gender, race/ethnicity, age and educational attainment were assessed at baseline).	Negative wealth shock caused the increased risk of more severe depressive symptoms amongst late middle-aged people.
Pu et al., 2011	Generalised estimation equation (GEE)	Education level	N	Financial satisfaction	CESD-10	Baseline age, sex, marital status, educational level, ethnicity, smoking, and number of people living together	Among those who were dissatisfied with their financial position, those who were illiterate had an odds ratio of 8.3% for having depressive symptoms compared with those who were very satisfied with their financial position.
Rautio et al., 2013	Logistic regression model	N	N	Financial satisfaction	BDI-21	Gender, age, marital status, number of chronic diseases, smoking, binge drinking, physical activity, education, and household income	Individuals who were less satisfied with their financial situation were more likely to suffer from depressive symptoms even after controlling for all the variables in the left cell.

Study ID	Econometrical methods	Subgroup analysis	Panel analysis	Exposures	Depression measure	Control for	Main findings
Reeves et al., 2016	Linear probability model	N	N	Reductions in the Housing Benefit (HB)	Self-reported depression	Age, sex, employment status, geographical region, ethnicity, number of dependent children in the household under the age of 19 years, income, occupation, education, whether the respondent was a job-seeker s allowance claimant, and the date of interview	Reducing housing support to low-income persons in the private rental sector increased the prevalence of depressive symptoms in the UK.
Richardson et al., 2016	Hierarchical linear multiple regression model	N	N	Index of financial stress, debt stress, how to perceive student loan	CESD-20	Age, gender, disability, mature student, ethnicity, family affluence scale, and symptoms at baseline	Greater financial difficulties such as being unable to pay the bills predicted greater depression and stress cross-sectionally. Depression worsened over time for those who had considered abandoning studies or not coming to the university for financial reasons, and there were effects on how students viewed their student loans. Greater stress about debt predicted greater depression when examined cross-sectionally.
Ross and Huber, 1985	Structural equation model with MLR estimation	Gender subgroup	N	Economic hardship, family income, wife's and husband's earnings	CESD-16	Age, education, race, number of young children, earnings, family income	Economic hardship increases both women/men's depression levels.

Study ID	Econometrical methods	Subgroup analysis	Panel analysis	Exposures	Depression measure	Control for	Main findings
Sareen et al., 2011	Multiple logistic regression model	Age, sex	N	Household income	DSM-IV	Age, sex, marital status, race and number of persons in the household.	Participants with household income of less than $20000 per year were at increased risk of incident mood disorders during the 3-year follow-up period in comparison with those with income of $70 000 or more per year. A decrease in household income during the 2 time points was also associated with an increased risk of incident mood, anxiety, or substance use disorders (adjusted odds ratio, 1.30; 99% confidence interval, 1.06-1.60) in comparison with respondents with no change in income. The baseline presence of mental disorders did not increase the risk of change in personal or household income in the follow-up period.
Sweet et al., 2013	OLS multiple regression model	N	N	Financial debt amount, financial debt/asset, subjective relative debt	Wave I: CESD-19; Wave III: CESD-9; Wave IV: CESD-5;	Wave I and Wave III socio-economic, psychological, and health factors (general health, depressive symptoms, medical exams, health insurance, skipped medical care, disease diagnoses, hospitalizations, exercise, smoking, diet, BMI, income, education, parental education, homeownership, and race/ethnicity); Wave IV socioeconomic and demographic factors (number of people in the household, education, income, smoking, physical activity, marital status, health insurance, job loss, and homeownership)	High calculated financial debt to assets ratio and subjective debt to assets ratio are independently associated with higher depression. The effect remains significant after controlling for prior socioeconomic status, psychological and physical health, and other demographic factors. High financial debt amount was an inconsistent predictor of more depressive symptoms.

Study ID	Econometrical methods	Subgroup analysis	Panel analysis	Exposures	Depression measure	Control for	Main findings
Tran et al., 2018	Structural equation model with MLR estimation	N	N	Student loan debt amount and debt stress	CESD-13	Household income, U.S. born, gender, mother's highest level of education, and father's highest level of education	Student loan debt was positively linked to debt stress, and debt stress was linked to poorer general health and greater depressive symptomatology.
Virtanen et al., 2008	Logistic regression model	Gender & Income level	N	Income	CIDI (DSM-IV)	Age, non-working factors (marital status, housing conditions, lack of social support outside work, victim of violence, smoking, abnormal somatic health, number of physical symptoms) and working factors (job demands, lack of job control, lack of social support at work, lack of educational prospects at work, job insecurity).	Low income is associated with frequent mental disorders among a working population. Work factors among men and non-work factors among women contribute to the income differences in mental health.
Zimmerman and Katon, 2005	Negative binomial regression model	Gender & Income level	Fixed effect regression & Instrumental variable negative binomial hurdle regression	Income	CESD-20	Non-economic correlates: age (and age-squared), race/ ethnicity, region, urbanity, marital status, the Rosenberg self-esteem scale, self-report of any major current or past physical health problems, and whether there are any children under 12 in the respondent's household. Economic covariates: current employment status, the logged ratio of debts-to-assets, logged years of education completed, job type, insurance status, and whether the respondent owns their own home.	Income is significantly correlated with depression after controlling for non-economic correlates. Statistical strength and the magnitude of the association between income and depressive symptoms are less with other economic covariates controlled. The association between depression and income has a greater magnitude at lower income levels than at higher ones.

Study ID	Econometrical methods	Subgroup analysis	Panel analysis	Exposures	Depression measure	Control for	Main findings
Zurlo et al., 2014	OLS regression model	N	N	Occurrence of unsecured debt, Amount of unsecured debt	CESD-8	Age, education, gender, marital status, race, employment status, self-reported health, household income, household net worth, ratio of housing costs/income	Both the occurrence of unsecured debt and the amount of unsecured debt was positively and significantly associated with more depressive symptoms independently. The negative effects of unsecured debt on depressive symptoms are largely accounted for by perceived control over personal financial circumstances.

N: No information reported.

Appendix B.1 The K6 scale in the 2014 CFPS (CFPS, 2014)

Here are some feelings or activities you may have experienced before. Please tell us how often you experienced them in the past month.

1. Never 2. Sometimes 3. Half of the time 4. Often 5. Almost daily

Questions:

How often during the past 30 days, did you feel so depressed that nothing could cheer you up?

How often during the past 30 days, did you feel nervous?

How often during the past 30 days, did you feel restless or fidgety?

How often during the past 30 days, did you feel hopeless?

How often during the past 30 days, did you feel that everything was an effort?

How often during the past 30 days, did you feel that life was meaningless?

Appendix B.2 Financial literacy questions (CFPS, 2014)

Basic financial knowledge

Q1. According to your estimation, what is the annual interest rate of a one-year fixed deposit in the bank?

1. Lower than 1% 2. 1–5% 3. 5–10% 4. 10% and higher 9. Don't know

Q2. Suppose you have a one-year fixed deposit of 10,000 yuan and the annual interest rate is 3%. If you don't withdraw within this period, how much money will you get on the due date? 1. 10300 yuan 2. More than 10300 yuan 3. Less than 10300 yuan 9. Don't know

Q3. After the due date of deposit in the above question, if you continue to save the money as a one-year fixed deposit and the annual interest rate is 3%, how much money will you have in this account after one year, including the principal and interest?

1. 10600 yuan 2. More than 10600 yuan 3. Less than 10600 yuan 9. Don't know

Q4. If the annual interest rate of your savings account is 3%, and the inflation rate is 5%, how many goods you can buy using your savings in this account after one year?

1. More than today 2. The same as today 3. Less than today 9. Don't know

Q5. Suppose Zhang San inherits 100,000 yuan today, and Li Si will inherit 100,000 yuan three years later. Who has a higher value of inheritance?

1. Zhang San has a higher value of the inheritance

2. Li Si has a higher value of the inheritance

3. They have the same value of the inheritance

9. Don’t know

Advanced financial knowledge

Q6. In general, investments with high returns have high risks.

1. Right 2. Wrong 9. Don’t know

Q7. In general, the risk of investing in one-share stock is smaller than that of investing in stock funds.

1. Right 2. Wrong 9. Don’t know

Q8. Which of the following banks is responsible for making and carrying out monetary policies? 1. Bank of China 2. Industrial and Commercial Bank of China 3. People’s Bank of China 4. China Construction Bank 9. Don’t know

Q9. Generally speaking, which of the following investments has the highest risk?

1. Bank savings 2. National debts 3. Stocks 4. Capital funds 9. Don’t know

Q10. If you purchase stocks of some company, which means:

1. No matter you hold these stocks for the short term or long term; you lend the money to the company anyway.

2. No matter you hold these stocks for the short term or long term; you are the stockholder of the company anyway.

3. You are the stockholder of the company when you hold these stocks for the long term, and you lend the money to the company when you hold these stocks for the short term.

4. None of the above is correct.

9. Don’t know.

Q11. Which one of the following is correct in terms of describing capital funds?

1. Low-price (low unit value) capital fund has a better future performance.

2. In general, the same capital fund could be invested in several assets; for example, one capital fund can be invested in both stocks and bonds.

3. In general, capital funds can provide a guaranteed rate of return based on past performance.

4. None of the above is correct.

9. Don't know.

Q12. Which of the following statements is correct about a bank's financial products?

1. Same as with other risky investments, a bank's financial products are also possible to suffer from the loss.

2. As safe as savings, bank financial products at least will not lose.

3. The expected profits of bank financial products are actual profits.

4. None of the above is correct.

9. Don't know

Q13. Which of the following statements correctly describes the core function of the stock market?

1. The stock market is helpful in predicting the profits of stocks.

2. The stock market increases the prices of stocks.

3. The stock market helps to make matches between stock buyers and sellers.

4. None of the above is correct.

9. Don’t know.

Financial attitudes

Q1. Spending money makes me more satisfied than saving money.

1. Totally inapplicable 2. Somewhat inapplicable 3. Generally applicable

4. Somewhat applicable 5. Totally applicable 9. Don’t know

Q2. I intend to live in the present more and do not consider the future.

1. Totally inapplicable 2. Somewhat inapplicable 3. Generally applicable

4. Somewhat applicable 5. Totally applicable 9. Don’t know

Q3. In my opinion, money is to be spent and we should spend it whenever we have money.

1. Totally inapplicable 2. Somewhat inapplicable 3. Generally applicable

4. Somewhat applicable 5. Totally applicable 9. Don’t know

Financial Behaviours

Q1. I will consider my capacity when I go shopping.

1. Totally inapplicable 2. Somewhat inapplicable 3. Generally applicable

4. Somewhat applicable 5. Totally applicable 9. Don’t know

Q2. I pay my bills on time (such as water, gas, electricity, credit card, etc.)

1. Totally inapplicable 2. Somewhat inapplicable 3. Generally applicable

4. Somewhat applicable 5. Totally applicable 9. Don’t know

Q3. I pay close attention to my financial situation (e.g., regular check of bank account and financial balance).

1. Totally inapplicable 2. Somewhat inapplicable 3. Generally applicable

4. Somewhat applicable 5. Totally applicable 9. Don't know

Q4. I make long-term financial plans.

1. Totally inapplicable 2. Somewhat inapplicable 3. Generally applicable

4. Somewhat applicable 5. Totally applicable 9. Don't know

Q5. I manage my own financial revenues and expenditures, as well as those of my family.

1. Totally inapplicable 2. Somewhat inapplicable 3. Generally applicable

4. Somewhat applicable 5. Totally applicable 9. Don't know

Q6. In my daily life, I make ends meet and consume according to my income.

1. Totally inapplicable 2. Somewhat inapplicable 3. Generally applicable

4. Somewhat applicable 5. Totally applicable 9. Don't know

Q7. I will collect product information and compare various products when I choose financial products.

1. Totally inapplicable 2. Somewhat inapplicable 3. Generally applicable

4. Somewhat applicable 5. Totally applicable 9. Don't know

Q8. I will maintain financial balance using loans.

1. Totally inapplicable 2. Somewhat inapplicable 3. Generally applicable

4. Somewhat applicable 5. Totally applicable 9. Don't know

Q9. I have the habit of note-keeping and record all the income and expenditures.

1. Totally inapplicable 2. Somewhat inapplicable 3. Generally applicable

4. Somewhat applicable 5. Totally applicable 9. Don’t know

Appendix B.3 Factor analysis of financial knowledge questions

The results based on indexes of financial knowledge calculated through factor analysis are displayed in Tables B.3-1 to B.3-4. To create an index for basic financial knowledge, ten items are taken into consideration including the correct and "do not know" answers to the five questions. According to the Kaiser criterion, factors with an eigenvalue of 1.0 or greater should be retained (Kaiser, 1960). As reported in Table B.3-1, only the eigenvalue of the first factor exceeds one. Thus, the first factor are kept in the factor analysis. This first factor explains 62.4% of the variability of the ten items. To create the index for advanced financial knowledge, sixteen items are taken into consideration including the correct and "do not know" answers to the eight questions related to more advanced financial knowledge. As reported in Table B.3-3, there are two factors with an eigenvalue larger than one. Thus, the first two factors are kept in the factor analysis, which explain 65.2% of the variability of the original sixteen items in total.

The Kaiser-Meyer-Olkin (KMO) test is used to examine the appropriateness of performing a factor analysis. KMO values range between 0 and 1. KMO values should be at least 0.5, which means the items are sufficiently correlated with each other to perform valid factor analysis. The higher the KMO values, the more efficient the factorisation. Tables B.3-2 and B.3-4 report the results for KMO test and factor loadings of each item on factors. The majority of KMO values in Tables B.3-2 and B.3-4 are all above 0.7. The mean value of KMO test in Tables B.3-2 and B.3-4 are respectively

0.815 and 0.854. The results of KMO tests indicate that performing a factor analysis is appropriate for the used data.

In factor analyses, the relationship between variables and factors can be expressed as:

$$X = AF + \varepsilon \quad (1)$$

where X is the matrix of each measurable and observable item; F denotes the common factor of X, which is independent and unobservable; ε is the uniqueness of X, which cannot be explained by the common factor F. ε is independent from common factor F. The matrix A is factor loadings, in which each element a_{ij} is the correlation between the item X and the common factor F.

The index can be calculated based on:

$$F = B * X + \varepsilon \quad (2)$$

Recall the estimation equation for the regression coefficient $\hat{B}$ in a linear regression model:

$$\hat{B} = (X * X')^{-1} * X'Y \quad (3)$$

Following this, the coefficient B for equation (2) in factor analysis can be written as:

$$\hat{B} = R^{-1} * A' \quad (4)$$

where A denotes the factor loading matrix and R is the variance matrix of the measured items. Stata is able to estimate the matrix of the score coefficients (i.e., B) of each item based on equation (3). Then the index for financial knowledge $\hat{F}$ can be predicted once the $\hat{B}$ is estimated.

Then the weighted summary method is used to combine the selected factors to create the index of financial knowledge should the number of common factors be more than one. In other words, the equation used to obtain the index is:

$$Total\ Index = \sum_1^j w_j * F_j, \quad j = 1,2,\cdots,m \tag{5}$$

where w_j denotes the proportion of the variance that can be explained by the j^{th} factor F_j relative to the cumulative proportion of the variance explained by all factors.

Table B.3-1. Factor analysis results (Basic financial knowledge)

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	4.491	3.505	0.624	0.624
Factor2	0.986	0.292	0.137	0.761
Factor3	0.694	0.172	0.097	0.857
Factor4	0.522	0.255	0.073	0.930
Factor5	0.267	0.088	0.037	0.967
Factor6	0.179	0.141	0.025	0.992
Factor7	0.038	0.019	0.005	0.997
Factor8	0.020	0.019	0.003	1.000
Factor9	0.000	0.000	0.000	1.000
Factor10	0.000	.	0.000	1.000

Table B.3-2. KMO test and factor loadings (Basic financial knowledge)

Variables	KMO test	Loadings on F1
FK1: Bank’s interest rate-Correct	0.737	0.651
FK1-Know	0.771	0.740
FK2: Simple interest calculation-Correct	0.905	0.455
FK2-Know	0.859	0.826
FK3: Compound interest calculation-Correct	0.885	0.524
FK3-Know	0.838	0.829
FK4: Inflation-Correct	0.818	0.602
FK4-Know	0.841	0.732
FK5: Time value of money-Correct	0.749	0.557
FK5-Know	0.797	0.680
Average	0.815	

Table B.3-3. Factor analysis results (Advanced financial knowledge)

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	5.508	4.187	0.526	0.526
Factor2	1.321	0.532	0.126	0.652
Factor3	0.788	0.060	0.075	0.727
Factor4	0.729	0.224	0.070	0.797
Factor5	0.505	0.076	0.048	0.845
Factor6	0.429	0.050	0.041	0.886
Factor7	0.378	0.018	0.036	0.922
Factor8	0.361	0.081	0.034	0.956
Factor9	0.279	0.192	0.027	0.983
Factor10	0.087	0.045	0.008	0.991
Factor11	0.043	0.020	0.004	0.996
Factor12	0.023	0.007	0.002	0.998
Factor13	0.015	0.008	0.002	0.999
Factor14	0.007	0.005	0.001	1.000
Factor15	0.002	0.003	0.000	1.000
Factor16	0.000	.	0.000	1.000

Table B.3-4. KMO test and factor loadings (Advanced financial knowledge)

Variables	KMO test	Loadings on F1	Loadings on F2
FK6: Relationship between risks and returns-Correct	0.702	0.427	0.642
FK6-Know	0.742	0.505	0.645
FK7: Risk Diversification-Correct	0.815	0.512	-0.104
FK7-Know	0.854	0.625	-0.029
FK8: Bank’s function-correct	0.846	0.380	-0.045
FK8-Know	0.914	0.632	0.010
FK9: Risk of financial products-Correct	0.790	0.575	0.271
FK9-Know	0.825	0.704	0.310
FK10-Know	0.931	0.746	-0.143
FK10: Understanding of stocks-Correct	0.882	0.350	-0.100
FK11-Know	0.895	0.713	-0.296
FK11: Capital Funds-Correct	0.857	0.401	-0.226
FK12-Know	0.909	0.755	-0.095
FK12: Bank’s financial products-Correct	0.878	0.498	-0.103
FK13-Know	0.879	0.773	-0.279
FK13: Core functions of the stock market-Correct	0.856	0.532	-0.208
Average	0.854		

Appendix B.4 K6 scores by age group

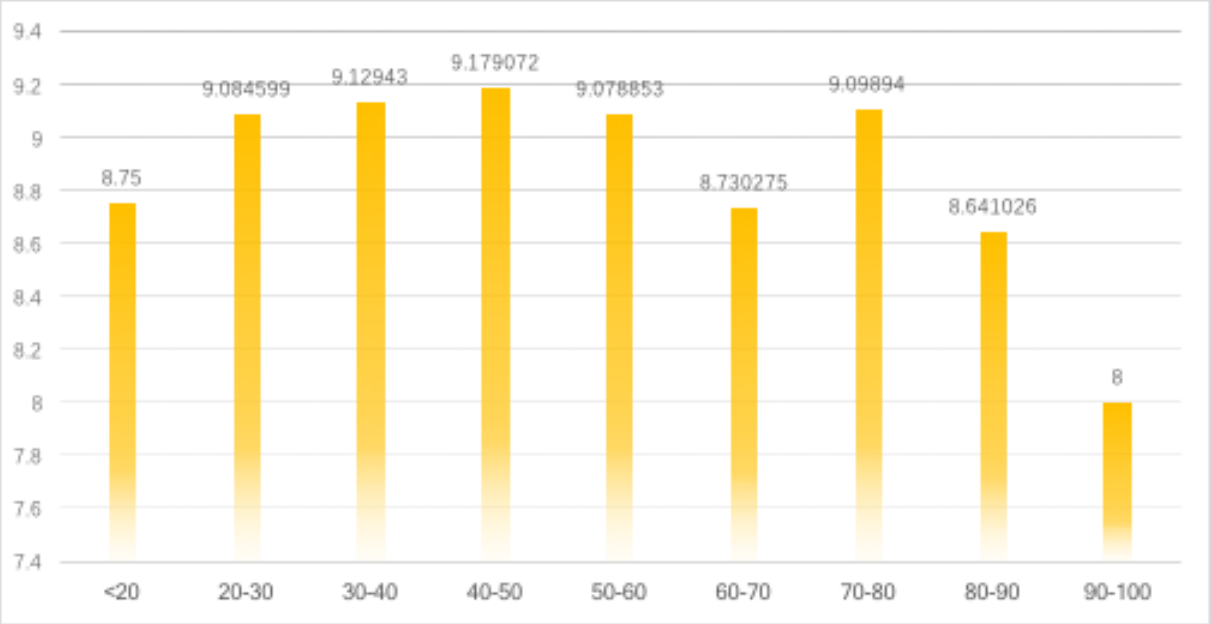


Figure B.4-1 K6 scores by age group

Note: Authors' calculations based on the 2014 wave of the CFPS

Appendix B.5 China's household debt to GDP ratio from 2007 to 2019

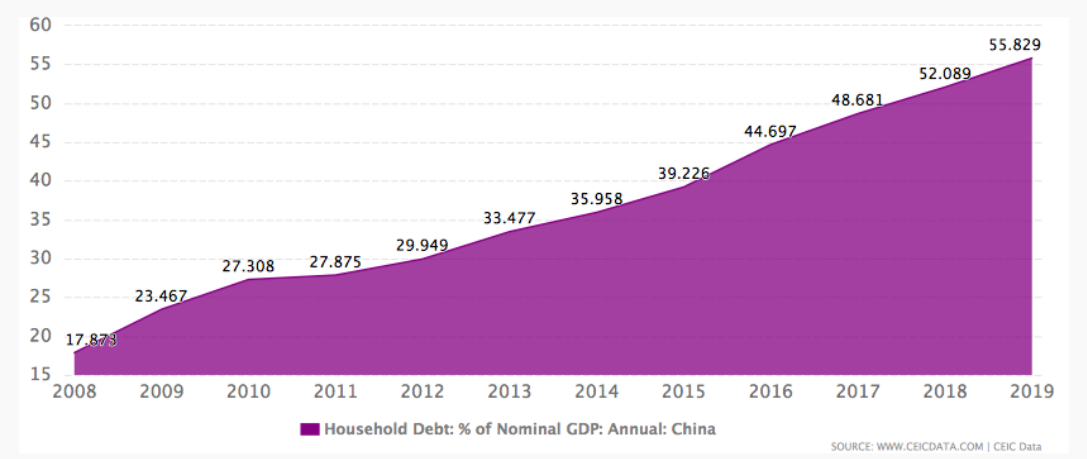


Figure B.5-1 China's household debt to GDP ratio from 2007 to 2019

Source: CEIC data

Appendix B.6 Chapter IV Robustness check estimates

The results obtained from the robustness check including: logit estimates of Equation 4-1, estimates with financial knowledge indexes calculated using factor analysis (described in Section 4.2.4 and Appendix B.3), IV estimates of Equation 4-1 are reported in Tables B.6-1, B.6-2, and B.6-3[9]. Similar to Table 4-8 in section 4.3.2, all models include control variables such as age; age squared; gender; urban versus rural residence; marital, health, exercise, and employment status; years of education; and provincial dummies. In Panel B (Models 5 to 8), three household financial variables (income, assets and debt) are also introduced.

[9] The sample size in this table is smaller than that in Table 4-8 in the main text due to missing values on the respondent's father's education.

Table B.6-1 Logit regression results for the probability of having a K6 score of 11 or above (marginal effects)

	Panel A				Panel B			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Basic financial knowledge score	-0.011**				-0.006			
	(0.005)				(0.005)			
Advanced financial knowledge score		-0.001				0.002		
		(0.005)				(0.005)		
Financial behaviour score			-0.007**				-0.007**	
			(0.004)				(0.004)	
Financial attitude score				-0.017**				-0.018**
				(0.007)				(0.007)
Log of income					-0.012	-0.014*	-0.013	-0.014*
					(0.008)	(0.008)	(0.008)	(0.008)
Log of assets					-0.012***	-0.013***	-0.012***	-0.013***
					(0.004)	(0.004)	(0.004)	(0.004)
Log of debts					0.005***	0.005***	0.005***	0.005***
					(0.001)	(0.001)	(0.001)	(0.001)

Notes: Data in this table is calculated using the 2014 wave of the CFPS. The sample size is 3,277. Marginal effects are reported with standard errors in parentheses. All models control for age; age squared; gender; urban versus rural residence; marital, health, employment, and exercise status; years of education; and provincial dummies, but their marginal effects are not reported for brevity. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table B.6-2 Financial literacy and mental health: negative binomial regression (NB) and logit regression results (financial knowledge is indexed by factor analysis)

	NB regression				Logit regression			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Basic financial knowledge index	-0.131*		-0.055		-0.015*		-0.006	
	(0.07)		(0.073)		(0.009)		(0.009)	
Advanced financial knowledge index		-0.028		0.098		-0.003		0.006
		(0.091)		(0.092)		(0.011)		(0.011)
Log of income			-0.070	-0.086			-0.013	-0.014*
			(0.070)	(0.069)			(0.008)	(0.008)
Log of assets			-0.124***	-0.132***			-0.122***	-0.013***
			(0.037)	(0.037)			(0.004)	(0.004)
Log of debts			0.050***	0.050***			0.005***	0.005***
			(0.012)	(0.012)			(0.001)	(0.001)

Notes: Data in this table is calculated using the 2014 wave of the CFPS. The sample size is 3,277. Marginal effects are reported with standard errors in parentheses. All models control for age; age squared; gender; urban versus rural residence; marital, health, employment, and exercise status; years of education; and provincial dummies, but their marginal effects are not reported for brevity. * p < 0.1, ** p < 0.05, *** p < 0.01

Table B.6-3. Financial literacy and mental health: IV regression results

	Panel A				Panel B			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
First stage								
Country basic financial knowledge	0.452***				0.344***			
	(0.058)				(0.058)			
County advanced financial knowledge		0.351***				0.325***		
		(0.055)				(0.054)		
County financial behaviours			0.376***				0.379***	
			(0.080)				(0.081)	
County financial attitudes				0.290***				0.290***
				(0.083)				(0.083)
Father's education	0.026***	0.030***	0.006	0.005	0.022***	0.027***	0.003	0.005
	(0.007)	(0.008)	(0.010)	(0.005)	(0.007)	(0.008)	(0.010)	(0.005)

Table B.6-3. Continued

	Panel A				Panel B			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Second stage								
Basic financial knowledge	-0.463*				-0.199			
	(0.269)				(0.373)			
Advanced financial knowledge		-0.345				-0.262		
		(0.287)				(0.312)		
Financial behaviours			-0.556*				-0.642*	
			(0.327)				(0.3333)	
Financial attitudes				-2.231**				-2.222**
				(1.038)				(1.028)
Log of income					-0.118	-0.125	-0.085	-0.145
					(0.112)	(0.099)	(0.100)	(0.110)
Log of assets					-0.128*	-0.122*	-0.132***	-0.167***
					(0.073)	(0.068)	(0.060)	(0.064)
Log of debt					0.037***	0.043***	0.055***	0.038***
					(0.017)	(0.016)	(0.018)	(0.018)
F	38.65	28.40	11.16	6.59	20.19	24.04	11.11	6.62
Wooldridge's robust score	1.690	1.321	2.541*	6.243**	0.140	0.752	3.568*	6.313**
J	0.85	0.91	0.75	0.91	0.96	0.90	0.88	0.73
Anderson	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
K-P	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: The dependent variable is the K6 score. The sample size is 2,349. All models control for age; age squared; gender; urban versus rural residence; marital, health, employment, and exercise status; years of education; and provincial dummies, but their marginal effects are not reported for brevity. The financial literacy variables are instrumented with the average financial literacy in the county in which the respondent resides, as well as his/her father's education. Wooldridge's robust score shows the test results of the null hypothesis that the instrumented variable is exogeneous. F denotes the F-test associated with the first-stage regression. The J statistic is a test of the overidentifying restrictions, distributed as chi-square under the null of instrument validity. The Anderson canonical correlation statistic and the Kleibergen-Paap (K-P) statistic are distributed as chi-square under the null that the equation is unidentified. P-values for the latter three tests are reported. Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Instrument validity

Table B.6-3 also reports a number of tests for instrument validity. IV methods rely on two assumptions: (1) the excluded instruments are distributed independently of the error process; (2) they are sufficiently correlated with the included endogenous regressor.

The J-test is a test for overidentifying restrictions, which addresses the first assumption. Specifically, it tests the joint null hypothesis that the excluded instruments are uncorrelated with the error term, and that they are correctly excluded from the estimated equation. Under the null hypothesis, the test has a large sample chi-squared distribution with degrees of freedom equal to the number of overidentifying restrictions. The p-values associated with the J-test in Table B.6-3 suggest that the null hypothesis cannot be rejected.

To test the second assumption, the goodness-of-fit of the first stage regression relating each endogenous regressor to the entire set of instruments is considered. A rule of thumb for instrument validity is that the F-statistic associated with the first stage regression be greater than 10 (Stock and Yogo, 2005). The large F-statistics reported in Table B.6-3 suggest that the selected instruments have high explanatory power and are therefore valid[10].

Additional tests of the second hypothesis are the Anderson test of the null hypothesis that the minimum canonical correlation is zero, and the Kleibergen-Paap (K-P) test for under-identification, which assess whether or not the instruments are adequate to identify the equation. In both cases, a significant result suggests that the model is identified, meaning that the relationship between the included endogenous regressors and the instruments is sufficiently strong to justify inference from the results. The statistics reported in both panels of the Table indicate that the models are generally identified.

[10] Exceptions can be found in columns 4 and 8, which show F-statistics slightly smaller than 10. Yet, because both the Anderson and the K-P test are satisfactory, this is considered as a source of concern.

Appendix B.7 Sample size flow chart

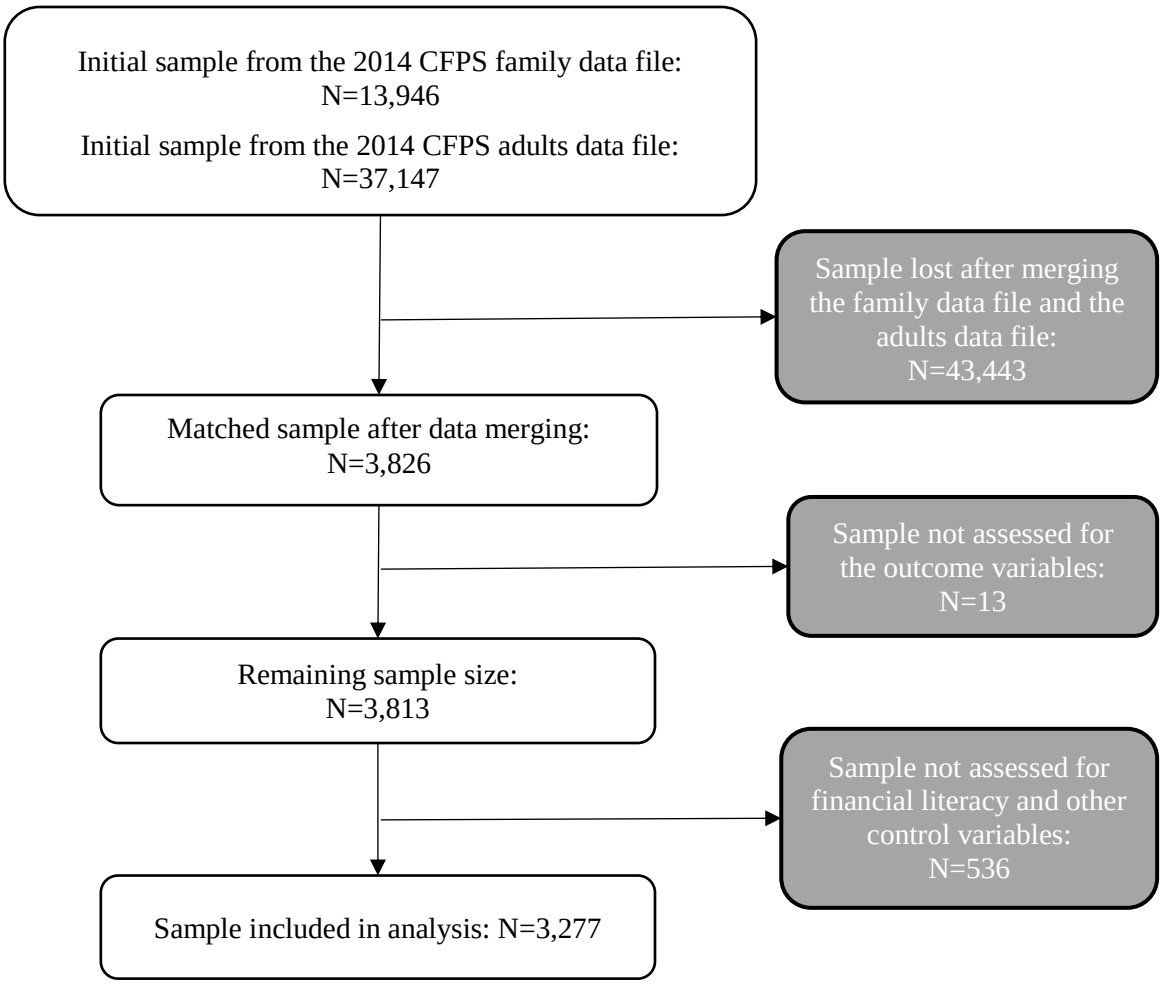


Figure B.7-1 Sample size flow chart

Note: After the family data file and the adults data file are combined, the total number of lost samples is higher than the original sample in the adults data file (i.e., 37,147). This is because some samples in the family data file can be different from samples in the adult data file.

Appendix B.8 Chapter IV Main results without health status

In the estimates of the OLS regression reported in Table 4-8 (see section 4.3.2), models 1-4 control for age; age squared; gender; urban versus rural residence; marital, health, exercise, and employment status; years of education; and provincial dummies and models 5-8 further control for economic factors such as income, assets and debt based on models 1-4. This study also examines if the main results are robust without controlling for health status, given that health is one of the key determinants of mental health (Ohrnberger et al., 2017). The estimated results of the OLS regression without controlling for health status are reported in Table B.8-1. Other control variables in Table B.8-1 are the same as those in Table 4-8. When health status is not taken into account, the main results still hold in general. The magnitudes of the estimated coefficients associated with financial knowledge, financial behaviour and financial attitudes in Table B.8-1 are slightly larger, as compared to those estimated in Table 4-8.

Table B.8-1 Financial literacy and mental health: OLS regression results

			Panel A			Panel B		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Basic financial knowledge score	-0.156***				-0.104***			
	(0.047)				(0.048)			
Advanced financial knowledge score		-0.008				0.024		
		(0.039)				(0.040)		
Financial behaviour score			-0.085***				-0.085***	
			(0.032)				(0.032)	
Financial attitude score				-0.127*				-0.129*
				(0.068)				(0.067)
Log of income					-0.076	-0.101	-0.088	-0.098
					(0.079)	(0.079)	(0.078)	(0.079)
Log of assets					-0.166***	-0.181***	-0.175***	-0.180***
					(0.049)	(0.049)	(0.049)	(0.049)
Log of debt					0.061***	0.063***	0.065***	0.063***
					(0.014)	(0.014)	(0.014)	(0.014)
Health control	No	No	No	No	No	No	No	No
Other control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Data in this table is calculated using the 2014 wave of the CFPS. The sample size is 3,277. Coefficients are reported with standard errors in parentheses. All models control for age; age squared; gender; urban versus rural residence; marital, employment, and exercise status; years of education; and provincial dummies, but their coefficients are not reported for brevity. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Appendix C.1 Measures of numeracy and financial literacy in the HRS

Numeracy measure in the HRS (Steffick, 2000)

Q1. If the chance of getting a disease is 10 percent, how many people out of 1,000 would be expected to get the disease?

Q2. If 5 people all have the winning numbers in the lottery and the prize is two million dollars, how much will each of them get?

Q3. Let's say you have $200 in a savings account; the account earns 10 percent interest per year. How much would you have in the account at the end of two year.

Financial literacy measure-The Big Three in the HRS (Steffick, 2000)

Q1. Suppose you had $100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow: more than $102, exactly $102, less than $102?

Q2. Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, would you be able to buy more than, exactly the same as, or less than today with the money in this account?

Q3. The following statement is true or false? "Buying a single company stock usually provides a safer return than a stock mutual fund."

Appendix C.2 Depressive symptoms measure in the HRS (Steffick, 2000)

Now think about the past week and the feelings you have experienced. Please tell me if each of the following was true for you much of the time during the past week.

Q1. Much of the time during the past week, you felt depressed. Would you say yes or no?

Q2. (Much of the time during the past week…)

You felt that everything you did was an effort.

(Would you say yes or no?)

Q3. (Much of the time during the past week...)

Your sleep was restless.

(Would you say yes or no?)

Q4. (Much of the time during the past week...)

You were happy.

(Would you say yes or no?)

Q5. (Much of the time during the past week...)

You felt lonely.

(Would you say yes or no?)

Q6. (Much of the time during the past week...)

You enjoyed life.

(Would you say yes or no?)

Q7. (Much of the time during the past week...)

You felt sad.

(Would you say yes or no?)

Q8. (Much of the time during the past week...)

You could not get going.

(Would you say yes or no?)

Appendix C.3 Chapter V Main results wihout health status

To examine if the results of multivariable regression (in section 5.4.2) are robust without controlling for health status, this study re-runs the regression models estimated in Table 5-5[11]. The estimated results of fixed effects regression and correclated random effects regression without controlling for health status are reported in Table C.3-1 (see Models 1b and 2b). The main results still hold in general when health status is excluded. The coefficients associated with financial literacy in Table C.3-1 are larger than those estimated in Table 5-5. The estimated coefficients associated with the majority of the control variables do not differ significantly.

[11] In Table 5-5 (see section 5.4.2), models 1a and 2a control for year dummies and all the time-unvarying convariates. Models 1b and 2b are regressions of CESD-8 scores on financial literacy, controlling for age, gender, race, marital status, health, educational attainment, employment status, region dummies and year dummies, household income and wealth, and all the time-unvarying covariates.

Table C.3-1 Financial literacy and depressive symptoms: fixed effects and correlated random effects estimates

	Fixed effect linear regression			**Correlated random effects negative binomial regression**		
	Model 1a	Model 1b	Model 1c	Model 2a	Model 2b	Model 2c
Financial literacy[a]	-0.024**	0.021*	-0.020*	-0.018**	0.017**	-0.016*
	(0.012)	(0.012)	(0.012)	(0.008)	(0.008)	(0.008)
Log of income		-0.016**	-0.017**		-0.007**	-0.007**
		(0.007)	(0.007)		(0.004)	(0.004)
Log of wealth		-0.011***	-0.011***		-0.005***	-0.005***
		(-0.002)	(-0.002)		(0.001)	(0.001)
Age		0.011	0.007		0.005	0.006
		(0.013)	(0.013)		(0.008)	(0.008)
Male			-		-0.063***	-0.052***
			-		(0.014)	(0.014)
Education (reference group: Lower than high school)						
High school			-		-0.125***	-0.118***
			-		(0.018)	(0.018)
Some colleges			-		-0.177***	-0.174***
			-		(0.021)	(0.020)
College and higher			-		-0.368***	-0.325***
			-		(0.024)	(0.023)
Race (reference group: White or Caucasian)						
Black/African American			-		-0.059***	-0.063***
			-		(0.018)	(0.017)
Others			-		0.052**	0.075***
			-		(0.024)	(0.024)

Table C.3-1 Continued

	Fixed effect linear regression			Correlated random effects negative binomial regression		
	Model 1a	Model 1b	Model 1c	Model 2a	Model 2b	Model 2c
Marital status (reference group: Being married)						
Separated/Divorced		0.341***	0.340***		0.206***	0.204***
		(0.055)	(0.055)		(0.027)	(0.027)
Widowed		0.540***	0.539***		0.330***	0.328***
		(0.040)	(0.040)		(0.021)	(0.021)
Never married		0.298***	0.300***		0.208***	0.210***
		(0.128)	(0.128)		(0.058)	(0.059)
Employment status (reference group: Employed)						
Unemployed		0.331***	0.328***		0.195***	0.193***
		(0.057)	(0.057)		(0.031)	(0.031)
Retired		0.067**	0.061**		0.051***	0.047***
		(0.026)	(0.026)		(0.018)	(0.018)
Not in labour market/ Disabled		0.263**	0.257**		0.140***	0.135***
		(0.041)	(0.041)		(0.022)	(0.022)

Table C.3-1 Continued

	Fixed effect linear regression			Correlated random effects negative binomial regression		
	Model 1a	Model 1b	Model 1c	Model 2a	Model 2b	Model 2c
Region (reference group: Northeast)						
Midwest		0.021	0.022		0.049	0.043
		(0.137)	(0.136)		(0.084)	(0.085)
South		-0.210**	-0.207**		-0.123**	-0.130**
		(0.100)	(0.100)		(0.065)	(0.066)
West		-0.163	-0.162		-0.089	-0.116
		(0.145)	(0.145)		(0.088)	(0.090)
Others		0.068	0.073		0.097	0.069
		(0.414)	(0.413)		(0.182)	(0.187)
Health condition (reference group: Having no disease)						
Having one to two diseases			0.057*			0.053**
			(0.031)			(0.027)
Having more than two diseases			0.200***			0.144***
			(0.043)			(0.033)

Notes: a. financial literacy is proxied by numeracy in Table C.3-1. Data in Table C.3-1 are calculated using waves 6, 8, 10, and 12 of HRS. Number of observations is 74,572. The number of individuals is 31,088. Marginal effects are reported in Models 2a-2c. Models 1a and 2a are regressions of CESD-8 scores on financial literacy scores controlling for year dummies and all the time-unvarying covariates. Models 1b and 2b are regressions of CESD-8 scores on financial literacy, controlling for age, gender, race, marital status, educational attainment, employment status, region dummies and year dummies, household income and wealth, and all the time-unvarying covariates. Models 1c and 2c further control for health status. Robust standard errors in parentheses for Models 1a-1c. Standard errors in parentheses for Models 2a-2c. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Appendix C.4 Chapter V Structural equation model estimates

The structural equation model estimates of the relationships between financial literacy, household income, household wealth, and depressive symptoms are reported in Table C.4-1. A detailed description of the key results is presented in Chapter V of the thesis (see section 5.4.3).

Table C.4-1 Structural equation model estimates of the relationships between financial literacy, income, wealth, and depressive symptoms

Path	**Estimate**	**-value**	***95% CI***
$FL_{T2} \leftarrow FL_{T1}$	0.414	0.000	[0.401, 0.431]
$FL_{T2} \leftarrow I_{T1}$	0.014	0.044	[0.005, 0.025]
$FL_{T2} \leftarrow W_{T1}$	0.005	0.006	[0.003, 0.008]
$FL_{T2} \leftarrow DEP_{T1}$	-0.018	0.000	[-0.025, -0.014]
$FL_{T3} \leftarrow FL_{T2}$	0.419	0.000	[0.408, 0.430]
$FL_{T3} \leftarrow I_{T2}$	0.022	0.003	[0.001, 0.032]
$FL_{T3} \leftarrow W_{T2}$	0.003	0.041	[0.000, 0.005]
$FL_{T3} \leftarrow DEP_{T2}$	-0.018	0.000	[-0.024, -0.014]
$FL_{T3} \leftarrow DEP_{T1}$	-0.007	0.052	[-0.013, -0.001]
$FL_{T4} \leftarrow FL_{T3}$	0.467	0.000	[0.454, 0.484]
$FL_{T4} \leftarrow I_{T3}$	0.022	0.000	[0.011, 0.026]
$FL_{T4} \leftarrow W_{T3}$	0.007	0.000	[0.004, 0.008]
$FL_{T4} \leftarrow DEP_{T3}$	-0.019	0.000	[-0.030, -0.015]
$FL_{T4} \leftarrow DEP_{T2}$	-0.014	0.005	[-0.022, -0.007]
$I_{T2} \leftarrow I_{T1}$	0.049	0.000	[0.030, 0.077]
$I_{T2} \leftarrow FL_{T1}$	0.083	0.000	[0.069, 0.098]
$I_{T2} \leftarrow FL_{T2}$	0.269	0.000	[0.233, 0.303]
$I_{T2} \leftarrow DEP_{T1}$	-0.026	0.000	[-0.037, -0.009]
$I_{T3} \leftarrow I_{T2}$	0.047	0.002	[0.012, 0.076]

$I_{T3} \leftarrow FL_{T2}$	0.089	0.000	[0.056, 0.125]
$I_{T3} \leftarrow FL_{T3}$	0.354	0.000	[0.318, 0.394]
$I_{T3} \leftarrow DEP_{T2}$	-0.035	0.006	[-0.044, -0.024]
$I_{T4} \leftarrow I_{T3}$	0.055	0.000	[0.034, 0.076]
$I_{T4} \leftarrow FL_{T3}$	0.074	0.000	[0.049, 0.091]
$I_{T4} \leftarrow FL_{T4}$	0.295	0.000	[0.270, 0.340]
$I_{T4} \leftarrow DEP_{T3}$	-0.037	0.000	[-0.045, -0.016]
$W_{T2} \leftarrow W_{T1}$	0.158	0.004	[0.080, 0.257]
$W_{T2} \leftarrow FL_{T1}$	0.107	0.024	[-0.001, 0.163]
$W_{T2} \leftarrow FL_{T2}$	0.495	0.000	[0.464, 0.513]
$W_{T2} \leftarrow DEP_{T1}$	-0.109	0.000	[-0.180, -0.068]
$W_{T3} \leftarrow W_{T2}$	0.124	0.029	[-0.016, 0.207]
$W_{T3} \leftarrow FL_{T2}$	0.144	0.001	[0.078, 0.222]
$W_{T3} \leftarrow FL_{T3}$	0.530	0.000	[0.512, 0.560]
$W_{T3} \leftarrow DEP_{T2}$	-0.139	0.000	[-0.197, -0.112]
$W_{T4} \leftarrow W_{T3}$	0.090	0.074	[0.025, 0.194]
$W_{T4} \leftarrow FL_{T3}$	0.175	0.000	[0.081, 0.263]
$W_{T4} \leftarrow FL_{T4}$	0.444	0.000	[0.397, 0.483]
$W_{T4} \leftarrow DEP_{T1}$	-0.073	0.002	[-0.108, -0.047]
$DEP_{T2} \leftarrow FL_{T1}$	-0.012	0.496	[-0.057, 0.005]
$DEP_{T2} \leftarrow FL_{T2}$	-0.079	0.000	[-0.113, -0.055]
$DEP_{T2} \leftarrow I_{T1}$	-0.024	0.100	[-0.045, 0.001]
$DEP_{T2} \leftarrow I_{T2}$	-0.083	0.000	[-0.106, -0.056]
$DEP_{T2} \leftarrow W_{T1}$	-0.011	0.023	[-0.017, -0.002]
$DEP_{T2} \leftarrow W_{T2}$	-0.025	0.000	[-0.033, -0.017]
$DEP_{T2} \leftarrow DEP_{T1}$	0.476	0.000	[0.462, 0.497]
$DEP_{T3} \leftarrow FL_{T1}$	0.038	0.086	[-0.074, -0.012]
$DEP_{T3} \leftarrow FL_{T2}$	-0.051	0.006	[-0.070, -0.017]
$DEP_{T3} \leftarrow FL_{T3}$	-0.067	0.002	[-0.095, -0.019]

$DEP_{T3} \leftarrow I_{T2}$	-0.029	0.107	[-0.064, 0.002]
$DEP_{T3} \leftarrow I_{T3}$	-0.059	0.000	[-0.089, -0.030]
$DEP_{T3} \leftarrow W_{T2}$	-0.004	0.438	[-0.012, 0.007]
$DEP_{T3} \leftarrow W_{T3}$	-0.023	0.000	[-0.033, -0.014]
$DEP_{T3} \leftarrow DEP_{T2}$	0.478	0.000	[0.460, 0.498]
$DEP_{T4} \leftarrow FL_{T2}$	-0.022	0.229	[-0.056, 0.003]
$DEP_{T4} \leftarrow FL_{T3}$	-0.056	0.003	[-0.084, -0.027]
$DEP_{T4} \leftarrow FL_{T4}$	-0.051	0.010	[-0.082, -0.011]
$DEP_{T4} \leftarrow I_{T3}$	0.001	0.949	[-0.029, 0.019]
$DEP_{T4} \leftarrow I_{T4}$	-0.090	0.000	[-0.119, -0.060]
$DEP_{T4} \leftarrow W_{T3}$	-0.002	0.522	[-0.010, 0.003]
$DEP_{T4} \leftarrow W_{T4}$	-0.015	0.000	[-0.024, -0.003]
$DEP_{T4} \leftarrow DEP_{T3}$	0.534	0.000	[0.504, 0.549]
Controls	Yes	Yes	Yes

Notes: Number of individuals in mediation analyses is 11,369. Number of observations is 45,476. *FL*: Financial literacy. Mediator *I*: Natural logarithm of household income; Mediator *W*: Natural logarithm of household wealth. *DEP*: Depressive symptoms. This table is based on waves 6, 8, 10 and 12 of the HRS. *T1*, *T2*, *T3*, and *T4* respectively denote the above-mentioned four waves. All models control for age, gender, race, residence, education, marital status, employment status and health condition. A bootstrapping approach is used to estimate the 95% confidence intervals. *p < .05, **p < .01, ***p < .001.

Appendix D.1 Chapter VI Main results without health status

To examine if the main results from multivariable regression still hold without controlling for health status, this study re-runs the regression models in Tables 6-5, 6-6 and 6-7 in section 6.4.2. The results obtained from the fixed effects poisson regression without controlling for health status are reported in Models 1-3 in Tables D.1-1 (for income shocks), D.1-2 (for wealth shocks) and D.1-3 (for job losses). As shown in Tables D.1-1, D.1-2, and D.1-3, the coefficients associated with financial shocks, financial literacy, and the interaction term between financial shocks and financial literacy in Models 1-3 are similar as those estimated in Models 4-6.

Table D.1-1 Fixed-effect Poisson estimates of income shocks on depressive symptoms considering the effect of financial literacy

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Income large shocks	1.003			1.004		
	(0.12)			(0.14)		
Income large shocks * Financial literacy	1.029			1.037		
	(1.38)			(1.51)		
Income medium shocks		1.008			1.009	
		(0.49)			(0.50)	
Income medium shocks * Financial literacy		1.040***			1.040***	
		(3.00)			(3.04)	
Income small shocks			1.011			1.011
			(0.85)			(0.82)
Income small shocks * Financial literacy			1.030***			1.031***
			(2.92)			(2.98)
Financial literacy	0.979***	0.975***	0.972***	0.980***	0.975***	0.972***
	(-2.90)	(-3.45)	(-3.66)	(-2.86)	(-3.39)	(-3.62)
Health status	No	No	No	Yes	Yes	Yes
Other control variables	Yes	Yes	Yes	Yes	Yes	Yes

Notes: 1. Financial literacy is proxied by numeracy questions in Table D.1-1. The number of observations is 74,489. The number of individuals is 28,990. IRRs are reported in Table D.1-1. Data in Table D.1-1 are calculated based on waves 6, 8, 10, 12, and 14 of the HRS. Control variables in Models 1-3 include age, gender, race, marital status, educational attainment, employment status, region dummies, year dummies, household income, and all the time-unvarying covariates. Models 4-6 further control for health status. t statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table D.1-2 Fixed-effect Poisson estimates of wealth shocks on depressive symptoms considering the effect of financial literacy

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Wealth large shocks	1.033**			1.034**		
	(1.95)			(2.05)		
Wealth large shocks * Financial literacy	1.023			1.024		
	(1.61)			(1.63)		
Wealth medium shocks		1.035**			1.037**	
		(2.44)			(2.55)	
Wealth medium shocks * Financial literacy		1.008			1.008	
		(0.67)			(0.68)	
Wealth small shocks			1.044***			1.045***
			(3.38)			(3.50)
Wealth small shocks * Financial literacy			0.986			0.987
			(-1.38)			(-1.32)
Financial literacy	0.978***	0.979***	0.985***	0.978***	0.980***	0.986*
	(-3.04)	(-2.79)	(-1.86)	(-2.97)	(-2.72)	(-1.82)
Health status	No	No	No	Yes	Yes	Yes
Other control variables	Yes	Yes	Yes	Yes	Yes	Yes

Notes: 1. Financial literacy is proxied by numeracy questions in Table D.1-2. The number of observations is 74,489. The number of individuals is 28,990. IRRs are reported in Table D.1-2. Data in Table D.1-2 are calculated based on waves 6, 8, 10, 12, and 14 of the HRS. Control variables in Models 1-3 include age, gender, race, marital status, educational attainment, employment status, region dummies, year dummies, household income, and all the time-unvarying covariates. Models 4-6 further control for health status. t statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table D.1-3 Fixed-effect Poisson estimates of job losses on depressive symptoms considering the effect of financial literacy

	Model 1	**Model 2**
Job loss		
Involuntarily job loss	1.100	1.097
	(0.89)	(0.87)
Voluntarily job loss	0.883	0.877
	(-1.05)	(-1.11)
Job loss * Financial literacy		
Involuntarily job loss * Financial literacy	1.157*	1.152*
	(1.91)	(1.85)
Voluntarily job loss * Financial literacy	1.304***	1.307**
	(3.04)	(3.07)
Financial literacy	0.980	0.979
	(-1.38)	(-1.42)
Health status	No	Yes
Other control variables	Yes	Yes

Notes: 1. Financial literacy is proxied by numeracy questions in Table D.1-3. The number of observations is 30,082. The number of individuals is 15,825. IRRs are reported in Table D.1-3. Data in Table D.1-3 are calculated based on waves 6, 8, 10, 12, and 14 of the HRS. Control variables in Model 1 include age, gender, race, marital status, educational attainment, region dummies, year dummies, household income, and all the time-unvarying covariates. t statistics in parentheses. Model 2 further includes health status. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

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