THE DETERMINANTS OF THE TIMING OF RETIREMENT: A CROSS-COUNTRY COMPARISON

by

SHULIN DENG

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Department of Economics

Birmingham Business School

College of Social Sciences

The University of Birmingham

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ABSTRACT

To ensure fiscal stability in the face of an ageing population, it is essential to stimulate labour market participation among older people across the world. Early retirement could increase the burden of supporting the older generation in the society, while delayed retirement could potentially improve the wealth accumulation for individuals. This thesis aims to examine how the observed retirement situation reflects health status and wealth position among people aged 45 to 80. The sample countries cover Austria, Germany, Sweden, Spain, Italy, France, Denmark, Switzerland, Belgium, and China, with comparative analysis carried out.

The second chapter investigates early retirement in nine European countries using dynamic models to analyse longitudinal associations which were explored by linking health, wealth and working conditions of respondents in the previous wave with prospective labour market participation in the follow-up waves. The analysis is based on five waves of the Survey on Health, Ageing and Retirement in Europe (SHARE). The study comprises two parts. One part is based on the two-year dynamic model to predict premature retire two years later. Another part presents the health and wealth effects observed four years previously on early retirement behaviour in the current survey year. We find that severe health problems in the past few years can lead to a decrease in the participation rate of individuals in the labour market in Europe. Moreover, there is a strong negative relationship between net non-housing wealth, housing mortgage and early retirement. High debt burdens are less likely to stimulate

an early retirement. Furthermore, people who retire earlier than the state pension age are more frequently from the disadvantaged working environment.

Chapter 3 makes a comparison analysis before and after the 2007-2008 Global Financial Crisis by employing the same five waves and nine countries in SHARE dataset as of chapter 2. The study examines the associations of health status, wealth position, and pension income with delayed retirement for a cohort of people aged 65 to 80. This study delivers the evidence that a better situation in either mental or physical health shall widely promote the growth of the labour supply for those 65 to 80 years of age in old age in Europe. Additionally, those individuals with higher housing values and non-housing values can remain on old-age employment. Evidence has provided for Sweden, Denmark and France. Moreover, people with high pension benefits are less likely to extend their working life. Self-employment presents a significant factor in the extension of labour market participation into older age.

We next turn to a Chinese study in Chapter 4. The study does both longitudinal analysis and treatment effects. We pool all three waves of the China Health and Retirement Longitudinal Study (CHARLS) and do comparison analysis by regions. We estimate treatment effects in the Propensity Score Matching (PSM) section. We observe a strong negative association between diseases, poor health and labour market participation. Stroke, memory problems and mental health problems are the top three chronic diseases that could push respondents out of the labour market at an early age. By contrast, stroke, heart problems, diabetes are the top three diseases that reduce working life. A high level of pension income received suggests a lower rate of labour participation. Pension contributors are less likely to retire before compulsory retirement age. Furthermore, rural residents show higher retention rate in the labour market, compared to urban residents.

To my beloved mother, Xiaoping Wu

for her endless love, support and encouragement.

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LIST OF ABBREVIATIONS

AD	Alzheimer's Disease
ADL	Activities of Daily Living
ATET	Average Treatment Effect on the Treated
CES-D	Centre for Epidemiologic Studies Depression Scale
CHARLS	China Health and Retirement Longitudinal Study
CHNS	China Health and Nutrition Survey
CLHLS	Chinese Longitudinal Healthy Longevity Survey
CNY	China Yuan
CPI	Consumer Price Index
ERI	Effort-Reward Imbalance
ESeC	European Socio-economic Classification
EU	European Union
FRD	Fuzzy Regression Discontinuity
GBP	Pound Sterling
IADL	Instrumental Activities of Daily Living
IRA	Individual Retirement Account
IRS	Internal Revenue Service
ISCED	International Standard Classification of Education
NCMS	New Cooperative Medical Scheme

NRSPI	New Rural Social Pension Insurance
OECD	Organization for Economic Co-operation and Development
PSM	Propensity Score Matching
RMB	Ren Min Bi
SD	Standard Deviation
SHARE	Survey of Health, Ageing, and Retirement in Europe

CHAPTER 1 INTRODUCTION

This thesis comprises three empirical studies on retirement timing. The studies focus on residents in Austria, Germany, Sweden, Spain, Italy, France, Denmark, Switzerland, Belgium and China, who changed their labour force involvement in response to different health status and wealth levels over their lives in a finite-lived economy. Section 1.1 introduces the general background of the thesis. Section 1.2 outlines the subsequent chapters. Section 1.3 provides a contribution of this research to the existing knowledge base.

1.1 Background

1.1.1 The determinants of the retirement decision

Given an increasing life expectancy[1] and the looming Social Security crisis around the world, governments are grappling with a way to stimulate labour supply. Understanding the factors underlying retirement decisions are essential for assessing the role of assets allocation, social welfare and medical care systems in the labour market. A variety of institutions have undertaken pension reforms which have potential implications for the retirement behaviour of old workers. Disability insurance is a key feature which particularly relates to the group of people who retire earlier than standard

[1] Oeppen *et al*. (2002) present that, over the past 150 years, life expectancy at birth have increased at a rate of 2.5 years per decade in the developed countries. This linear trend is likely to continue.

retirement age in many countries. The exogenous health shocks could largely influence retirement decisions. Given eligibility criteria, agents could choose when to stop working and when to apply for pension and disability benefits. Wage income generates substantial inequality across older workers. Pension income is often uncertain before retirement. Standard assets, such as housing assets and financial assets, are valuable instruments to compensate the individual for the shortage from general wage income and maintain the preretirement living standard. Investors with sophisticated financial knowledge could participate in financial markets, obtain more from a well-diversified portfolio, save at higher rates and accumulate wealth by retirement (Neumuller *et al*. 2017). However, there exists heterogeneity in individual-specific wealth situations and skills. Individuals with larger debts may face difficulty in selecting the retirement age as they wish as they will have to service the debt in the future. The serious commitment to debt repayment will force them to continue working. Notably, the demographic changes associated with improving longevity have posed considerable social challenges in many developed economies.

1.1.2 The life-cycle model and retirement timing

In neoclassical theory, retirement is part of the life-cycle choice concerning wealth and leisure. Retirement and leisure time have a trade-off effect. The reduction of less accumulation in the pension account caused by early retirement can be compensated by high accumulated wealth. However, wealthier people with large debt need to be more cautious towards retirement as they need to generate income to finance debt. It will, in turn, incentivise people to work more.

The perspective on the life cycle can determine retirement decisions. In the phase of pre-retirement, individuals should have adequate net worth and have achieved their financial goals. Given the impending retirement procedure, individuals need to think about their wealth portfolio, whether loans need to be repaid, which type of lifestyle to lead, and how regular expenses will meet. At the stage in life, the proportion of portfolio in liquid assets tend to be small as the children should have started to accumulate their wealth and made a contribution to the family. Individuals need to consider the usage of illiquid assets, such as property, whether to downsize to a smaller house in order to compensate for the possible low pension income, and whether transfer to wealth to the next generation. In the retirement phase of the life cycle, capital should be only for contingencies, but not for regular needs. There should also have some growth assets like stocks and fixed income bonds to protect the family from inflation during the retirement years. The family should have an amount to meet the negative wealth shocks from the contingent events in the financial market. The pension income and its coverage will determine the corpus requirement.

The life-cycle model is critical to investigate the interaction between retirement decisions and health status, in association with the wealth situation. Individuals are different concerning health status, wealth conditions, their preference for intergenerational family transfers and demographic characteristics. A rational agent should maximise utility throughout life. Many previous studies have inquired the optimal retirement age and savings in response to changes in wealth circumstances (Chang 1991; Bloom *et al*. 2007; Kalemli-Ozcan *et al*. 2010). When considering health status in the life-cycle model, a utility function for optimal retirement decision combining with goods and leisure is obtained by Bloom *et al*. (2007). Their results emphasise the existence of the optimal retirement age when the interest rate equals the rate of time preference. Also, the retirement decision can be influenced by the net amount of intergenerational transfers. Parents who are near to the retirement age could choose to stay in labour market until they have strong willingness to transfer their net worth to the next generation through either lifetime gift or bequests. By examining 11 countries in the Survey of Health, Ageing, and Retirement in Europe (SHARE), Mudrazija (2014) presents a nonlinear pattern in the transition of net family support from parents to children across the adult lifetime. In general, the positive transfer in parent-child dyads decreases modestly until the advanced old age when the net family transfer decreases intensively. The magnitude of intergenerational transfers largely depends on cash flow needs from children and welfare-regime in the society. The net value transition starts later, and the negative relationship of transfer amount with parents' age is more modest in social democratic welfare-regime societies, while the net family transfer appears earlier, and the decline occurs abruptly in traditional welfare-regime countries.

Because the retirement age is not generally selectable by people in most countries, the factors which determine early retirement and delayed retirement could be hugely different. For example, out-of-pocket medical expenditure differs before and after retirement due to insurance coverage and social welfare programmes. Some health care expenditures are not available before standard retirement age, say 65 years in most countries. Whether insurance is contingent on working and health care can be received by individuals before retirement age has particularly important implications for labour market participation. Therefore, we apply the life-cycle model by integrating health functioning and wealth situation. We aim to find out how individuals' retirement decision varies under heterogeneous health status due to individual-specific wealth condition. The motivation for doing this is that retirement behaviours differ substantially as a result of health divergence due to both shocks and medical care coverage.

Moreover, we allow retirement behaviours to depend on wealth conditions. The reason for introducing wealth is that heterogeneity in health status is not enough to generate sufficient variation in retirement decisions. Our model also captures various demographic characteristics, such as homeownership, gender and age, to evaluate the disutility from work.

1.1.3 Retirement in Europe

While population ageing is a common feature across European countries, governments are seeking ways to encourage people to stay in the labour market for a longer time. The current statutory retirement age in most European countries is 65, with the increasing trend of some people extend their working lives beyond 65. Government programmes, notably in employer/occupational pension, disability pension and old-age pension, in most European countries, are very generous. The pension programmes create large incentives for early retirement once individuals meet eligibility criteria (Laun *et al*. 2016). Given large incentives built into Social Security systems, Laun *et al*. (2016) point out that some Europeans work as much as they can, which is very different with Americans. They make sensitivity analysis and explain this puzzle by suggesting that some endogenous factors which are outside their model have exerted an impact on labour supply. These factors are arose purely from incentives built into Social Security systems.

Social Security in most European countries still applies pay-as-you-go defined-benefit public pension system, although some countries are in the process of pension reform switching from the old pension system to pay-as-you-go defined contribution plan. For example, in the old Swedish pension scheme, the pension benefit is based on the highest 15 years in their lifetime earnings. Given the fact that wages tend to level off when individuals are in their 50s, this potentially reduce the incentives for remaining in the labour market when Swedes are near the retirement age. Also, the old pension scheme is sensitive to change in social demographics. The new system aims to address these issues. In addition to the regular pension, it is important to investigate health-related conditions (both health functioning and well-being dynamics), wealth situations (housing assets and non-housing assets), working environment and socio-demographic factors and predict the risk of retiring in the following years.

1.1.4 Retirement in China

In China, urban residents with formal working units can expect to receive pension benefits upon retirement but must retire at compulsory retirement age[2]. In particular, Chinese residents with a higher education background, no matter in agricultural *hukou* or non-agricultural *hukou*, generally work in government, institutions or state-owned firms. The types of working unit strictly follow national retirement pattern. Professors are allowed to extend the retirement age but must get permission from the human resource department[3]. Pension benefits for urban residents can provide financial support in retirement to some extent, while rural residents do not generally have

[2] By 2017, mandatory retirement age for men is 60, women working in while collar occupations and blue-collar occupations are consistent to a retirement age of 55. Since 2018, retirement age for women will extend 1 year every 3 years. Men will extend retirement age for 1 year every 6 years. The retirement age will reach 65 years for both men and women by 2045 (Chinese Academy of Social Sciences 2017).

[3] Professors who satisfied the certain conditions can apply to extend the retirement age. Men cannot older than 65, female cannot older than 60 (Organization Department of the CPC Central Committee and Ministry of Human Resources and Social Security 2015). The conditions are: (1) Healthy and can do normal work; (2) currently presiding provincial and ministerial level or above research projects; or (3) Ph.D. or master directors who are currently supervising Ph.D. or master students; or (4) subject or technology leader; or (5) key staff in special, key and cutting-edge discipline; or (6) no one has the ability to take over the work; or (7) persons that are highly demanded in remote areas and units where lack of professionals; (8) approved by supervising authority.

protection. Also, rural residents normally have lower income and less accumulated wealth throughout the life cycle (Kanbur *et al*. 1999; Ravallion *et al*. 2007). According to Giles *et al*. (2011a, b), a one per cent of population sample in 2005, 45.4 per cent of urban residents aged 60 years or above reported that the pension income is an important source of personal finance. By contrast, only 4.6 per cent of rural residents note an important role for pension income. However, 38 per cent of rural residents aged 60 years or above claimed that the majority of financial support is income from employment.

The stark differences in retirement decision between urban and rural residents reflect the diversity of wealth positions and pension schemes. Giles *et al*. (2011) estimate the Chinese employment rate by applying locally weighted regression (LOWESS) by age. They emphasise that Chinese rural residents are far more likely to continue working after the compulsory retirement age than urban residents. Based on the China Health and Retirement Longitudinal Study (CHARLS) pilot 2008, nearly 86 per cent of rural men aged 60 to 64 were still at work, while only 45 per cent of urban men in the same age range were in employment for at least one hour per week. For women in this age range, the number is 57 per cent in rural areas and 16 per cent in urban areas respectively.

1.2 Outline of the Thesis

The organisation of the thesis is as follows. Chapter 2 analyses longitudinal associations of health status in previous years on the observed current early retirement in nine European countries. We emphasise the different effect of housing assets and financial assets on the early retirement behaviour. Considering various adverse health conditions, employment status and demographic factors. We use two-year or four-year lag of housing assets, financial assets, health status and working situations as explanatory variables in two separate models. The explained variable is observed early retirement behaviour for the current situation. After adjusting with potential control variables, findings suggest that improving equalities in health functioning tends to maintain the ability of an ageing workforce. The results show that people who are suffering from severe mental health and physical health problems are more likely to retire early. Also, high effort in a job with low reward in return will push an old worker to retire early. Furthermore, our results provide a strong negative association between housing mortgage and early retirement in all cases. Finally, compared with those who work, people who exit labour market participation before the statutory retirement age appear to have a lower educational background.

Chapter 3 investigates the determinants of delayed retirement. The study applies the Survey on Health, Ageing and Retirement in Europe (SHARE) dataset and the same sample period from 2004 to 2016 as chapter 2. We include health conditions, pension income, housing equity, housing mortgage, financial equity, financial debt, and demographic factors as explanatory variables for the current situations. People who extend their working life between 65 and 80 years are defined as delayed retirement and set as an explained variable in this chapter. For comparison, we separate the analyses into two sections. In the first section, we distinguish possible financial crisis effect by applying two subgroups: (1) data before 2007 (waves 1 and 2); (2) data after 2008 (waves 4, 5 and 6). In the second section, we show the factors influencing retirement behaviour within each country by pooling five waves together. Based on the results, people who suffered adverse health condition are less likely to stay in the labour market when they reach the statutory retirement age. Additionally, high pension income dampens the incentives of delayed retirement. The results indicate that housing equity and longer working life have a positive relationship. By examining retirement behaviour in every single country, we verify that health status and pension income matter a lot to retirement behaviour, but the influences are heterogeneous in both significance and direction among the nine countries.

Chapter 4 provides the associations of retirement with health functioning, wealth status, pension schemes, demographic indicators and working situations in China. The sample members are aged 45 to 80. We use both longitudinal analysis and treatment effects in an empirical study. Given the default retirement age in China, this chapter separates the whole sample into two panels; one is the younger group which contains female respondents aged below 55 and male respondents aged below 60. The remaining members in the sample were assigned to the older group. In this chapter, we consider the labour force in both agricultural jobs and non-agricultural jobs, so long as the respondents are still contributing in the labour market. The definition of labour market participation is based on whether the respondent is currently working. Health functioning, wealth, pension schemes, homeownership, *hukou* location and demographic characteristics are the explanatory variables. The status of currently working is the explained variable in two panels. The baseline health functioning comprises chronic diseases, limitations and mental health problems. The study generates evidence that labour market participation is highly linked with poor health, *hukou* location and pension insurance. The significant effects are common in all cohorts.

All chapters apply the random-effects probit models to estimate the effect of explanatory variables on retirement timing. A conclusion, providing the summary of this empirical study, the implications of the findings and limitations of this thesis, together with proposed research areas worth further investigations, is given in Chapter 5.

1.3 Contribution of the Research

In the literature review, we analyse previous studies which examine retirement timing in association with health functioning, household income, job well-being and pension systems. The richness of our framework comes from modelling various health measurements in addition to wealth conditions do not present in previous papers. The health status applied in our framework is objective, which avoids potential bias in the retirement decision.

This research contributes to the existing literature as follows. In Chapter 2, for the first time, we evaluate the effect of health status, as well as housing assets and non-housing assets in a dynamic model using a European dataset across different countries and over two and four years. While population ageing is a common feature across European countries, given volatile financial market in Europe, it is essential to find out the extent to which a level of high housing mortgage or financial debt among older people with the prospective early retirement in the following few years.

In Chapter 3, we provide evidence that people in the same stratification of wealth act differently in the labour market across European countries. Both housing assets and non-housing assets produce a significant impact on delayed retirement decision. Higher housing mortgage will force people aged 65-80 years to continue working in many European countries. To our knowledge, such associations under the designation of a prospective comparison across a variety of European countries are not available in previous studies. We contribute to the existing literature in the following aspects. First, there is a lack of studies on retirement examining the effect of health problems, combining housing assets, in a single model. We put health and wealth variables in one single model to examine the impact on retirement decisions. The model aims to find out potential partial effect between health and wealth indicators. Additionally, most studies have been restricted to a single cohort or a single country. In our study, we undertake a comparative analysis for the pre-crisis period and post-crisis period, as well as cross-country analysis. Moreover, we investigate the combined effect of wealth sectors and health-related indicators on delayed retirement by including information, and further on a partial correlation of health status and wealth status in this former association.

In Chapter 4, we apply both longitudinal analysis and treatment effects on examining the associations between health functioning and working situations in mainland China. While heavy employment pressures on the younger generation and population ageing are two critical issues in the society, the Chinese government faces a question on how to improve the labour market participation among the mid-old aged population while not harm the benefit distributions for younger people. Therefore, the authorities need to look at the factors that influence the older generation the most and attempt to achieve a win-win outcome for both the government and the people. In this chapter, we examine the effect of specific treatments on labour market participation. The empirical analysis provides associations between specific ill health and retirement behaviour. The analyses complement the panel estimation in more details, as the method effectively reduce the selection bias, especially for those diseases which are fairly rare for certain individuals in a Chinese population.

Compared with previous studies, the novel feature of our study is again the integration of objective health status, pension insurance and wealth conditions in the analysis of labour market participation. While many of the ingredients of our model, namely chronic diseases, physical health status, mental health status, have been extensively explored separately. We address labour market issues by including these features with wealth situations in a single framework, which is extremely important for the model predictions.

CHAPTER 2 WHO RETIRES EARLY IN EUROPE? EVIDENCE FROM SHARE

Applying a dynamic structural model, we use both cross-sectional and panel data for nine European countries over the period from 2004 to 2016 to understand the determination of early retirement among residents aged 50 to 64 years old. The focus of the empirical study lies on the effects of poor health and heavier debt burden. The findings show a strong negative association between housing mortgage and early retirement in a two-year dynamic model. Severe health problems in the past few years can reduce labour market involvement in European countries.

2.1 Introduction

There is increasing life expectancy and faster demographic ageing in Europe, compared with populations in many other countries (Vaupel 2010). Consequently, the proportion of 'people at early old age', those aged between 50 and 64 years, in Europe has been continually increasing. This group of people is at the stage in the life cycle with a stable wealth portfolio but suffering considerable health impairment more generally (OECD 2010). This chapter aims to answer the effect of poor health on the increased probability of early retirement, considering outstanding debts. There are three aspects which update the existing literature. First, we use housing mortgage and financial debt as two independent variables in the model. Assets contain equity and liability. High-equity owners could lever up their total assets by raising larger debt than average-equity owners. High leverage and heavy outstanding debt can force people to work longer due to the commitment of debt repayment. Second, we use residential and financial assets to measure wealth rather than occupational incomes or salaries. People at pre-retirement stage face a considerable drop in human capital[4]. However, the accumulated wealth from investments, excluding salary, could reach a maximum at a mature period and are more stable. The value of the financial portfolio at the pre-retirement stage can better represent an individual's economic position. Third, the study measures potential partial correlation between economic positions and health-related status. People with low net worth are more likely in low occupational positions which generally require heavy physical demands. Such a situation could lead to large health impairment at early old age. Therefore, it is important to constructed multivariable regression equations and considered the partial correlation between wealth and health status.

Wealth positions differ among people aged 50-64. It is useful to investigate more precisely the economic position, socio-demographic and employment status of men and women who involuntary retire in their 'early old age' due to a change in health status or Social Security systems. Residents may keep staying in the labour market to accumulate additional pension entitlement if they predict an abrupt financial position

[4] Human capital is measured by discounting all future salaries back to today.

in retirement. The importance of pension income and economic position for older people provides an entry point for policymakers to maintain labour market involvement. Previous studies scaled gradient indicators on health conditions (Koukouli *et al*. 2002; Huisman *et al*. 2003; Rautio *et al*. 2005; Schoeni *et al*. 2005; Minkler *et al*. 2006; Ramsay *et al*. 2008; Wahrendorf *et al*. 2017). The scaled gradient indicators demonstrate the fact that people with low income are more likely those who undertake a heavy workload. Heavy physical demand, in turn, could impair the individual's health. These studies usually linked unidirectional characters of housing to the likelihood of retirement.

There are many studies relating to health functions. They purely employ health status as both a dependent and independent variables (Reinhardt *et al*. 2013). They investigated how large current health conditions can predict later impairment or disability. Health impairment is considered to have a partial effect on labour market participation. In this context, Avendano *et al*. (2010) and Haan *et al*. (2009) have worked out the determinants of inequality of health functions on retirement behaviour at early old age. Few retirement studies have adjusted for the stock of illiquid assets (i.e. housing assets) and liquid assets (i.e. financial assets) in empirical analysis.

The financial crisis is a shock in financial market. It impacted on household wealth and influenced individual's retirement planning entirely. The retirement plan breaks up at the point of the financial crisis. Both the equity market and the debt market reflect the effect of the financial crisis. The values of the assets have decreased dramatically after the financial crisis. People fail to meet the financial target after the financial crisis, which forces individuals to work longer and meet the financial demand in retirement again. On one hand, equity has received large drop in value. The devaluation of housing equity after the financial crisis drives a switch from a big house to a small one if the resident is not willing to pass their property to the next generation. On the other hand, people need to make a serious commitment to increasing their debts after the financial crisis. Agents who consider assets as preretirement income and use the assets as part of saving have to reschedule their retirement plan. Research into this topic could help to understand why some people delayed retirement and keep working in old age.

The remainder of this chapter is constructed as follows: Section 2.2 reviews previous studies on early retirement. In Section 2.3, we propose research hypotheses. Section 2.4 describes data source as well as target respondents used in SHARE. Section 2.5 presents the empirical model. Section 2.6 reports detailed information on key variables and control variables applied in this study. They are done for all subsequent groups. In Section 2.7, we describe sample statistics. In Section 2.8, we provide regression results. Section 2.9 contains discussions and comes to a conclusion based on the results.

2.2 Literature Review

Previous studies which have analysed labour market participation employed income, health status, work environment, socio-demographic factors, educational qualifications, partnership and gender (Hasselhorn *et al*. 2015). For example, some investigations assert that married women seem more likely to exit the labour market before state pension age than people who were not in a partnership (Lund *et al*. 2005; Kubicek *et al*. 2010; Majeed *et al*. 2015; Wahrendorf 2015). Additionally, people with a high education background and income are more likely to retire late (Komp *et al*. 2010). The existing literature on early retirement examine the effect of poor health and economic circumstances separately.

2.2.1 Health effect on early retirement

Adverse health condition could reduce labour market participation, for instance, people with chronic diseases, poor mental and physical health are more likely to claim disability pension and retire at early age rather than continue to work regardless of their ability (Harkonmäki *et al*. 2006; Van Den Berg *et al*. 2010; van Rijn *et al*. 2014; Virtanen *et al*. 2014; Leijten *et al*. 2015). Specifically, disability pension benefit is for people who are of working age, but permanently or temporarily unable to work due to physical or mental disability. It is distinct from normal welfare. The benefits from disability insurance will continue to be paid to claimants after they reach state pension age, although employees have not paid the premiums in full at earlier life.

Prior papers have argued that health status is the primary factor that determines the retirement decision (Quinn 1977). Many studies have created various health indexes based on the limitation of health or self-assessment health status (Cullinan 1979; Clark *et al*. 1980; Gustafson 1982). The use of these indexed has some shortcomings. A major concern is that health limitation may not have a long-term effect on health. The poor health status is probably only temporary. Self-evaluation of health are subjective, and interviewees may claim poor health status if they plan to reduce labour market involvement in the coming few months.

Furthermore, the workplace itself has an impact on labour market participation, for example, people working in an advantageous environment seem to have a longer working life. By contrast, people working in an unfavourable environment, combined with high physical demands (in particular, elementary manual jobs), are more likely to retire early (Lain *et al*. 2014). Also, much of the research has shown that psychosocial factors influence labour force status. These factors refer to high physical demands, low decision latitude and low rewards received in return (Blekesaune *et al*. 2005; Elovainio *et al*. 2005; Laine *et al*. 2009; van Den Berg *et al*. 2010; Siegrist *et al*. 2011; Robroek *et al*. 2013; Juvani *et al*. 2014; Schnalzenberger *et al*. 2014; Carr *et al*. 2015; Hintsa *et al*. 2015). Some recent empirical studies have raised concerns about the association of psychosocial work stress with disability (Reinhardt *et al*. 2013).

2.2.2 Wealth effect on early retirement

Previous studies on early retirement consider economic conditions using individual income or salary. Various studies relating retirement timing have investigated the effect of salary income on labour market participation at a point in time or working transitions between two points in time. The measures of income used have often been criticised. First, near-retirees are likely to estimate the income replacement ratio, which is measured by the ratio of retirement income and preretirement income. The adequacy of retirement income is essential to assess whether an individual can maintain a satisfied living standard in retirement (Purcell 2012). If income from pension, benefits, and social security cannot finance pre-retirement living standard, an individual could face difficulty to maintain the financial plan in retirement, which perhaps generates unexpected choices of labour force involvement. For example, workers with lower income typically need a higher replacement ratio than average-income workers as their spending on necessities such as food, clothing, living and transport occupy a large proportion of their income. Individuals with higher income could need a higher replacement ratio as well. This groups of people require substantial expenditures on leisure activities and recreation to maintain their living standard as experienced before retirement (Purcell 2012).

Over the past decades, many analysts have evaluated the replacement ratio using both administrative data and household-level surveys. Some studies use social security benefits to replace the income replacement ratio (Fox 1979, 1982; Grad 1990; Mitchell *et al*. 2006; Biggs *et al*. 2008). Others calculated the replacement ratio by considering both the Social Security system and pension benefits (Fox 1982; Grad 1990). A few studies attempt to use all source of income before and after retirement and examine total income replacement ratio (Butrica *et al*. 2012). Comparing the income replacement ratio across different studies is difficult because of differences in data and methods, even though some studies apply similar concepts, such as waged-indexed earnings or price-indexed earnings, in the calculation. Though the replacement ratio is a typical way to compare income before retirement with target income after retirement, a rational retirement planner should maximise the income from every asset when planning to leave the workforce.

People generally believe that wealthier individuals will choose to retire early. Based on utility maximisation, a high level of wealth is associated with more leisure time and less work. However, empirical evidence provided by Bloemen (2002) indicates a negative relationship between wealth and the transition out of employment, which is opposite to the prediction made by economic theory. In the economic theory, leisure is a normal goods. Income effect tends to dominate under a high accumulated wealth. The wealthier of a person, the more demands on leisure time and reduce the working time. Bloemen (2002) focuses on workers in the Netherlands aged 20 to 64. The possible explanation of this finding could be that wealth acts as a proxy for unobserved heterogeneity. Wealthier people could have favourable characteristics that will make them stay in the labour market. Bloemen (2002) tries various ways to incorporate unobserved heterogeneity, by allowing random effects, endogeneity of wealth, and initial conditions. Although these efforts reduce the positive association of wealth with a longer working life, it remains positive (Bloemen 2006). Bloemen (2006) considers that young adults normally have insufficient wealth to finance necessities of life and still have a long way to go until retirement age, say, 65. It is necessary to accumulate more wealth and get ready for retirement (Bloemen 2006). Bloemen (2006) explores the wealth impact on an early exit from the labour market in the Netherlands among the elderly. The study indicates that individuals with high level of wealth and favourable pension arrangement will be unlikely to work longer. However, wealthier people with heavy loans reduce the value of assets. The commitment debt servicing in the future induces delayed retirement. Therefore, our study looks at net wealth and debt.

2.2.3 Dynamic structural models in early retirement study

The previous studies aim to predict workability in later years conditioning on current income and psychosocial status. Most analyses use cross-sectional samples. They were also limited to a single country or cohorts and often recruited specific respondents during midlife. Our study adds to the existing literature by using data collected from five waves and nine countries of SHARE, with comparative analysis carried out. We measure economic circumstances of an individual by using the value of stock of housing assets and non-housing assets.

Our research constructs a life-cycle model of the early retirement and examines the extent to which the wealth accumulation and health situations with observed at-retirement behaviour or subsequent-to-retirement behaviours in the following two years or four years among people aged from 50 to 64 years old. The accumulated wealth amount and, also, health measurements, employment status, and other factors are likely to affect the retirement decision. The early retirement is observed in a contemporaneous year. It avoids the health status being affected by ex-post rationalisations of early retirement because health-related variables are collected from pre-retirement periods.

2.2.4 Contribution

Our study is in the light of the work made by Reinhardt *et al*. (2013). The results in Reinhardt *et al*. (2013), exploiting SHARE data from 11 European countries, demonstrate that later disability is partially correlated by low socioeconomic status and adverse working environment. Our study contributes to the growing literature in three parts. First, the study highlights the effects of outstanding debts on early retirement. Second, the study uses property values and financial assets in measuring wealth status and examine the partial effects of wealth and health conditions on early retirement. Third, the study is dynamic and considers previous values of variables on the early retirement decision. The approach can figure out potential delayed effects from poor health.

2.3 Hypotheses

We use this section to present four hypotheses which are examined in this chapter. According to the life-cycle model, the ratio of retired people to working people will increase if people live longer. Early retirement induces the loss of wage income. However, a high level in wealth could compensate for the shortage of pension income and smooth consumption over time. The asset accumulation enhances the ability to choose early retirement and make pension claiming less pronounced. Higher wealth leads to less working years if the intertemporal elasticity of substitution in real wage with respect to consumption is less than unity, and the market is complete (assuming workers are risk-averse) (Bloom *et al*. 2007).

In our framework, we quantify the impact of wealth profiles on observed early retirement. Agents expect a hump-shaped pattern to wage income and a decreasing growth rate of income over the life cycle. Higher property value or financial assets could reduce working years if the agents have no debt and aim to use the value of the assets to fund the retirement.

Hypothesis 1*: A high accumulated wealth should positively correlate with early retirement.*

An increase of life expectancy increased agents' budget set. An enlarged wealth accumulation generates "income" effects, and hence increases agents' utility. In contrast, the increased life expectancy allows agents to finance their mortgage or debt with higher leverage. The equity holding effect in the retirement decision could be offset by a large debt to service. People could use equity as collateral to apply for a mortgage and loan. Debt overhang reduce the actual value of the overall assets in a household and the perspectives on future consumption (Alter *et al*. 2018), which in turn, changes the retirement decision. From the demand point of view, the ramifications of the financial structure characterise saving plans and retirement behaviour in old age. Given eligibility criteria, a high debt burden will dampen the incentives of early retirement.

Hypothesis 2*: A large outstanding debt should be associated with less likelihood of early retirement even if individuals have high wealth accumulation.*

Individuals with an adverse health conditions should opt for early retirement. Over the past two centuries, research in the US has shown that the average age of incidence of ill health increases proportionately with an increase in life expectancy (Fogel 1994, 1997; Costa 2002). By contrast, a declining health can occur at near retirement age (Bloom *et al*. 2007). A poor health status reduces both labour productivity and utility of labour. However, associated with an increase of lifespan, improved health is also expected to have happened; in other words, the quality of life is improved, and people are living longer. The age that symptoms of infirmity, chronic diseases, or other disability have been postponed to a later age such that the illness period at the later stage of life is compressed (Fries 1980). We examine the impact of rising morbidity on retirement if people are in poor health.

Hypothesis 3*: There should be a positive relationship between adverse health and early retirement.*

Bloemen (2006) provides the evidence of a positive relationship between liquid wealth and the early job exit. So far, there is little empirical evidence on the role of housing assets in the retirement decision. Housing is usually used as long-term investment with inflation-hedging capabilities. Non-housing assets are generally short-term investments and realise gains quicker. Therefore, benefits from non-housing assets face heavier taxation and value deduction than housing assets in the short run. People are less likely to dip into capital at old age and face contingent event in the retirement phase.

Hypothesis 4*: Housing assets and financial assets could have heterogeneous impacts on early retirement. A higher housing value should associate with larger probabilities of early retirement, whereas non-housing assets and probability of early retirement should have a negative association.*

2.4 The Data

SHARE is a panel database designed to provide broad information on retirement, wealth, health, working conditions and well-being dynamics of people aged 50 and above in selected countries in Europe (Börsch-Supan *et al*. 2005). The dataset consists of six waves by 2016, including a retrospective Survey (SHARELIFE), with ongoing data collection undertaken every two years. The first wave covered information from 2004 to 2005 for 11 countries (Austria, "AT[5]"; Belgium, "BE"; Denmark, "DK"; France, "FR"; Germany, "DE"; Greece, "GR"; Italy, "IT"; The Netherlands, "NL"; Spain, "ES" ; Switzerland, "CH" and Sweden, "SE"). Two new countries (The Czech Republic, "CZ" and Poland, "PL") joined in wave 2. Four new countries joined SHARE in wave 4 (Estonia, "EE"; Hungary, "HU"; Portugal, "PT" and Slovenia, "SI"), while Greece and Ireland left SHARE at this stage. SHARE wave 5 covers one new country: Luxembourg ("LU") and three countries left, these being Poland, Hungary, and Portugal. In SHARE wave 6, one new country, Croatia ("HR") joined, while the Netherlands left. In contrast to all other waves, wave 3 (as known as SHARELIFE) contained respondents' previous lives retrospectively, being a separate assessment with limited information on current data. The dataset employed in this study is the five waves in the Survey of Health, Ageing and Retirement in Europe (SHARE Release 6.0) (Börsch-Supan *et al*. 2013). The overall panel data contain 600,235 observations

[5] Country-specific variables contain the short country code as prefix, e.g. "AT" for Austria.

from all countries. We use balanced panel data which contains all countries observed in all time frames. The choice of balanced data depends on frequency and the reasons for missing data. The characteristics of SHARE cannot get rid of additional disturbances from the missing data being random. In other words, the exogeneity assumption cannot hold in unbalanced data, which results in a biased sample data. Also, the frequent missing data generates considerable loss in efficiency, which can significantly reduce observations (Baltagi 2005; Cameron *et al*. 2010). Moreover, since most of the previous studies are only focus on a single wave or cohort, this study aims to look at the multi-dimensional path, including both longitudinal information and cross-sectional variables. Thus, this study selects nine countries which involve in 5 waves all the time. Overall, the panel study in this research uses data collected from nine countries: Austria, Germany, Sweden, Spain, Italy, France, Denmark, Switzerland, and Belgium, which participated in five waves (wave 1, wave 2, wave 4, wave 5 and wave 6). Table 2A.1 contains details on the construction of the relevant variables in the analysis. It results in a total number of 23,571, with 47.58% men and 52.42% of women. For two-year dynamic model (i.e. early retirement prediction in two years), the observations are 22,702. For four-year dynamic model (i.e. early retirement prediction in four years), the total observations are 8,689.

In SHARE, data collection of each wave is based on a representative sample of households. Age-eligible respondents are aged 50 or older in each household (wave 1 covered all age-eligible persons in each sampling household; wave 2 only selected one age-eligible person per sampled household). All eligible respondents who participated in any previous SHARE wave are sampled in the longitudinal data.

Regarding household participation in SHARE, the household response rates show considerable large variation across countries (Bergmann *et al*. 2017). The differences are chiefly caused by survey agency settings and the sampling framework. For example, Sweden and Denmark chose stratified simple random selection, while the sample in Germany, Italy, Spain, France and the Netherlands was drawn by multistage sampling selection by region. Survey agencies in Greece, Austria, and Switzerland chose the telephone directory as the contact method (Alcser *et al*. 2005). Also, the change of survey institutions, legal restrictions for refusal conversion, as well as general survey circumstance can lead to different response rates (Kneip *et al*. 2015; Loosveldt *et al*. 2016; Bergmann *et al*. 2017). In SHARE, wave 1 contains information from 28,517 respondents, where the average household response rate is 59% for the whole sample. The range is from 40.3% in Belgium to 97.6% in France, with rates above 50% in 10 out of 11 countries. Following the same calculation method, the average household response rate across the country in wave 2 is 58%, ranging from 35.7% in Sweden to 95.3% in France. For the new countries in wave 4, the response rate was 58%, with 77% of the sample countries have a response rate of 50% or above. Notably, survey participation has declined in general over the past. Therefore, there is an attrition response rate of 47% and 49% in wave 5 and wave 6, respectively. In spite of this, most of the rates in SHARE are consistent with or above the average level of comparable European surveys in the same timeline.

Because we are interested in a panel study, it is important to consider the retention rate. Only if respondents remain in the survey, it can be possible to learn their particular ageing processes and the way they alter their behaviour as the environment changes. The average wave-to-wave retention rates (retention wave 1-2, wave 2-3, wave 3-4, wave 4-5, wave 5-6) for nine sample countries in this study are 76% in Austria, 82% in Belgium, 84% in Denmark, 74% in France, 73% in Germany, 84% in Italy, 82% in Spain, 76% in Sweden and 84% in Switzerland. The number of excluded respondents who missed one or more waves but were brought back into the sample. As can be seen, SHARE has done well on keeping former respondents who have participated in previous waves. It is worth noting that the attrition rate might influence sample structures, as a certain group of people may be more likely to drop out of the sample than other groups. Fortunately, previous analyses made by Bergmann *et al*. (2017) have demonstrated that the attrition bias in SHARE is relatively small. They found that only the oldest respondent appears to have a slightly higher probability to drop out, probably a mortality problem rather than severe bias. Regarding our study, which investigates labour force participation among people aged between 50 and 64, attrition will not be treated as an issue[6].

2.5 The Empirical Model

2.5.1 Model outline

In this study, we use dynamic models based on the work made by Hintsa *et al*. (2015) who examine higher effort-reward imbalance (ERI) and lower job control associating early exit from the labour market. The work used wave 2 in English Longitudinal Study of Ageing (ELSA) as base year and the follow-up wave 5 to measure working status. Our study applies both two-year and four-year dynamic models to measure the change of health status. The fact that diseases have characters of delay, recent change in health status could take time to be diagnosed or put into effect in patients' life. Two methods are useful for robustness checking and get rid of potential biases in sample selection.

We use comparable variables to test the direct associations of health functioning, level of wealth, well-being in the job, employment conditions and socio-demographic with labour market participation at early old age. Reinhardt *et al*. (2013) proved that low socioeconomic position and chronic stress at work will increase the level of disability two years later. Considering this, we expect to figure out a positive relationship

[6] More details about SHARE and its methodology can be found online. Online available: www.share-project.org.

between a poor health status and higher possibilities of early retirement. Meanwhile, we apply all control variables used in the work of Reinhardt *et al*. (2013). The control variables are for controlling individual characters in health functioning. Also, our study will use wealth status as a key variable to explore its impact on early retirement. It is because that people with high level of wealth will unlikely to retire early (Bloemen 2006). However, we adjust the wealth status into four variables and expect to give the evidence that high debt burden will reduce the possibilities of early retirement.

2.5.2 Regression model

We present estimates of three regression models, for early retirement, focusing on debts and health-related status.

$$\begin{aligned} Eretired_{it} = {} & \alpha_0 + \alpha_1 Housewealth_{it-1} - \alpha_2 NHwealth_{it-1} + \alpha_3 Mortgage_{it-1} \\ & + \alpha_4 Debt_{it-1} + \alpha_5 Homeownership_{it-1} + \alpha_6 Education_{it-1} \\ & + \alpha_7 Marriage_{it-1} + \alpha_8 \boldsymbol{X}_{it-1} + \omega_{it} \end{aligned} \tag{1}$$

Equation (1) focuses on the wealth effect on early retirement. All control variables have presented in the work of Reinhardt *et al*. (2013). The control variables are for adjusting demographic information, including homeownership, gender, age, marital status, and educational background. Subscript *i* denotes individuals, *t* denotes current survey year, and *t-1* denotes last survey year. *Eretired* takes value 1 for people aged between 50 and 64 who have retired in the current wave but worked in the previous wave, and 0 otherwise. *Housewealth* is net housing assets. *NHwealth* estimates the value of net non-housing assets. *Mortgage* represents outstanding repayment in the main residence. *Debt* is outstanding financial repayment excluding mortgages. *Homeownership* estimates the ownership of a house. *Education* measures the education level. *Marriage* estimates marital status. ***X*** is a vector of cohort characteristics which contains demographics, including age and gender. ω is the residual term containing time and country fixed effects.

Specifically, α_1 shows the association of net housing values and the likelihood of early retirement. α_2 measure the wealth effect of net financial assets on early retirement. Based on the economic theory on utility maximisation, α_1 should be positive (hypothesis 1). α_2 should be negative, which corresponds to the findings made by Bloemen (2006) (hypothesis 2). Based on the arguments made by Alter *et al*. (2018), the divergence in the directions of α_1 and α_2 shows the different effects of net housing assets and net non-housing assets on early retirement (hypothesis 4). α_3 *and* α_4 are of particular interests in the analyses. The coefficients demonstrate outstanding debt effects out of total wealth on early retirement decision. Both α_3 *and* α_4 should show positive associations for the hypothesis 2 to hold.

$$Eretired_{it}=\beta_0+\beta_1 Depression_{it-1}+\beta_2 Disability_{it-1} +\beta_3 Lowcontrol_{it-1}+\beta_4 higheri_{it-1}+\beta_5 Homeownership_{it-1} +\beta_6 Education_{it-1}+\beta_7 Marriage_{it-1}+\beta_8 \boldsymbol{M}_{it-1}+\mu_{it} \qquad (2)$$

The focus of equation (2) lies on the health effect on early retirement. *Depression* measures a mental health problem and *Disability* represents a physical health problem. *Lowcontrol* and *higheri* measures “control” indicator and ERI separately, which demonstrate stress at work. *Homeownership* estimates the ownership of a house. *Education* measures the education level. *Marriage* estimates marital status. ***M*** is a vector of cohort characteristics which contains demographics, including age and gender. μ is the residual term containing time and country fixed effects.

Particularly, β_1 and β_2 measure health effect on early retirement. Given the analyses made by Fogel (1994, 1997), Costa (2002) and Bloom *et al*. (2007), we expect both β_1 and β_2 presenting positive signs which predict a positive association between poor health and early retirement (hypothesis 3).

$$\begin{aligned} Eretired_{it} = {} & \gamma_0 + \gamma_1 Housewealth_{it-1} + \gamma_2 NHwealth_{it-1} + \gamma_3 Debt_{it-1} \\ & + \gamma_4 Health1_{it-1} + \gamma_5 Health2_{it-1} + \gamma_6 Homeownership_{it-1} \\ & + \gamma_7 Education_{it-1} + \gamma_8 Marriage_{it-1} + \gamma_9 \boldsymbol{Z}_{it-1} + \varepsilon_{it} \end{aligned} \qquad (3)$$

In equation (3), we combine the effect of wealth position and health indicators in one equation and test the potential partial correlation between wealth and health factors. *Debt is* a vector which covers two dimensions. One is outstanding mortgage on the main residence, the other one is outstanding financial debt excluding mortgages. *Health1* is a vector to cover mental health problem and physical health problem. *Health2* is a vector which measures stress at work, including “control” indicator and ERI. *Homeownership* estimates the ownership of a house. *Education* measures the education level. *Marriage* estimates marital status. ***Z*** is a vector of cohort characteristics which contains demographics, including age and gender. ε is the residual term containing time and country fixed effects.

If the variables for wealth and health are independent with each other, and the statistically significant results in Equation (1) and Equation (2) are robust, coefficients γ_1, γ_2, and γ_3 should consistent with the signs and the magnitudes of coefficients α_1, α_2, α_3 and α_4 in Equation (1), and coefficient γ_4 should consistent with coefficients β_1 and β_2 in Equation (2).

Additionally, women or people who are married seem have higher probability of reducing working life than men or people not in a partnership (Lund *et al*. 2005; Kubicek *et al*. 2010; Majeed *et al*. 2015). High educational background and advantaged economic status are associated with longer employment histories (Komp *et al*. 2010). Therefore, we expect α_6 to be negative, α_7 to be negative for those people not in a partnership. People are more likely to reduce working time when they age (Nikolova *et al*. 2014). We should expect the sign of age to be positive in Equation (1) to Equation (3).

2.5.3 Probit regression model

We estimate random-effect Probit models using dynamic multivariable dimensions. First, a Probit model allows for controlling random effects. We use Probit model with a random intercept to predict the likelihood of early retirement for each respondent nested in countries (Skrondal *et al*. 2010). The procedure allows for the variation in constant terms across countries which exploit the fact that the results for our equation accurately adjust country affiliation (Wahrendorf *et al*. 2017). It is essential for our analyses because we can focus on individual predictors while controlling for country-specific characters. Second, the dependent variable in our equation is binary. A Probit model is a specification for a binary response model estimating the probability that $y = 1$ as a function of the independent variables.

$$P = \Pr[y=1|\mathbf{x}] = F(\mathbf{x}'\beta) \tag{4}$$

For the Probit regression model, $F(\mathbf{x}'\beta)$ is the cumulative distribution function of the standard normal distribution, where

$$F(\mathbf{x}'\beta) = \Phi(\mathbf{x}'\beta) = \int_{-\infty}^{\mathbf{x}'\beta} \phi(\mathrm{z})\mathrm{dz} \tag{5}$$

The predicted probabilities are limited between 0 and 1.

This study applies a dynamic panel model with lagged observations of health status, wealth and demographic conditions on the probability of observed early retirement in a contemporaneous year.

2.6 Variable Selection and Creation

2.6.1 Respondents

In this study, respondents are restricted to people aged from 50 to 64 for both men and women. The sample includes people who reported their job situation as "retired", "permanently sick or disabled" and "homemaker"[7]. Each respondent was coded only

[7] We have no doubt there are various routes of early exit from labour market in SHARE. In this study, we merge different exit routes and simply name it "retirement" in the later section.

once among all options in each wave. We excluded people aged 65 or above because the general statutory retirement age is 65 years in the EU15 states (Austria, "AT[8]"; Belgium, "BE"; Bulgaria, "BG"; Croatia, "HR"; Cyprus, "CY"; Denmark, "DK"; France, "FR"; Germany, "DE"; Great Britain, "GBR"; Luxembourg, "LU"; Netherlands, "NL"; Poland, "PL"; Romania, "RO"; Slovenia, "SI" and Spain, "ES")[9].

2.6.2 Measurement

2.6.2.1 Sample construction

This study analyses the determinants of early retirement, which is believed to be caused by health-related status and the level of wealth. To construct our sample, we use individuals appearing in any of waves in wave 2 through wave 6 in the age range of 50 and 64 who report "retirement" as job situation. Then we check the employment status of the same individuals in the previous waves (i.e. two years ago or four years ago[10])[11]. Therefore, we need to observe individuals' characteristics in the past. We select a group which consists of respondents who were in the labour market either as

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[8] Two upper case letters in double quotation marks refer to the short country code, e.g. "AT" is for Austria.
[9] More details about EU retirement ages can be found online. Retirement age, 2017. Online available: www.etk.fi/en/.
[10] In the later section, we name the two panels with two-year dynamic model and four-year dynamic model respectively.
[11] For instance, in two-year dynamic model, the definition of early retirement bases on retirement status in wave 6 and wave 5. Respondents aged from 50 to 64 years old who exit from the labour market in wave 6 but was in employment in wave 5 were classified into "early retirement" category. Explanatory variables, such as the level of housing asset, the level of the non-housing asset, characteristics of the working environment and health status were assessed at wave 5, and so on. In four-year dynamic model, explained variable, that is, early retirement, bases on the employment status in wave 6 and wave 4. The explanatory variables were assessed at wave 4, and so on.

employees or self-employees and have reported wealth and health status in previous waves. The data consists available information of all individuals. Once an individual lacks information for retirement status in the contemporaneous survey, they were excluded from our sample.

2.6.2.2 Early retirement

In our study, the explained variable measure labour market transitions from "employment" to "retirement" over two years or four years in two panels, respectively. The explained variable "early retirement" is defined based on three conditions: (1) in the age range of 50 to 64 when retired; (2) retired in any of the survey waves; (3) in employment in the previous wave or two waves ago. The criteria are applied uniformly across all sample waves. As described above, the participants were restricted to those aged 64 years or younger. People retired in the current wave but worked in the previous wave were included in the "early retirement" category. The reasons for not working at the current wave in our sample were retired from their own work (approximately 76%), permanently sick leave (approximately 11%) or homemaker (approximately 13%). Participants grouped as retired from own work includes semi-retired, partially retired, early retired and pre-retired. Permanently sick leave contains people who are partially disabled or partially invalid. Homemaker covers those respondents who were looking after the home or family or looking after grandchildren but had previously been working. If respondents did not fit in any of these categories, they were defined as “others”. In particular, respondents who selected that unemployed best describes their current employment status were exclude from our sample as this study only concern those people who quit the labour market permanently. The participants who were defined as working in previous waves include employed or self-employed. It covers people in paid jobs or unpaid family business work but receiving other benefits, for example, dividends. Activities without pay, such as voluntary work, are not included.

2.6.2.3 Wealth factors

We construct discrete variables in wealth. Nevertheless, the inherent feature of a model with discrete variables is that the retirement behaviour responses to wealth conditions may be larger than with continuous values. Our models nest individuals in countries. In other words, the effect of wealth is conditional on an individual’s state variables. The rate of convergence in each estimator declines with the number of continuous explanatory variables. In empirical models, with more than two continuous variables, the estimator of the regression equation can be quite imprecise unless the number of observations in our dataset is very large (Aguirregabiria 2010). In applications, discrete indicators in income and wealth are introduced as proxy variables of socioeconomic position (Lynch *et al*. 2000; Reinhardt *et al*. 2013). We would, however, argue that given asymmetry in economic growth and the value of money across countries, the assets are well approximated by discrete values. The wealth indicators specified by discrete variables give good of a fit across chosen sample countries.

Four variables illustrate the wealth circumstances: net housing values, net non-housing values, mortgage and debt. Net housing value is calculated by summing up the value of the main residence and the value of other real estates net of mortgages or loans on the properties. Net non-housing value covers both financial and fixed assets[12], including the value of their own share of the business, the value of individual retirement account (IRA) and other long-term savings, the value of bonds and equities, the value of the current account and savings account, excluding financial debt. The survey only contains mortgage information on the main residence. Therefore, housing mortgage refers to the mortgage on the main residence. Debt refers to all debts outstanding, excluding mortgages or money owed on land, property or firms. In particular, calculations of net housing values and net non-housing values are at the household level and based on the perceived value of the property sold at the time of the interview. Both housing value and non-housing value were calculated by summing up various elements of properties or fixed and financial assets that were declared in each questionnaire. In case of missing values in any component, data were imputed (Paccagnella *et al*. 2005). We dropped the symmetrical 1% outliers for non-housing assets. In this chapter, we further calculate wealth terciles (i.e. low, medium, high) for both housing assets and non-housing assets. Due to different wealth circumstances across nine countries, the category is sorted by country to avoid any selection bias.

[12] For simplicity, we name it "non-housing asset" in the later sections.

Because we are concerned about early retirement, the level of wealth is derived from accumulated household wealth rather than salary income, more appropriate for people who leave the labour market before state pension age and so lose income from employment. All money-based values are indexed with CPI 2010 (2010 index points=100). After controlling four variables in wealth status, the observations for two-year dynamic model are 23,571. For four-year dynamic models, the observations after controlling wealth status are 8,470.

2.6.2.4 Well-being in job

Stress at work has attracted great concern in the past decades. Many studies have examined its significant impact on health (Cooper 1998; Dunham 2001; Perrewe *et al*. 2002; Landsbergis 2003). Based on the primary questionnaires, the measurements of well-being in employment are based on two dimensions. They are two noteworthy approaches for investigating stress at work: the demand-control model (Karasek *et al*. 1990) and the effort-reward imbalance (ERI) model (Siegrist *et al*. 2004). The demand-control model is defined to measure stress at work. It identifies psychosocial work-based stress by looking at job task profile where jobs with high quantitative demands in combination with low task control are considered stressful. Another prominent model, the effort-reward imbalance model (ERI) focuses on the working environment. It measures low rewards received in compensation for a high degree of effort spent at work. Rewards include benefits, reputation and promotion opportunities. The model claims that high effort put in at work and low rewards in return can generate strong psycho-biological stress and bring more negativity into working lives. This lack of reciprocity may generate long-term negative effects on health. The situations characterised in the two models were assumed to cause arousal of the autonomic nervous system and lead to an associated neuroendocrine response. These can contribute to the development of subsequent stress-related diseases (Perrewe *et al*. 2002).

These two models cover different, but equally relevant, aspects of the occupational environment, where low control and lack of rewards matter most. Due to the different disciplinary measures applied in the two models, it is not possible to cover the full information of the two models in one questionnaire. Therefore, SHARE applies a simplified version according to the original frames of the two models. It covers the core elements of the two models, and the information is collected based on psychometric properties. Regarding the demand-control model, SHARE uses control rather than demand at work as the core dimension. It is based on the evidence of inconsistent results produced by the interaction of 'control' multiplied by 'demand' (Marmot *et al*. 2006). Also, 'control' has been tested to have the highest power of prediction in potential retirement behaviour (Marmot *et al*. 1997). Following several published papers, we use a sum-score indicator of two Likert-scale elements to measure 'low control' (see Table 2.1). Each element contains four options from “strongly agree” to “strongly disagree”. The value 1 represents “strongly agree” to 4 for “strongly disagree” for positive questions such as “I have an opportunity to develop new skills”, and the numbers are reversed from 4 for “strongly agree” tapering off to 1 for “strongly disagree” for negative questions such as “I have very little freedom to decide how I do my work”. The score range of 2 to 8 with higher values indicating lower control at work. For comparison, we rescale the “control” indicator to a range of 1 to 4 and create a binary variable to measure ‘low control’. Respondents whose score fall into the upper terciles in corresponding countries are defined as ‘low control’ (Dragano *et al*. 2011; Siegrist *et al*. 2011).

Regarding the effort-reward imbalance (ERI) model, ‘effort’ is measured by 2 out of 5 items, ‘reward’ is assessed by 5 out of 11 items (see Table 2.1). All selected items are based on the original questionnaire for psychometrical study (Siegrist *et al*. 2004) or its abbreviated version (Leineweber *et al*. 2010). ERI is computed for corresponding respondents using a formula: *e/r*, where *e* is valued by the sum score of the ‘effort’ items. The denominator gives the sum score of the ‘reward’ items (Peter *et al*. 1998; Siegrist 2002). All items describe participants’ present (main) job if they are currently working in the corresponding survey year, or the last job before retiring if they have retired. The effort scale is consistent with the ‘control’ indicator, with a higher score indicating more effort. For the reward indicator, a score of 4 is assigned to “strongly agree”, and 1 is for “strongly disagree” for positive questions such as “I receive adequate support in difficult situations”. For negative questions such as “My job promotion prospects/prospects for job advancement/job promotion prospects are poor”, the scores are reversed from 1 for “strongly agree” and 4 for “strongly disagree”. Therefore, for the reward scale only, a higher score demonstrating a better reward in return. We then rescale the sum score of both ‘effort’ and ‘reward’ by dividing the number of categories in each session. After taking the ratio, we finally get an ERI ratio ranging from 0.25 to 4 where lower values indicate lower effort and higher reward, a relatively favourable working environment. A ratio above 1 means that the reward does not compensate the high effort spent. Again, respondents whose score is located in the upper terciles of a specific country are considered to have strong psychometric stress at work, defined as 1 in a binary indicator for people scoring in upper terciles (Dragano *et al*. 2011; Siegrist *et al*. 2011). The two measurements on ‘control’ and ERI are in line with several published studies either on mental health (Siegrist *et al*. 2002; Wahrendorf *et al*. 2017) or on early retirement (Hintsa *et al*. 2015). The observations drop to 4,120 for two-year dynamic model in pre-crisis period and 14,311 in post-crisis period. For four-year dynamic model, the observations after controlling wellbeing in job are 8,007. The full list of ERI items is presented in Table 2A.2.

Table 2.1: Items measuring psychosocial work stress

Dimension	Item
Control	1. I have very little freedom to decide how I do my work.
	2. I have an opportunity to develop new skills.
Effort	3. My job is physically demanding.
	4. I am under constant time pressure due to a heavy workload.
Reward	5. I receive adequate support in difficult situations.
	6. I receive the recognition I deserve for my work.
	7. Considering all my efforts and achievements, my salary is/earnings are adequate.
	8. My job promotion prospects/prospects for job advancement are poor.
	9. My job security is poor.

Note: The text given to the interviewees are as follows: "Please look at the card. Regarding your present job/the last job we would like to know whether you strongly agree, agree, disagree or strongly disagree with the following statements."

2.6.2.5 Emotional health status

In SHARE, emotional health or well-being in daily life is measured by the EURO-D[13] scale. The generated health variables in SHARE provide internationally standardised coding of EURO-D items. The full scale was incorporated into the dataset directly. The EURO-D scale contains 12 symptoms: depression, pessimism, suicidality, guilt, sleepless, interest, irritability, appetite, fatigue, concentration, enjoyment and tearfulness. The respondents were asked "How you feel about things that happen around you" on each contributing item as being present in the last month. Participants need to select yes or no for each question. We consider all 12 items and give a value 1 for yes and 0 for no, summing up the total scores for the 12 items. We use a cut-off point of 3 symptoms to identify the people who are suffering severe depression, an

[13] EURO-D scale is initiated by European Union for comparing depression symptoms in European countries (Prince *et al*. 1999).

evaluation method verified as valid and uniform score of depression severity in factor-analytic studies across Europe (Prince *et al*. 1999). We tested internal consistency reliability across the 12 items by using Cronbach's Alpha. Within the sample, the scale reliability coefficients are 0.8 in wave 1, 0.82 in wave 2, 0.82 in wave 4, 0.8 in wave 5 and 0.72 in wave 6. The coefficients emphasise that the EURO-D 12-item scale is conceptual relevant.

2.6.2.6 Physical health status

Concerning physical health, the measurement is based on the limitations of doing living activities. The interviewers were asked to select ten items (see Table 2.2) based on the question "Whether you have any difficulty doing each of the everyday activities on this card. Exclude any difficulties that you expect to last less than three months." Respondents could have multiple selections on these ten symptoms. Based on the information provided, a binary dummy variable equals 1 if the respondents had more than two difficulties in mobility as having a functional limitation (Wahrendorf *et al*. 2017).

Table 2.2: Physical limitation symptoms

Item
1. Walking 100 meters
2. Sitting for about two hours
3. Getting up from a chair after sitting for long periods
4. Climbing several flights of stairs without resting
5. Climbing one flight of stairs without resting
6. Stooping, kneeling, or crouching
7. Reaching or extending your arms above shoulder level
8. Pulling or pushing large objects like a living room chair
9. Lifting or carrying weights over 10 pounds/5 kilos, like a heavy bag of groceries
10. Picking up a small coin from a table

2.6.2.7 Additional variables

In addition to the above explanatory variables, our framework considers homeownership, educational background, marital status, gender and age, as presented in Reinhardt *et al*. (2013). Homeownership is based on actual ownership at the interview. We regroup the whole sample into three categories: “rent-free”, “tenant” and “entire ownership”. Specifically, “rent-free” covers the respondents who chose that “rent-free” best describes their current ownership of the dwelling they live in. “Tenant” contains the respondents who selected “tenant” or “subtenant”. “Entire ownership” is for the respondents who declared themselves as an owner or member of a cooperative. Educational background refers to the level of higher education or vocational training achieved. Due to inconsistent education categories in each sample countries, SHARE used the International Standard Classification of Education (ISCED), which is helpful to standardise education level under internationally agreed on indicators and concepts. Given the information in SHARE, we regrouped the full sample into three categories (low, medium and high). “Low” education covers people with a pre-primary, primary or lower secondary education background. “Medium” contains respondents who have an upper secondary education or a post-secondary but non-tertiary education. Those individuals with the first and second stage of tertiary education are classified as “high” education. Regarding marital status, we apply the information in the SHARE dataset directly. In the regression, we set married people as the baseline. After controlling all variables, the observations for two-year dynamic model drops to 14,279. For four-year dynamic model, the observations are 5,751. More detailed data information is provided in Table 2A.1.

2.6.3 Analytical strategy

The sample period covers 12 years, from 2004 to 2016. In this study, we create a panel data covering all sample waves. Missing information on cohort individuals were taken into account by using multiple imputation models[14]. All variables in our framework have been included in the imputation model estimation. Accordingly, we estimate random-effect Probit models to explain early retirement by using explanatory variables contained in previous waves. For comparison, we restrict the sample to those countries which have data in all sample waves (wave 1, wave 2, wave 4, wave 5 and wave 6),

[14] It is realised by putting ‘mi’ suite of commands in STATA. In the procedure, missing values were assumed to occur randomly. Visual inspection showed that the imputed values filled in the data sets randomly without any trend, suggesting a stable imputation process (Hintsa *et al*. 2015).

which results in a balanced panel data.

Based on the multilevel structure of the data, we estimate random intercept models and control for country dummies and time fixed effect. In other words, all models account for two components: the fixed effects, including country and year fixed effects, which control the effect of those time-invariant characteristics within the individual, and random effects which take into account those different unobserved elements across the sample (random intercepts for each person). It allows for time-invariant variables (e.g. gender) to play a role as an explanatory variable. All parameters use maximum likelihood estimation.

2.7 Statistical Analysis

2.7.1 Distribution of explained variables by labour market participation

The data were derived from the Survey of Health, Ageing and Retirement in Europe (SHARE, Release 6.0). Early retirement was conditional on labour market transitions observed over two years or four years in two panels, respectively. Table 2.3 presents an overview of the sample based on two years lagged data. In the final sample, in wave 1, there are 11,387 core respondents aged 50 to 64. These numbers are 11,180 in wave 2, 15,890 in wave 4, 19,777 in wave 5 and 16,106 in wave 6. The average percentage of people who were working but now retired is 21.95. The number of permanently sick or disabled people occupies 2.4% of this sample with homemakers occupy 2.8% of the population.

Table 2.3: Construction of labour market status by waves in SHARE (two years dynamic model)

Construct	Employment participation two years ago	Current age	Elements	Wave 2		Wave 4		Wave 5		Wave 6	
				N	Prevalence (%)	N	Prevalence (%)	N	Prevalence (%)	N	Prevalence (%)
early retirement	working	50-64s	retired	512	12.9	815	22.7	937	14.5	1,114	12.9
			permanently sick or disabled	110	2.8	74	2.1	136	2.1	179	2.1
			homemaker	100	2.5	111	3.1	145	2.2	192	2.2
still working			employed	2,743	68.8	2,187	60.9	4,491	69.2	6,175	71.5
			self-employed	519	13.0	402	11.2	779	12.0	981	11.3
Overall				3,984	100	3,589	100	6,488	100	8,641	100

Table 2.4: Construction of labour market status by waves in SHARE (four years dynamic model)

Construct	Employment participation four years ago	Current age	Elements	Wave 4		Wave 6	
				N	Prevalence (%)	N	Prevalence (%)
early retirement	working	50-64s	retired	815	22.7	1,080	21.2
			permanently sick or disabled	74	2.1	138	2.7
			homemaker	111	3.1	128	2.5
still working			employed	2,187	60.9	3,213	63.0
			self-employed	402	11.2	541	10.6
Overall				3,589	100	5,100	100

We further describe labour market participation sorted by nine sample countries. The statistics are shown in Table 2.5 and Table 2.6. For those respondents who were employees or self-employed two years ago, people in Austria present the highest probability of early retirement with 35.61%, considerably greater than the average level of all SHARE countries. Among these, 33.59% were retired. The Swedes occupied the lowest percentage of early retirement with only 11.61%, compared to the other eight countries. Among those who were still working, most people were in employment (79.17%) rather than self-employment (9.22%). Employed people in Sweden also occupy the highest percentage across the nine sample countries. In Switzerland, although the percentage of early retired people is below the average level of all SHARE countries, the proportion of homemakers is considerable large (4.9%). Belgium has the highest percentage that is permanently sick or disabled. Among those who were working two years ago and still working now, people in Spain present the highest percentage in self-employment with 21.35%. In sum, we can observe that most people below 65 years old will continue to be active in the labour market if they were in employment two years previously. Turning to Table 2.6, we can see that the percentage of early retirement is significantly higher, possibly because independent variables, such as housing assets, stress at work and health situation have delayed effect on labour market participation. Austrian has the highest probability of early retirement (42.99%), which is considerably above the EU average of 28.84%. Again, the main reason for early retirement in Austria is retirement. However, a homemaker in largest percentage in Spain with 6.96%. The percentage of self-employment in Spain is 20.65%, which is twice the average in SHARE. Workers in Denmark and Sweden are likely to be employees with percentages equal to 74.29% and 73.5% respectively, which is considerably far ahead of other countries. By contrast, these two countries have a relatively low percentage in self-employment, 8.8% in Denmark and 7.78% in Sweden.

Table 2.5: Labour market participation by sample country (two years dynamic model)

Country	Early Retirement				Active in Labour Market		
	Retired (%)	Permanently sick or disabled (%)	Homemaker (%)	Sum (%)	Employed (%)	Self-employed (%)	Sum (%)
Austria	33.59	0.78	1.24	35.61	52.36	12.03	64.39
Germany	16.85	2.46	4.69	24.00	65.97	10.03	76.00
Sweden	9.17	1.93	0.51	11.61	79.17	9.22	88.39
Spain	10.51	2.39	6.68	19.58	59.07	21.35	80.42
Italy	19.33	0.63	4.67	24.63	59.09	16.28	75.37
France	22.84	2.45	1.11	26.40	64.78	8.82	73.60
Denmark	11.85	2.48	0.41	14.74	76.66	8.60	85.26
Switzerland	8.23	1.49	4.90	14.62	69.88	15.50	85.38
Belgium	19.43	4.12	1.48	25.03	63.68	11.29	74.97
SHARE total	16.70	2.42	2.48	21.60	66.46	11.94	78.40

Note: Each type of labour market participation is based on the current status conditional on the position two years ago. SHARE total is the average percentage of all countries in each sample wave. All percentages in the table are the average numbers of the sample waves.

Table 2.6: Labour market participation by sample country (four years dynamic panel)

Country	Early Retirement				Active in Labour Market		
	Retired (%)	Permanently sick or disabled (%)	Homemaker (%)	Sum (%)	Employed (%)	Self-employed (%)	Sum (%)
Austria	41.44	0.40	1.15	42.99	46.06	10.95	57.01
Germany	27.34	2.32	5.62	35.28	56.79	7.93	64.72
Sweden	14.1	2.1	2.52	18.72	73.50	7.78	81.28
Spain	14.39	2.52	6.96	23.87	55.48	20.65	76.13
Italy	21.8	0.68	5.54	28.02	58.50	13.48	71.98
France	31.28	2.86	1.19	35.33	56.88	7.79	64.67
Denmark	14.24	2.02	0.65	16.91	74.29	8.80	83.09
Switzerland	10.04	1.28	4.69	16.01	69.35	14.64	83.99
Belgium	29.86	4.83	1.66	36.35	54.24	9.41	63.65
SHARE total	23.61	2.75	2.48	28.84	60.78	10.38	71.16

Note: Each type of labour market participation is based on the current status conditional on the position four years ago. SHARE total is the average percentage of all countries in each sample wave. All percentages in the table are the average numbers of the sample waves.

2.7.2 Sample description

Spearman's correlation coefficients were calculated to assess the relationship between early retirement and the covariates. Table 2.7 gives detailed information of the variables using the two years dynamic model and Table 2.8 describes sample characteristics for four years dynamic panel. In Table 2.7, *p*-value is smaller than 0.001 for housing mortgage, non-housing debt, physical health problem, emotional health problem, educational qualification and age indicate that the early retirement could be potentially attributed to these factors. Also, net non-housing assets and gender have *p*-values, which are lower than 0.1. If we further look into each indicator by waves, people who were in employment but now retired are more likely to be older. People who have a higher housing mortgage are more likely to continue working. 42.86% of individuals with a large mortgage are still working compared to 25.72% in the early retirement group. Similarly, a high non-housing debt will push people to continue working rather than retire. For a net non-housing asset, if respondents have an amount which is located into the top terciles in the corresponding country, the likelihood of still working will be higher. For individuals who are still working, the percentage of high net non-housing assets occupy 44.12%, while the percentage of low net non-housing value is 24.09. Regarding physical health problem, 6% of people who have suffered severe physical health problem are still working conditional on working status two years ago. By contrast, those who retire early, 14.97% probability is attributed to a physical health problem. Emotional health problems also present a significant effect on early retirement. However, the effects seem to vary across waves based on the *p*-values in Table 2.7. Other control variables do not generate clear effects on early retirement.

Turning to the panel with a four-year dynamic data, which is shown in Table 2.8. Housing mortgage, physical health problem, ERI, low control, education level and age appear to have strong influences on early retirement decision. Regarding stress at work, respondents who experienced higher ERI or lower control in the past four years will increase the probability of the individual being retired today. In other words, less favourable working environments will make people leave the labour market before the statutory retirement age. Respondents with high housing debt are more likely to continue working. The percentage of those staying in the labour market with high housing mortgage is 44.05% while the percentage drops to 29.16% among those who leave the labour market early. Also, people who retire early tend to have a lower educational qualification.

Table 2.7: Sample description of covariates by labour market status (two years dynamic): Observations (no.) and percentage (%) or mean and standard deviation (SD)

Variables	Wave 2				Wave 4			
	Early retirement		Still working		Early retirement		Still working	
	Prevalence (%) or mean (SD)	N	Prevalence (%) or mean (SD)	N	Prevalence (%) or mean (SD)	N	Prevalence (%) or mean (SD)	N
Sex								
Male	46.63	166	50.81	1,922	46.45	275	48.07	1,510
Female	53.37	190	49.19	1,861	53.55	317	51.93	1,631
p value	0.13	356		3,783	0.47	592		3,141
Age years	58.99 (3.39)	356	56.70 (3.52)	3,783	60.90 (2.70)	592	58.26 (3.19)	3,141
p value	<0.001				<0.001			
Marital status$_{t-1}$								
Married	78.37	279	76.89	2,908	79.35	465	76.80	2,397
Registered partnership	4.78	17	6.72	254	5.46	32	7.15	223
Divorced	5.89	21	7.75	293	5.12	30	8.07	252
Widowed	6.18	22	3.28	124	5.80	34	2.59	81
Never married	4.78	17	5.36	203	4.27	25	5.39	168
p value	0.49	356		3,782	0.23	586		3,121
Education$_{t-1}$								
High	21.35	76	32.25	1,220	23.14	137	34.93	1,097
Medium	36.79	131	38.07	1,440	44.09	261	41.48	1,303
Low	41.86	149	29.68	1,123	32.77	194	23.59	741
p value	<0.001	356		3,783	<0.001	592		3,141

Net housing value $_{t-1}$								
High	42.13	150	40.60	1,536	36.99	219	37.89	1,190
Medium	38.76	138	39.78	1,505	43.07	255	42.18	1,325
Low	19.11	68	19.62	742	19.94	118	19.93	626
p value	0.61	356		3,783	0.77	592		3,141
Net non-housing value $_{t-1}$								
High	39.61	141	45.04	1,704	47.30	280	43.30	1,360
Medium	32.30	115	29.84	1,129	33.11	196	32.19	1,011
Low	28.09	100	25.12	950	19.59	116	24.51	770
p value	0.06	356		3,783	0.02	592		3,141
Housing mortgage $_{t-1}$								
High	23.60	84	44.09	1,668	29.05	172	46.13	1,449
Low	76.40	272	55.91	2,115	70.95	420	53.87	1,692
p value	<0.001	356		3,783	<0.001	592		3,141
Non-housing debt $_{t-1}$								
High	23.59	84	36.77	1,391	24.49	145	33.24	1,044
Low	76.41	272	63.23	2,392	75.51	447	66.76	2,097
p value	<0.001	356		3,783	<0.001	592		3,141
Emotional health problem $_{t-1}$								
Yes	28.93	103	18.42	695	21.73	128	17.28	541
No	71.07	253	81.58	3,079	78.27	461	82.72	2,589
p value	<0.001	356		3,774	0.01	589		3,130

Physical health problem $_{t-1}$								
Yes	19.94	71	6.03	228	11.00	65	5.73	180
No	80.06	285	93.97	3,555	89.00	527	94.27	2,961
p value	<0.001	356		3,783	<0.001	592		3,141
Low control $_{t-1}$								
Yes	16.05	56	17.74	669	21.77	106	17.19	529
No	83.95	293	82.26	3,102	78.23	381	82.81	2,547
p value	0.43	349		3,771	0.01	487		3,076
Effort reward imbalance $_{t-1}$								
Yes	17.77	62	18.03	680	21.15	103	18.52	570
No	82.23	287	81.97	3,092	78.85	384	81.48	2,507
p value	0.90	349		3,772	0.17	487		3,077
Home ownership $_{t-1}$								
Rent free	2.39	6	2.62	69	2.39	9	2.52	54
Tenant	18.73	47	20.25	533	18.62	70	20.50	439
Entire ownership	78.88	198	77.13	2,030	78.99	297	76.98	1,648
p value	0.53	251		2,632	0.40	376		2,141
Total	100	≤356	100	≤3,783	100	≤592	100	≤3,141

p values base on analysis of Spearman's correlation.

Source: Survey on Health, Ageing and Retirement in Europe (release 6.0).

Table 2.7: Sample description of covariates by labour market status (two years dynamic): Observations (no.) and percentage (%) or mean and standard deviation (SD) (continued)

Variables	Wave 5				Wave 6			
	Early retirement		Still working		Early retirement		Still working	
	Prevalence (%) or mean (SD)	N	Prevalence (%) or mean (SD)	N	Prevalence (%) or mean (SD)	N	Prevalence (%) or mean (SD)	N
Sex								
Male	42.44	261	47.61	2,906	43.63	308	46.73	3,867
Female	57.56	354	52.38	3,197	56.37	398	53.27	4,408
p value	0.01	615		6,103	0.11	706		8,275
Age years	60.32 (3.10)	615	57.24 (3.58)	6,103	60.61 (3.04)	706	57.73 (3.54)	8,275
p value	<0.001				<0.001			
Marital status $_{t-1}$								
Married	77.55	463	72.53	4,372	75.32	525	74.37	6,101
Registered partnership	6.19	37	8.96	540	6.17	43	9.02	740
Divorced	6.53	39	9.66	582	7.60	53	8.35	685
Widowed	4.19	25	2.54	153	5.31	37	2.43	199
Never married	5.54	33	6.31	380	5.60	39	5.83	478
p value	0.03	597		6,027	0.68	697		8,203
Education $_{t-1}$								
High	24.55	151	34.44	2,102	22.43	181	36.23	2,998
Medium	44.39	273	44.54	2,718	36.40	257	43.35	3,587
Low	31.06	191	21.02	1,283	41.17	268	20.42	1,690

p value	<0.001	615		6,103	<0.001	706		8,275
Net housing value $_{t-1}$								
High	38.05	234	37.99	2,319	36.54	258	37.26	3,083
Medium	43.09	265	42.99	2,624	40.08	283	43.79	3,624
Low	18.86	116	19.02	1,160	23.38	165	18.95	1,568
p value	0.95	615		6,103	0.11	706		8,275
Net non-housing value $_{t-1}$								
High	40.81	251	44.44	2,712	42.63	301	43.69	3,615
Medium	33.66	207	31.98	1,952	32.44	229	33.15	2,743
Low	25.53	157	23.58	1,439	24.93	176	23.16	1,917
p value	0.09	615		6,103	0.39	706		8,275
Housing mortgage $_{t-1}$								
High	25.85	159	40.00	2,441	24.36	172	41.21	3,410
Low	74.15	456	60.00	3,662	75.64	534	58.79	4,865
p value	<0.001	615		6,103	<0.001	706		8,275
Non-housing debt $_{t-1}$								
High	22.44	138	28.05	1,712	20.96	148	28.21	2,334
Low	77.56	477	71.95	4,391	79.04	558	71.79	5,941
p value	0.003	615		6,103	<0.001	706		8,275
Emotional health problem $_{t-1}$								
Yes	23.86	146	20.16	1,226	27.27	192	18.82	1,549
No	76.14	466	79.84	4,856	72.73	512	81.18	6,680
p value	0.03	612		6,082	<0.001	704		8,229

Physical health problem $_{t-1}$								
Yes	15.64	96	7.01	428	13.31	94	7.03	582
No	84.36	518	92.99	5,674	86.69	612	92.97	7,692
p value	<0.001	614		6,102	<0.001	706		8,274
Low control $_{t-1}$								
Yes	18.24	81	19.61	1,178	16.12	44	18.64	750
No	81.76	363	80.39	4,830	83.88	229	81.36	3,274
p value	0.48	444		6,008	0.30	273		4,024
Effort reward imbalance $_{t-1}$								
Yes	15.54	69	18.35	1,103	14.29	39	21.08	848
No	84.46	375	81.65	4,907	85.71	234	78.92	3,175
p value	0.14	444		6,010	0.01	273		4,023
Home ownership $_{t-1}$								
Rent free	3.87	15	2.07	87	2.28	11	2.12	118
Tenant	18.04	70	22.48	943	18.26	88	21.02	1,172
Entire ownership	78.09	303	75.45	3,165	79.46	383	76.86	4,286
p value	0.35	388		4,195	0.21	482		5,576
Total	100	≤615	100	≤6,103	100	≤706	100	≤8,275

p values base on analysis of Spearman's correlation.

Source: Survey on Health, Ageing and Retirement in Europe (release 6.0).

Table 2.8: Sample description of covariates by labour market status (four years dynamic): Observations (no.) and percentage (%) or mean and standard deviation (SD)

Variables	Wave 4				Wave 6			
	Early retirement		Still working		Early retirement		Still working	
	Prevalence (%) or mean (SD)	N	Prevalence (%) or mean (SD)	N	Prevalence (%) or mean (SD)	N	Prevalence (%) or mean (SD)	N
Sex								
Male	46.45	275	48.07	1,510	43.63	308	46.73	3,867
Female	53.55	317	51.93	1,631	56.37	398	53.27	4,408
p value	0.47	592		3,141	0.11	706		8,275
Age years	60.91 (2.70)	592	58.26 (3.18)	3,141	60.60 (3.04)	706	57.73 (3.54)	8,275
p value	<0.001				<0.001			
Marital status $_{t-2}$								
Married	79.35	465	76.80	2,397	72.52	351	72.17	3,025
Registered partnership	5.46	32	7.15	223	7.44	36	9.26	388
Divorced	5.12	30	8.07	252	8.47	41	9.66	405
Widowed	5.80	34	2.59	81	4.96	24	2.34	98
Never married	4.27	25	5.39	168	6.61	32	6.57	275
p value	0.23	586		3,121	0.92	484		4,191
Education $_{t-2}$								
High	23.14	137	34.93	1,097	28.65	157	35.08	1,570
Medium	44.09	261	41.48	1,303	37.04	203	44.98	2,013
Low	32.77	194	23.59	741	34.31	188	19.94	892

p value	<0.001	592		3,141	<0.001	548		4,475
Net housing assets $_{t-2}$								
High	36.99	219	37.89	1,190	37.19	183	37.46	1,590
Medium	43.07	255	42.18	1,325	43.49	214	43.20	1,834
Low	19.94	118	19.93	626	19.32	95	19.34	821
p value	0.77	592		3,141	0.94	492		4,245
Net non-housing assets $_{t-2}$								
High	47.29	280	43.29	1,360	45.12	222	43.44	1,844
Medium	33.11	196	32.19	1,011	32.93	162	32.58	1,383
Low	19.60	116	24.52	770	21.95	108	23.98	1,018
p value	0.02	592		3,141	0.34	492		4,245
Housing mortgage $_{t-2}$								
High	29.05	172	46.13	1,449	29.27	144	41.96	1,781
Low	70.95	420	53.87	1,692	70.73	348	58.04	2,464
p value	<0.001	592		3,141	<0.001	492		4,245
Non-housing debt $_{t-2}$								
High	24.49	145	33.24	1,044	22.76	112	28.65	1,216
Low	75.51	447	66.76	2,097	77.24	380	71.35	3,029
p value	<0.001	592		3,141	0.006	492		4,245
Emotional health problem $_{t-2}$								
Yes	21.73	128	17.28	541	26.12	128	20.29	857
No	78.27	461	82.72	2,589	73.88	362	79.71	3,366
p value	0.01	589		3,130	0.003	490		4,223

Physical health problem $_{t-2}$								
Yes	10.98	65	5.73	180	14.87	73	6.79	288
No	89.02	527	94.27	2,961	85.13	418	93.21	3,949
p value	<0.001	592		3,141	<0.001	491		4,237
Low control $_{t-2}$								
Yes	21.77	106	17.20	529	22.92	91	19.45	787
No	78.22	381	82.80	2,547	77.08	306	80.55	3,260
p value	0.01	487		3,076	0.09	397		4,047
Effort reward imbalance $_{t-2}$								
Yes	21.15	103	18.52	570	24.43	97	17.94	726
No	78.85	384	81.48	2,507	75.57	300	82.06	3,321
p value	0.17	487		3,077	0.002	397		4,047
Home ownership $_{t-2}$								
Rent free	2.39	9	2.52	54	2.68	9	2.35	68
Tenant	18.62	70	20.50	439	19.94	67	22.98	666
Entire ownership	78.99	297	76.98	1,648	77.38	260	74.67	2,164
p value	0.40	376		2,141	0.31	336		2,898
Total	100	≤592	100	≤3,141	100	≤706	100	≤8,275

p values base on analysis of Spearman's correlation.

Source: Survey on Health, Ageing and Retirement in Europe (release 6.0).

2.8 Empirical Results

In this section, we present findings from the empirical analysis. Specifically, in all tables, Model (1) focus on the effects of household wealth on labour market participation. Model (2) presents health behaviour and well-being on labour market participation. Models (3) investigate the overall effects of all covariates in Model (1) and Model (2), which could examine potential partial correlation in wealth accumulation. Marginal effects were presented for all models[15][16]. We firstly perform the outcomes for the two-year dynamic model (see Table 2.9). Based on Reinhardt *et al*. (2013), all our models have controlled for homeownership, educational background, marital status, age and gender. This procedure is used to explore to what extent there is a transition from employment to retirement in two consecutive survey years.

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[15] Due to insufficient observations in each sample country, this chapter estimate overall effect from all nine countries.

[16] We have created a dummy variable equal one if the observations are collected before 2007 financial crisis, and 0 otherwise. We used interaction terms on the relevant variables tying to estimate possible financial crisis effect. The results do not present statistically significant difference before and after financial crisis, which indicates that financial crisis does not significantly differentiate the effect of each variable on retirement. Therefore, we employ a panel incorporating nine sample countries in all time frames.

Table 2.9: Predictors of early retirement in the two-year dynamic model: results of multilevel Probit regression models: incidence marginal effects and significance level

Variables	Model (1) Early Retired	Model (2) Early Retired	Model (3) Early Retired
adjhomewealth$_{t-1}$			
Low (ref.)			
Medium	-0.0804* (0.048)		0.001 (0.120)
High	-0.094* (0.053)		-0.003 (0.064)
adjffwealth $_{t-1}$			
Low (ref.)			
Medium	-0.059 (0.042)		-0.031 (0.049)
High	-0.152*** (0.042)		-0.151*** (0.049)
adjhsmort $_{t-1}$			
Low (ref.)			
High	-0.196*** (0.041)		-0.197*** (0.048)
adjfinancldebt $_{t-1}$			
Low (ref.)			
High	-0.099*** (0.039)		-0.123*** (0.046)
lowcontrol_early $_{t-1}$			
No (ref.)			
Yes		0.009 (0.050)	0.009 (0.049)
higheri_early $_{t-1}$			
No (ref.)			
Yes		0.042 (0.050)	0.078 (0.049)
depressive $_{t-1}$			
No (ref.)			
Yes		0.152*** (0.045)	

disability $_{t-1}$			
No (ref.)			
Yes		0.472*** (0.058)	
home ownership $_{t-1}$			
Rent free (ref.)			
Tenant	0.016 (0.102)	0.122 (0.124)	0.099 (0.123)
Entire ownership	0.198** (0.101)	0.207* (0.118)	0.268** (0.122)
education $_{t-1}$			
Low (ref.)			
Medium	-0.130 (0.040)	-0.072 (0.047)	-0.081 (0.047)
High	-0.343*** (0.044)	-0.280*** (0.052)	-0.286*** (0.053)
rmstat $_{t-1}$			
Married (ref.)			
Registered partnership	-0.039 (0.063)	-0.052 (0.075)	-0.028 (0.074)
Divorced	-0.211*** (0.053)	-0.138** (0.061)	-0.145** (0.061)
Widowed	0.019 (0.067)	0.075 (0.078)	0.031 (0.078)
Never married	-0.136** (0.060)	-0.021 (0.068)	-0.065 (0.069)
ragender			
Male (ref.)			
Female	0.216*** (0.032)	0.155*** (0.038)	0.192*** (0.038)
ragey	0.156*** (0.005)	0.153*** (0.006)	0.149*** (0.006)
Cons	-9.680*** (0.322)	-9.869*** (0.387)	-9.481*** (0.388)
Obs	15,963	12,515	12,515

Source: Survey on Health, Ageing and Retirement in Europe (release 6.0)

All estimates of Model are controlled country fixed effect and time fixed effect

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

After controlling for fixed effects across countries and time series, we observe a significantly negative association of high housing mortgage on early retirement behaviour (Model (1) and Model (3) in Table 2.9). Specifically, the value of the mortgage locates in the upper 50% of the distribution in corresponding country is associated with a decreased probability of early retirement by 19% on average. The effects are independent of all other covariates. Also, respondents whose financial debt is in the upper half of the corresponding country are associated with a 10% decrease in the probability of early retirement on average (Model (1) and Model (3) in Table 2.9). The results confirm the arguments made by Alter *et al*. (2018) and prove hypothesis 2 that a higher outstanding debt will decrease the possibility of early retirement. The net non-housing assets also has a consistent and stable impact on the early retirement as expected. Respondents holding the top terciles of net non-housing wealth in corresponding countries are less likely to leave the labour market earlier (Model (1) and Model (3) in Table 2.9), with the difference being approximately 15%. The result on net non-housing assets stands on the opposite side of hypothesis 1 that a higher financial status and early retirement have positive relationship, although the results are unclear in terms of statistical significance. Our findings demonstrate the evidence that a higher non-housing asset associating with lower probability of early retirement, which confirms the findings made by Bloemen (2006). First, the accumulation of net worth is growing if people continue stay in the labour market. Because they can consume their salary income rather than reduce their stock of assets. Second, people may worry about future. They choose to stay in the labour market because they are more risk-aversion and prefer a stable employment. Net housing assets do not present statistically significant effect on early retirement in every model. The heterogeneity on early retirement in housing assets and non-housing assets reveal the different roles of the two types of assets which confirm the hypothesis 4.

Consistent with the work in Bloemen (2006), physical and mental health problems provide strong impacts on early retirement (disability$_{t-1}$ and depressive$_{t-1}$ in Model (2) of Table 2.9). Respondents who have suffered two or more limitations doing daily activities over the past two years are associated with an increased probability of early retirement by 47% conditional on their working status two years ago. The positive relationship between adverse health status and high probability of early retirement justify the prediction of hypothesis 3. Additionally, people experienced three or more symptoms of depression will increase the probability of early retirement by 0.152. The result is consistent with cross-sectional data analysis in SHARE (Wahrendorf *et al*. 2017). Referring to the group with a primary educational background, people with first or second stages of tertiary education have a much higher probability of staying in the labour market up to the age of 65 years. That is, the higher the education level, the lower likelihood that respondents exit from the labour market early. The evidence confirms the findings made by Komp *et al*. (2010), where a higher level of education and longer working life have positive relationship. Based on our results, compared with other levels, people holding the strongest educational background have 30% lower probability of early retirement on average (Model (1) to Model (3) in Table 2.9). In line with the results presented by Reinhardt *et al*. (2013), respondent who has the ownership in a dwelling is associated with a 22% more probability of early retirement, compared with those who are in free renting (Model (1) to Model (3) in Table 2.9). As the literature mentioned before (Lund *et al*. 2005; Kubicek *et al*. 2010; Nikolova *et al*. 2014; Majeed *et al*. 2015), women, and those closer to the statutory retirement age, tend to leave the workforce earlier (Model (1) to Model (3) in Table 2.9). Other covariates, such as marital status, do not present a clear and constantly significant effects in the estimating.

Table 2.10 shows the results of multivariate analysis based on current labour market participation and independent variables observed four years ago. The main purpose of the comparison between Table 2.9 and Table 2.10 is for examining the delay in the effects of illness. All other variables should consistent with the findings in the two-year dynamic model. Similar to the two-year dynamic analysis, mortgage plays a significant role in predicting early retirement in the latest decade. Sampled respondents with a higher mortgage are less likely to retire in the following four years, compared with those in the same age group but with a relatively low mortgage. The difference of this probability is around 15% (Model (1) and Model (3) in Table 2.10).

Compared with the findings in the two-year dynamic model, unfavourable working environments, exemplified by higher ERI and lower control, generate a statistically significant positive effect on early retirement in the next four years. In general, higher ERI can increase the probability of early retirement (Model (2) and Model (3) in Table 2.10). No such evidence shown in the two-year dynamic model (Model (2) and Model (3) in Table 2.9). The results confirm our prediction in model outline section that health problems can have a delay in exerting the effect on labour market participation. Again, people who have a physical health problem are associated with an increased probability of early retirement (Model (2) in Table 2.10). Significant effects of educational background (lower), age (older) and gender (female) on a higher probability of early retirement still exist (Model (1) to Model (3) in Table 2.9). The results are consistent with the findings in the two-year dynamic model (Model (1) to Model (3) in Table 2.9). Again, country dummies and time fixed effects have been included in all regressions.

Table 2.10: Predictors of early retirement in the four-year dynamic model: results of multilevel Probit regression models: incidence marginal effects and significance level

Variables	Model (1) Early Retired	Model (2) Early Retired	Model (3) Early Retired
adjhomewealth $_{t-2}$			
Low (ref.)			
Medium	0.072 (0.074)		0.093 (0.077)
High	-0.051 (0.082)		-0.007 (0.086)
adjffwealth $_{t-2}$			
Low (ref.)			
Medium	-0.009 (0.065)		-0.034 (0.067)
High	-0.024 (0.063)		-0.024 (0.066)
adjhsmort $_{t-2}$			
Low (ref.)			
High	-0.159*** (0.060)		-0.136** (0.062)
adjfinancldebt $_{t-2}$			
Low (ref.)			
High	-0.073 (0.056)		-0.076 (0.059)
lowcontrol_early $_{t-2}$			
No (ref.)			
Yes		0.104 (0.066)	0.093 (0.066)
higheri_early $_{t-2}$			
No (ref.)			
Yes		0.197*** (0.067)	0.222*** (0.067)
depressive $_{t-2}$			
No (ref.)			
Yes		-0.049 (0.063)	

disability $_{t-2}$			
No (ref.)			
Yes		0.359*** (0.085)	
home ownership $_{t-2}$			
Rent free (ref.)			
Tenant	-0.134 (0.145)	-0.063 (0.152)	-0.081 (0.152)
Entire ownership	0.104 (0.142)	0.093 (0.144)	0.130 (0.150)
education $_{t-2}$			
Low (ref.)			
Medium	-0.158*** (0.062)	-0.138*** (0.064)	-0.149*** (0.064)
High	-0.349*** (0.067)	-0.299*** (0.069)	-0.303*** (0.070)
rmstat $_{t-2}$			
Married (ref.)			
Registered partnership	0.080 (0.089)	0.068 (0.092)	0.069 (0.093)
Divorced	-0.150* (0.078)	-0.127 (0.079)	-0.128 (0.080)
Widowed	0.102 (0.104)	0.207* (0.108)	0.177 (0.108)
Never married	-0.103 (0.089)	-0.041 (0.091)	-0.063 (0.092)
ragender			
Male (ref.)			
Female	0.217*** (0.048)	0.187*** (0.051)	0.201*** (0.050)
ragey	0.198*** (0.009)	0.194*** (0.009)	0.193*** (0.009)
Cons	-12.42*** (0.577)	-12.32*** (0.597)	-12.24*** (0.600)
Obs	5,144	4,958	4,958

Source: Survey on Health, Ageing and Retirement in Europe (release 6.0)

All estimates of Model are controlled country fixed effect and time fixed effect

Standard errors in parentheses

* p < 0.10, ** p < 0.05, *** p < 0.01

2.9 Discussion and Conclusion

In this study, we investigate the labour market participation of men and women aged 50 and 64 years across nine European countries. We describe the differences among people who retire before the statutory pension age and people who continue working in the same age interval. There are several variables covered in this study, including health functioning, wealth, well-being and demographic indicators. There are four main findings in our study: first, after adjusting for baseline early retirement and covariates, physical health problems and chronic stress at work exerted robust effects on retirement before the "standard" pension age. Second, the effect of stress at work may take time to exert a negative effect in the labour market involvement. Third, we observe that people who retire early are more likely to have a lower mortgage. This group of people could have less incentive to stay in the labour market, compared with those who need to repay loans in their later life. Fourth, higher qualification holders are less likely to leave the labour market early. This finding is strong and constant across all dimensions. Given low fertility rate and decreased working-age population (20 years to 64 years) across European countries, the authorities should keep labour force staying in the labour market for remaining a stable growth rate in the economy. A favourable working environment can reduce inequalities of well-being and remain people's ability to work. The country should set rules in support services and compliance team of company so that the employees could get effective help when they are under heavy pressure or in difficulties. Also, education is essential for people to stay in the labour market. Education can improve people's skills and knowledge and get them ready for the labour market. Well-educated people can adapt the changing economic environment quicker and gain more opportunities in the societies. The authorities should advance education system so that people are more confident in education and actively participating economics activities in later life.

In conclusion, our findings are concordant with previous studies which investigated the effects of work stress and socio-demographic factors on early retirement. However, we view the contribution of this study as three-fold: first, we develop a direct wealth effect on early retirement. The results show that respondents with high property mortgage, net non-housing value and financial debt are less likely to exit the labour market early. Second, we explore the relationship between health and labour market participation in association with housing assets, which are another innovative aspect of the study. Specifically, most previous studies focus on health effects in labour market yet ignore wealth accumulation. We analyse various types of illness in conjunction with housing and financial assets in labour market participation. Also, by comparing the information obtained two years ago and four years ago, we provide the intensity of prediction on labour market participation when focusing on stress at work. Third, we apply the full duration of exposure to assess the dynamic effect of explanatory variables on early retirement. Additionally, we estimate two dimensions on all variables and provide a comprehensive comparison between the two measurements.

While this study has several strengths, for instance, a large amount of housing wealth data, comprehensive information on illness and well-being, several limitations must be considered. First, we conduct regression analyses by merging all countries into one panel. Additional and valid information on the exposure of data points will enrich the analyses and provide the availability to do comparative analysis in each single country. Second, it is hard to rule out selection bias. Low response rates in some countries and attrition could lead to some groups being more likely to stay in the sample than other groups. Previous studies have indicated that healthier people are more likely to stay in the sample (Schröder *et al*. 2008). Also, the non-response rate is generally higher among people with low economic positions, leading to under-reporting of household wealth in our study. Third, the measurement of stress at work bases on abbreviated dimensions. A comprehensive scale of all respected items, including "Component esteem", "Component job promotion" and "Component job security" in the ERI model, can provide the possibility to test the full models and it is more appropriate to assess the effects of employment well-beings on labour market participation.

Appendix 2A

Table 2A.1: Variables and descriptions

Variable name	Definition
Early Retired (Table 2.9)	binary dependent variable=1 if respondents satisfy the following three conditions simultaneously: (1) are retired/permanently sick or disabled/homemaker in contemporaneous survey year; (2) were in employment or self-employment (including working for family business) in the last wave (**two** years ago); (3) aged below 65 years old in contemporaneous survey year; 0 otherwise
Early Retired (Table 2.10)	binary dependent variable=1 if respondents satisfy the following three conditions simultaneously: (1) are retired/permanently sick or disabled/homemaker in contemporaneous survey year; (2) were in employment or self-employment (including working for family business) **four** years ago; (3) aged below 65 years old in contemporaneous survey year; 0 otherwise
adjhomewealth $_{t-1}$	the position of CPI adjusted net housing wealth **two** years ago; 1=bottom terciles; 2=medium terciles; 3=top terciles
adjffwealth $_{t-1}$	the position of CPI adjusted net non-housing wealth **two** years ago; 1=bottom terciles; 2= medium terciles; 3=top terciles
adjhsmort $_{t-1}$	binary independent variable=1 if the CPI adjusted housing mortgage was located in the upper 50% in the corresponding country **two** years ago; 0 otherwise
adjfinancldebt $_{t-1}$	binary independent variable=1 if the CPI adjusted financial debt was located in the upper 50% in the corresponding country **two** years ago; 0 otherwise

depressive $_{t-1}$	binary independent variable=1 if respondents presented more than 3 symptoms in EURO-D scale **two** years ago; 0 otherwise
disability $_{t-1}$	binary independent variable=1 if respondents presented more than 2 symptoms in physical limitation **two** years ago; 0 otherwise
lowcontrol_early $_{t-1}$	binary independent variable=1 if respondent's control score falls into the upper terciles (the worse situation in job control) in corresponding countries **two** years ago; 0 otherwise
higheri_early $_{t-1}$	binary independent variable=1 if respondent's ERI ratio falls into the upper terciles (the worse situation in ERI) in corresponding countries **two** years ago; 0 otherwise
education $_{t-1}$	educational grade **two** years ago; 1=low; 2=medium; 3=high
rmstat $_{t-1}$	marital status **two** years ago; 1=married; 2=registered partnership; 3=divorced; 4=widowed; 5=never married
home ownership $_{t-1}$	homeownership **two** years ago; 1= rent free; 2= tenant; 3=entire ownership
adjhomewealth $_{t-2}$	the position of CPI adjusted net housing wealth **four** years ago; 1=bottom terciles; 2=medium terciles; 3=top terciles
adjffwealth $_{t-2}$	the position of CPI adjusted net non-housing wealth **four** years ago; 1=bottom terciles; 2= medium terciles; 3=top terciles
adjhsmort $_{t-2}$	binary independent variable=1 if the CPI adjusted housing mortgage was located in the upper 50% in the corresponding country **four** years ago; 0 otherwise
adjfinancldebt $_{t-2}$	binary independent variable=1 if the CPI adjusted financial debt was located in the upper 50% in the corresponding country **four** years ago; 0 otherwise
depressive $_{t-2}$	binary independent variable=1 if respondents presented more than three symptoms in EURO-D scale **four** years ago; 0 otherwise
disability $_{t-2}$	binary independent variable=1 if respondents presented more than two symptoms in physical limitation symptoms **four** years ago; 0 otherwise

lowcontrol_early $_{t-2}$	binary independent variable=1 if respondent's control score falls into the upper terciles (the worse situation in job control) in corresponding countries **four** years ago; 0 otherwise
higheri_early $_{t-2}$	binary independent variable=1 if respondent's ERI ratio falls into the upper terciles (the worse situation in ERI) in corresponding countries **four** years ago; 0 otherwise
education $_{t-2}$	educational grade **four** years ago; 1=low; 2=medium; 3=high
rmstat $_{t-2}$	marital status **four** years ago; 1=married; 2=registered partnership; 3=divorced; 4=widowed; 5=never married
home ownership $_{t-2}$	homeownership **four** years ago; 1= rent free; 2= tenant; 3=entire ownership
ragey	age years in the contemporaneous survey year
ragender	1=female; 0 otherwise

Table 2A.2: ERI items

Dimension	Section	Element
Effort		
		ERI1 I have constant time pressure due to a heavy workload;
		ERI2 I have many interruptions and disturbances in my job;
		ERI3 I have a lot of responsibility in my job;
		ERI4 I am often pressured to work overtime;
		ERI6 Over the past few years, my job has become more and more demanding;
Reward	Component esteem	
		ERI7 I receive the respect I deserve from my superiors;
		ERI8 I receive the respect I deserve from my colleagues;
		ERI9 I experience adequate support in difficult situations;
		ERI10 I am treated unfairly at work;
		ERI15 Considering all my efforts and achievements, I receive the respect and prestige I deserve at work;
	Component job promotion	
		ERI11 My job promotion prospects are poor;
		ERI14 My current occupational position adequately reflects my education and training;
		ERI16 Considering all my efforts and achievements, my work prospects are adequate;
		ERI17 Considering all my efforts and achievements, my salary/income is adequate;
	Component job security	
		ERI12 I have experienced, or I expect to experience an undesirable change in my work situation;
		ERI13 My job security is poor;

Reasons why we use categorical variables in the model

There are disparities of economic growth in the nine sample countries. The same value in houses or financial assets could generate unbalanced purchasing power and asymmetrical lifestyle. We want to observe labour market participation, given an equivalent incentive from housing assets and non-housing assets. The categorical variables are based on the accumulated value of wealth and sorted by each country. People located in the same stratification could generate consistent incentives in the labour market, holding all others the same.

The deviation in the mean value of houses and financial assets among nine sample countries are considerable. For example, the mean value of the net non-housing value in Switzerland is nearly nine times as against the mean value in Spain. We have no doubt the value can be rescaled into a smaller number. However, the parameters will be influenced by the scale. The sample scale could differ the tantiles in the parameters in the different countries. A larger and significant number does not necessarily indicate a more sensitive effect. If the scales vary across nine countries, it will influence the interpretation of the parameters. Therefore, it is reasonable to choose categorical variables as the measurement of value-based indicators in our model.

CHAPTER 3 WHAT FACTORS AFFECT RETIREMENT BEHAVIOUR IN EUROPE? A STUDY OF PEOPLE AGED 65 TO 80

Using country-level panel data, we compare the effects of health status in association with non-housing assets and housing assets on delayed retirement behaviour in nine European countries. The study further evaluates and compare the timing of delayed retirement in the pre-crisis and post-crisis periods using panel data. Health status plays different roles in delayed retirement among the nine European countries. The findings show a strong negative relationship between adverse health status (i.e. emotional health problem or physical health problem) and longer working life in both pre-crisis and post-crisis period. Also, a heavy debt burden is likely to force people to work longer.

3.1 Introduction

Life expectancy has improved dramatically over the past 100 years. On the one hand, the improvement in both lifespan and living quality has resulted in not only a welfare gain (Nordhaus 2003; Becker *et al*. 2005) but also a changing life-cycle behaviour (Hamermesh 1985). On the other hand, the growth of the ageing population has forced a resource re-allocation in society and influenced social policy profoundly. Although retirement age, employment rate, as well as projected dependency rates, vary across European countries, with an increasing life expectancy, governments across European countries expect people to work longer and retire later (OECD 2011). This chapter aims to find out the relationship between adverse health status on delayed retirement.

The study fills in a gap with existing literature as follows. First, while previous studies have provided various reasons for early retirement, such as “pushing factors”, including health conditions which deteriorate with age, low working positions (Stattin 2005; Börsch-Supan *et al*. 2009; Bohle *et al*. 2010), or “pulling indicators”, including strong preference of leisure time, duty of looking after relatives at home (Bohle *et al*. 2010; Ekerdt 2010), there is no clear conclusion about the effects of health functions on delayed retirement among European elderly who voluntarily choose to prolong their working life. Second, the study controls wealth-based variables (i.e. housing assets and non-housing assets) on observing delayed retirement. Moreover, we undertake comparative analysis across nine European countries. To my knowledge, no research has taken both housing assets and financial assets into account when examining late retirement. It is necessary to locate the reasons of delayed retirement given the conflict between the extending retirement age and people who are reluctant to work longer.

A report for the European Union (EU) presents that the old-age dependency rate is expected to double between 2000 and 2040 (Banks *et al*. 2002). Linking the retirement age to life expectancy, Denmark, France, Germany and Spain have decided to raise the retirement age from 65 to 67 years, while the goal is 68 years in Britain and Ireland. The changes will happen in the 2020s according to current projections. By 2050, the highest retirement age within the OECD area will be in Denmark at 72 years. However, the desire to work beyond 65 years of age seems low in all age cohorts. According to the calculation made by the Finnish Centre for Pensions, in 2017 the average expected effective retirement age for 25- and 50-year olds were 61.2 and 62.8 respectively. Although consistent with forecasts, these numbers have not differed since 2014[17].

In addition to an increase in retirement age, most European governments, although the policies vary a bit, have reformed national pension systems to build up the incentives for ageing workers to extend their careers into older age and avoid potential the "pension crisis" (Rechel *et al*. 2013). For example, in Germany, the public pension (i.e. social security) programmes are rather generous, and there is no reduction in benefits from early retirement and disability pension programme if people leave the labour market before the retirement age of 65. More specifically, people who retired early can claim the same pension benefits as those who retired at the age of 65 (Börsch-Supan *et al*. 2007). It generates enormous incentives to retire early when the benefits are first available. However, if German programme provisions shift retirement benefits from fully taken before 65 years to a reduction of 6% per year and an increase of 6% per year for workers who retire at statutory retirement age, the average retirement age for both men and women will increase by about three years (Wise 2010).

[17] More details can be found online: www.etk.fi/en.

Regarding economic status, performance in retirement could be attributable to household wealth stratification. When moving towards the retirement age, agents need to estimate the living cost when retired and understand how to allocate their wealth for retirement to meet any earning shortfalls (Hershey *et al*. 2007). Therefore, it is essential to have insights as to the financial context, the state of health, and demographic factors among older workers and analyse the determinants of these indicators on late withdrawal from employment in European countries.

In this study, we extend an infinitely overlapping framework, known as the Blanchard-Yaari-Weil model, with finite lives to determine the retirement behaviour, a framework first created by Blanchard (1985). The Blanchard-Yaari-Weil model assumes that youth is perpetual. A mortality rate is a constant number throughout the lifespan, and it is the same for every agent regardless of their age. In other words, no matter how old the agent is, 30 years or 100 years old, or the expected time horizon, all agents face a fixed hazard rate over the entire lifetime, which means their weighted incomes are all the same regardless of their age. Also, everyone faces the same discounting rate in human capital. The weighted average of present values of all future income are the same for all agents. Our study applies this model and incorporates the life-cycle dimension taking into account the changes of health status and the dominance of financial capital. In other words, the discount rate of human capital is increasing with age while the growth rate of salary is decreasing. Therefore, human capital decreases sharply in later life and financial capital dominate. We show that how retirement behaviour responds to rising probability of deteriorating health with age and wealth cycle[18] in a finite horizon. We also identify the circumstances under which employment status and demographic factors indeed affect delayed retirement.

This study employs data from the Survey of Health, Ageing and Retirement in Europe (SHARE) (Börsch-Supan *et al*. 2013). Due to the substantial differences in question settings in wave 3, known as SHARELIFE, compared to all other waves, this study is based on data from five waves: waves 1, waves 2, waves 4, waves 5, waves 6. The empirical analyses are carried out in two parts. In the first part, we focus on the adaption of retirement behaviour to the time-varying economic environment. We build two subgroups bounded by the 2007-2008 financial crisis. Group one covers the waves before 2007. We present the association of wealth, measured by housing value and non-housing value, illness and employment status, with delayed retirement. The second group investigates the associations over the period 2011 to 2015 (i.e. data collected after 2008). Then, we provide comparative assessments of delayed retirement between the two subsamples. In the second part, we compare retirement behaviour among nine countries.

[18] Wealth cycle is a way to look at a person's profile. Generally, there are five stages: first, accumulation. Individual gets to start to build his wealth. It covers the working years of the individual (i.e. the phases of the life cycle from unmarried young adult to pre-retirement). Second, transition. At this stage, individual faces more money demand, such as purchasing house, education fees for children, marriage cost etc. People tend to increase the proportion of the portfolio in liquid assets, such as current account. Third, reaping or distribution. It is the stage where individual needs regular expenses. It is normally parallel of retirement phase in the life cycle. Fourth, inter-generational transfer. During this period, elderly starts to think about family transfer to the next generation, in the event of death. Five, bonus, such as winning lotteries, unexpected inheritance of wealth, unusually high capital gains. A rational person should do investment and gain long-term benefit from a big amount of money.

Delayed retirement is the explained variable, health status associated with the level of wealth are independent variables. In every model, apart from the factors mentioned above, the study considers employment status and demographic details as covariates, which possibly affect the workforce participation in older age.

The remainder of this chapter is as follows: Section 3.2 reviews previous studies on delayed retirement. In Section 3.3, we present the hypotheses. In Section 3.4, we describe the empirical model in this study. Section 3.5 details target responses used in SHARE, as well as explained variable and all explanatory variables. Section 3.6 reports descriptive statistics for both key variables and control variables used in this study for both subsamples. The empirical findings are presented in Section 3.7, with the results discussed in the following section.

3.2 Literature Review

Why do some people extend their employment beyond the statutory retirement while others do not? It has been a common research theme in Europe. The issue is related to a variety of scientific disciplines, including economics, social psychology, epidemiology, occupational health and social psychology.

3.2.1 Retirement status in single discipline

Previous studies tend to focus on single factors that may affect people working into old age. There are three main dimensional analyses in this aspect.

3.2.1.1 Working environment and retirement

One is occupational factors and retirement (Beehr *et al*. 2000; Frederiksen *et al*. 2007). The relationship between workplace characteristics and workforce participation has been thoroughly investigated. For example, lower physical demand in the job is associated with longer working lives.

3.2.1.2 State security system and retirement

Some studies have focused on regulations and retirement (Ebbinghaus 2006; Hartlapp *et al*. 2008). A vast literature has investigated the link between insurance programmes and retirement (Gustman *et al*. 1986; Pozzebon *et al*. 1989; Stock *et al*. 1990; Berkovec *et al*. 1991; Rust *et al*. 1997; Gruber *et al*. 2004, 2009; French 2005; Coile *et al*. 2007a,b; Low *et al*. 2010a,b; French *et al*. 2011; French *et al*. 2014). These studies generally refer to government actions concerning labour market participation. The results generate a strong effect from government behaviour, which can explain the reason for adjustment to pension schemes to some extent. For instance, the granting of disability pension benefits highly correlate with health situation. A generosity in disability benefits produces large incentives for retirement among older worker. However, the screening process of disability status is generally imperfect (Laun *et al*. 2016).

3.2.1.3 Individual characteristics and retirement

The third approach concerns characteristics and retirement (Choi 2001; Van Der Meer

2006; Komp *et al*. 2010). They describe the associations of personal characteristics, compared health status, educational levels and economic position, with employment behaviour.

3.2.2 Retirement status with multiple disciplines

There is a lack of studies taking a broad view to look at the delayed retirement decision covering housing and financial wealth, health and individual characteristics in one general framework. Most of the studies in this field applied a single-level methodology and missed the insight of the multi-level influence, the macro level, meso level and micro level (Hasselhorn *et al*. 2015). In which, macro-level refers to the political and economic environment. Also, previous investigations neglect the interactions among society, occupational factors and individual characteristics on workforce participation (Wang *et al*. 2010; Szinovacz 2013). Therefore, at each of the organisational level, industry level and national level, the limitations of the current studies raise an increased concern about the validity of the findings for policy implications (Phillipson *et al*. 2005; Szinovacz 2013). As a consequence, effort has been focused on an interdisciplinary structure with a broader consideration of the factors affecting delayed retirement (Phillipson *et al*.2005; Wang *et al*. 2010; Szinovacz 2013).

A complex set of variables often influences the determinants of voluntarily delayed retirement. Although only a few empirical studies have reflected such investigations, the complexity of the retirement behaviour among older worker is acknowledged at the theoretical level within the research communities of labour market. For example, Brown *et al*. (2011) have demonstrate the positive association between health problems (i.e. physical illness problems and mental health problems) and labour market withdrawal. Hakola (2002) suggested that health status dominates many other factors, such as financial position and caring responsibilities, in labour market exit. They emphasise the complexity of the retirement decision by discussing the interaction among economic, political and socio-cultural factors, i.e. macro-level analysis - the results in various reflections on specific personal conditions and household circumstances. Wise (2010) made an overview of delayed retirement by viewing social and economic decisions in societies. The study firstly provides evidence of a large inflow of female worker into the labour market in the past decades with little change in the employment rate of men over the same period. Wise (2010) sequentially points out the failed efforts to decrease the unemployment rate among younger persons, particularly youth, by reducing or eliminating the employment rate of older workers. The discussion refers to the “lump of labour” theory of the labour market, which assumes that the whole economy is restricted, and the number of job opportunities cannot be increased. However, many studies have corrected this false view by demonstrating that there is no necessary correlation between a higher employment rate for older workers and a consequent increase in the unemployment rate among younger persons. A high unemployment rate among young people is probably driven by a heavy tax burden. The key features in labour market participation among older workers emphasised the complexity. The discussions have been assessed in many qualitative analyses (Higgs *et al*. 2003; Pond *et al*. 2010; Brown *et al*. 2011; De Vries *et al*. 2011; Loretto *et al*. 2012; de Wind *et al*. 2013), quantitative examinations (de Wind *et al*. 2014; de Wind *et al*. 2015) and overview studies (Phillipson *et al*. 2005; Ekerdt 2010; Szinovacz 2013).

3.2.3 The features determining delayed retirement

In sum, five distinctive aspects add up to characterise the complexity of delayed retirement. The timing of the retirement decision expresses the character and development of the individual; for example, the educational background may influence the profession and hence determine the timing of the retirement decision. Equally, people who have changed jobs at around the age of 60 may not be able to adapt to the changed working environment due to lack of skills or new technologies, such as digital software. Additionally, the retirement process is driven by the interaction between micro, meso and macro levels and different domains. It contains household structure, occupational environments, legislation and social position. For instance, people who worked under extreme pressure or obtained less support from employers in their early career may decide to exit the labour market in their early stage rather than stay on. Moreover, a constant change in societies and the economic entity may determine the retirement behaviour, such as economic growth, technological development and changes in societal values or cultures. For example, the nature of work has been changed by the technological progress of information and communication. Older people today are substantially different from earlier cohorts regarding their social-economic position (e.g. educational background) or attitude. Also, the proposition that more female workers have entered the workforce, as well as migrants, changes the composition of older workers nowadays. Therefore, the change of working-age population leads to a question as to whether the existing research findings are still valid given the fluidity in the determinant of employment participation over the time. Another one is the ramifications for different groups. It relates to demographics such as gender, age group, family size, religion or social position. For example, women typically have lower income than men when they are older. Women usually play particular roles in private, or family life and so are more likely to leave the labour market earlier than men. Consequently, a variety of aspects which may influence the retirement decision need to be considered and reflected in the research. The last but not least, some people could be in partial retirement, transitioning from a full-time job to full retirement (as known as bridge employment) (Beehr *et al*. 2015). Some evidence suggests that, in the United States, bridge employment has become a rule rather than an exception (Cahill *et al*. 2012). Nowadays, many countries have introduced a set of new regulations for employment maintenance, for example, disability benefits, pension schemes, retirement, and returning to employment after retirement. The combination of these mechanisms is mostly triggered by the targeted policy intervention and reflects an increase in the "fragmentation of retirement" (Hasselhorn *et al*. 2015). The consideration of the heterogeneous issues in labour force participation is a challenge for deeper research in this field.

3.2.4 Contribution

Along these lines, the majority of published studies focus on a single or few determinants, rather than taking a broad view of multiple issues among society (i.e. macro-level), working units or enterprises (i.e. meso-level) and personal characteristics (i.e. micro-level) (Wang *et al*. 2010; Szinovacz 2013). Therefore, it is important to advance the research in this field. Our framework will fill in this gap by looking at the interdependencies among health, wealth, socioeconomics and demographics in delayed retirement.

3.3 Hypotheses

We use this section to present four hypotheses which are examined in our study.

As a country's population ages and individuals live beyond working age, the proportion of labour force declines. Due to the retirement of the baby boomer generation, job openings will increase in the next five years. Therefore, given the truth of a low fertility rate in combination with a rapidly increasing proportion of older people in comparison with those working-age persons (20-64) across European countries (United Nations 2018[19]), it is reasonable and important to encourage people aged 65 and above to stay in the labour force. Health status is assumed to be a key factor that determines the ability to

[19] For more details, please find online: www.un.org.

work among the elderly. The results of our investigation can serve as a benchmark in the application of the social security system.

Hypothesis 1*: There should be a negative relationship between adverse health status and the probability of extending working life beyond the "standard" retired age.*

Pension income plays an important role in accounting for retirement decisions across countries. Generous Social Security schemes produce large incentives for retirement in the developed world (Laun *et al*. 2016). The length of working life largely depends on how much people expect to receive from the pension account. If people have accumulated enough pension benefits, and the increase in the expected future pension benefits for working one additional year is not enough to offset the fact that they can receive for one fewer years, workers would stop working at the earliest possible age and claim benefits (Gruber *et al*. 1999, 2004). Our study accounts for employer/occupational pension, disability pension and old-age pension in the model. We assume that the incentives for continued employment in the various European countries depend on social insurance programmes.

Hypothesis 2*: There should be a negative association between high pension income and the probability of delayed retirement.*

The 2007-2008 financial crisis reshaped financial markets, with banks acting to handle exposures to risk and deal with liquidity issues. On one level, pro-cyclical deleveraging required more collateral when household raise a mortgage or financial debt. In other words, in the post-crisis period, of the overall household assets, housing equity should occupy the major amount[20]. On another level, wage incomes tend to level off when individuals are approaching the end of working life; the financial crisis reduced labour earnings substantially. We are interested in exploring how these dual financial and economic shocks will change agents' reaction in retirement patterns.

Hypothesis 3*: Higher outstanding mortgage or debt should associate with increased probability of delayed retirement, even if the values of the houses or financial assets are high.*

The predicted positive relationship between high net housing wealth and longer working life may be caused by either more maintenance needed in a big house, which in turn force residence to extend their working life. Similarly, higher holding values of the net non-housing assets are predicted to associate with a higher possibility of extending employment after 65 years. The general rule is that large investment in financial market is often associated with high leverage in the assets, which in turn generating heavy debt burden to serve, and force people to reconsider their retirement plan. However, there may exist divergence in the significance or direction of housing wealth and non-housing wealth. It is because everyone needs a place to live, while people could sell off all their financial assets.

[20] Total assets equal equity plus the total debt.

Hypothesis 4*: High net housing wealth and net non-housing wealth should associate with a longer working life over standard retirement age.*

3.4 The Empirical Model

3.4.1 Model outline

In this study, we estimate random-effects Probit regression models. We combine factors from multiple disciplines to examine their impacts on delayed retirement. We aim to verify if health status can override many other factors in delayed retirement. It is because majority of studies have applied a single dimension in retirement study while neglecting the potential partial correlation among health status, socioeconomic position, working environment and personal characteristics (Wang *et al*. 2010; Szinovacz 2013; Hasselhorn *et al*. 2015). Based on the literature summarised previously, we will put health status, housing values, non-housing wealth, social security system, working environment, socioeconomic status and demographics in one framework.

3.4.2 Regression model

Based on the available observation on each variable, we estimate two regression models. One is for all country analysis. The other is for each country separately.

$$\begin{aligned} Delayretire_{it} = {} & \alpha_0 + \alpha_1 House_{it} + \alpha_2 NHouse_{it} + \alpha_3 Mortgage_{it} + \alpha_4 Debt_{it} \\ & + \alpha_5 PhysicalHealth_{it} + \alpha_6 MentalHealth_{it} \\ & + \alpha_7 Pensioninc_{it} + \alpha_8 Healthcare_{it} + \alpha_9 Medexp_{it} \\ & + \alpha_{10} Selfemploy_{it} + \alpha_{11} Homeownership_{it} + \alpha_{12} \boldsymbol{X}_{it} + \omega_{it} \end{aligned} \tag{6}$$

Subscript *i* denotes individuals, *t* denotes current survey year.

Delayretire is a binary variable which is defined as 1 for agents aged 65 to 80 years who are working in the corresponding wave, and 0 otherwise. *House* is net housing wealth. *NHouse* estimates net non-housing wealth. *Mortgage* represents outstanding repayment in the main residence. *Debt* is outstanding financial repayment excluding mortgages. *PhysicalHealth* measures health problems faced by the agent on doing daily activities. *MentalHealth* measures emotional health or wellbeing. *Pensioninc* measures pension benefits. *Healthcare* shows whether respondents receive health care or not. *Medexp* refers to the out-of-pocket medical payment. *Selfemploy* measures whether or not the respondents are in self-employment. *Homeownership* estimates the ownership of a house. ***X*** is a vector of personal characteristics which contains demographics, including education level, marital status, family size, age and gender. ω is the residual term containing time and country fixed effects.

The association of net housing values and the likelihood of delayed retirement is given by α_1. α_2 measure the effect of net non-housing assets on delayed retirement. Both α_1 and α_2 should be positive (hypothesis 4). α_3 *and* α_4 demonstrate outstanding debt effects out of total wealth on delayed retirement decision and should show positive associations for the hypothesis 3 to hold.

α_5 *and* α_6 are of particular interests in the analyses. The coefficients estimate the association between adverse health status and delayed retirement. Both signs should be negative under hypothesis 1, which response to the findings made by Brown *et al*. (2011).

The sign of α_7 corresponds to hypothesis 2, which should be negative in response to the arguments made by Laun *et al*. (2016).

$$
\begin{aligned}
Delayretire_{it} = {} & \beta_0 + \beta_1 House_{it} + \beta_2 NHouse_{it} + \beta_3 Mortgage_{it} + \beta_4 Debt_{it} \\
& + \beta_5 PhysicalHealth_{it} + \beta_6 MentalHealth_{it} \\
& + \beta_7 Pensioninc_{it} + \beta_8 Selfemploy_{it} \\
& + \beta_9 Homeownership_{it} + \beta_{10} \boldsymbol{Z}_{it} + \mu_{it}
\end{aligned} \tag{7}
$$

Z is a vector of cohort characteristics which comprises individual demographics, including marital status, education level, age and gender. μ is the residual term containing time and country fixed effects. β_1 to β_4 measure wealth effect on delayed retirement. For countries with low homeownership rate (e.g. Germany), the sign of β_1 should be positive. The sign of β_2 should be positive if the respondents have heavy outstanding debt (hypothesis 4). Both β_3 and β_4 should be positive, indicating positive association between large outstanding debt and the higher probability of delayed retirement (hypothesis 3). Negative signs in β_5 and β_6 demonstrate that adverse health status negatively relate to delayed retirement (hypothesis 1), which relates to the results made by Brown *et al*. (2011). Given the results in Laun *et al*. (2016), a positive sign of β_7 is required for hypothesis 2 to hold.

In addition, people in self-employment tend to extend working life (McNair *et al*. 2004; Wahrendorf *et al*. 2017). The coefficient of self-employment (β_8 in Equation (7)) should be positive. Responding to early retirement study, high educational background is associated with longer employment histories (Komp *et al*. 2010; Wahrendorf *et al*. 2017).

People who are working between the ages of 65 to 80 years are more likely to be younger, not in a partnership (Wahrendorf *et al*. 2017). Therefore, we should expect β_{10} to be positive for those people who have stronger educational background, and not in a partnership. The sign of age to be negative in Equation (6) to Equation (7).

3.5 Variable Selection and Creation

3.5.1 Respondents

In this study, 65 to 80 is the sample age group for analysis. We excluded the people aged below 65 years because this is the statutory retirement age in the EU15 states in 2017[21]. People aged above 80 are excluded from our sample because the average life expectancy in Europe was 75 years for males and 82 years for females in 2018 (World Population Data Sheet 2018)[22]. Therefore, people aged above 80 may have particular longevity situations and drop into the outliers of the panel. The EU15 states are Austria (AT[23]), Belgium (BE), Bulgaria (BG), Croatia (HR), Cyprus (CY), Denmark (DK), France (FR), Germany (DE), Great Britain (GBR), Luxembourg (LU), Netherlands (NL), Poland (PL), Romania (RO), Slovenia (SI) and Spain (ES)[24].

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[21] By 2018, the retirement age in nine sample countries are: Austria: 65 for men and 60 for women. Belgium: 65 for both men and women. Denmark: 65 for both men and women. France: 62 to 67 for both men and women. Germany: 65 years 7 months for both men and women. Spain: 65 years for both men and women. Sweden: 65 years for both men and women. Switzerland: 65 for men and 64 for women. Retirement age in Italy averaged 65.35 from 2009 until 2018, reaching an all-time high of 66.58 in 2016 and a record low of 59 in 2009. Retirement age in most sample countries have an averaged 65 for men and women. Due to a swing in retirement age across sample wave, our study adopts 65 as the retirement age.
[22] For additional information on European demographics, please refer to online sources: https://www.statista.com/statistics/274514/life-expectancy-in-europe/.
[23] Two upper case letters refer to the short country code, e.g. “AT” is for Austria.
[24] For more details about EU retirement age, please refer to information online: www.etk.fi/en/.

Our study has restricted the respondents to people in the nine SHARE countries (Austria, Belgium, Denmark, France, Italy, Germany, Spain, Sweden, and Switzerland) for both men and women. All nine countries have been involved in 5 waves (i.e. wave 1, wave 2, wave 4, wave 5 and wave 6), which provides the availability of previous data in case any information was missing in a particular wave. Sample data were based on the respondents' employment situation, with respondents declared as "employed or self-employed" or "retired" as the best description of their current job situation. It results in a total number of 64,539, comprising 47.44% of men and 52.56% of women.

3.5.2 Measurement

3.5.2.1 Delayed employment between 65 and 80 years

Given the available information in the surveys, respondents were classified into 0-1 categories based on two conditions: (1) aged 65 to 80 in the survey wave; (2) employment situation. The criteria were applied uniformly across all sample waves. The participants who reported yes on either of the following two independent questions were defined as "delayed retirement": (1) "employed or self-employed" best describes their current employment situation at the time of the interview; (2) they did "paid work". In particular, respondents grouped as "employed or self-employed" comprise paid work, working for a family business or own business account without payment, and workers who are hired by an organisation or an individual. Respondents who were coded as "paid work" contain employed and self-employed. In the cases where data were missing in the categories listed above, we gathered the information from the sequent question, which asked about working sectors. There are three options in this question: private-sector employee, public sector employee, self-employed. Participants who reported yes to any of these three options and aged from 65 to 80 were defined as “delayed retirement”. All information was based on the data collected in the corresponding survey year. Among the women aged 65 to 80 in our sample, 2.02% of women are still working beyond 65 years.

For comparison, the multilevel Probit regressions were estimated on two datasets. Group one comprises data collected before the financial crisis. Whereas the second used waves released after the financial crisis. That is to say, section one comprises wave 1 and wave 2 with 16,693 observations. Section two is made up of wave 4, wave 5 and wave 6 with 47,846 observations.

3.5.2.2 Pension income

In our framework, pension income covers three types: employer/occupational pension, public disability pension and public old-age pension. Of which, employer/occupational pension contains lump-sum transfer and before-tax annuity. Public old-age pension consists of an old-age pension and early retirement pensions. We calculate total pension income by summing up three types together. All values are imputed at the household level and adjusted with a price index. The observation after controlling for adjusted pension income is 51,815. For comparison purposes, we rescale pension income[25] so that the parameters are more comparable with other covariates.

3.5.2.3 Financial factors

Four indicators measured the wealth of the household, these being net housing value, housing mortgage, net non-housing value and debt. Net housing value is defined as the sum of the value of the main residence and the value of other real estate, subtracting the mortgage on the main residence. Housing mortgage is directly obtained from the survey available data, which is the mortgage or loan on the main residence. Net non-housing value is calculated by the sum of a fixed and financial assets and debts on these assets. In particular, we add up the value of the own share of the business, the amount in an individual retirement account (IRA) and other long-term savings, the value of bonds and equities, the amount in current and savings accounts, and subtract financial debt. Financial debt was obtained directly from the survey data. In particular, all values described above are measured at the household level. The value of housing is based on what it would be worth if sold at the time of the interview. In SHARE, all monetary amounts have converted into Euro values. all values are inflation-indexed values by using the CPI deflator for avoiding potential bias in housing-related values (OECD 2018[26]). In our sample, six countries are member countries of the Euro area. Although Denmark has

[25] In the regression, we use pension income/100000 to estimate the coefficient.
[26] OECD (2018). Inflation (CPI) (indicator).

its own currency, it is pegged against the Euro. Therefore, the Euro Area Consumer Price Index (CPI) is used to adjust the nominal values in 7 countries (Austria, Germany, Spain, Italy, France, Switzerland, and Belgium) for inflation. For Sweden and Switzerland, the corresponding CPI was used. In case of missing components in the data, information was obtained through imputation (Alcser *et al*. 2005). We dropped the symmetrical 1% outliers for non-housing asset. Furthermore, we create four categorical indicators of wealth. In particular, net housing values and net non-housing values were regrouped into three classes by wealth terciles (i.e. low, medium, high). It is worth noting that, in the section of the country-specific analysis, we classify housing value into two levels (i.e. low and high)[27]. Housing value located in the upper 50% in the corresponding country is defined as a "high" position. The rest is grouped into "low". Mortgage and non-housing debt are regrouped into two levels (i.e. low and high) as half of the observations did not report any positive values of mortgage or debt. Because of a large difference in wealth among sample countries, the values are sorted by each country to avoid selection bias. Based on the sample statistics in SHARE, the majority of people aged between 65 and 80 who are still working are self-employed in waves 1 to wave 4. From wave 5 onwards employed respondents outnumber self-employees (see Table 3.1). The economic situations were evaluated by the housing and non-housing wealth rather than salary,

[27] The definition of the level of housing value bases on the fact that 40% of survey respondents in Austria, 35% in Germany, and 33% in Switzerland report zero net value in housing asset. There are an averaged 18% survey respondents in other six sample countries report 0 net value in housing asset. For comparison, we use 50% as the cutoff point for distinguish high and low level in net housing value in country-specific analysis.

which is appropriate for people who worked beyond statutory retirement age. After controlling four indicators of wealth status, the observation is 57,298.

3.5.2.4 Health conditions and well-being

In this study, the measurements of the state of health comprise two binary indicators: emotional health or well-being, and physical health. The signals represent different aspects of health conditions.

-Emotional health:

In SHARE, the EURO-D scale was incorporated into the surveys to measure the symptoms of emotional health or well-being. The scale contains 12 symptoms: depression, pessimism, suicidality, guilt, sleepless, interest, irritability, appetite, fatigue, concentration, enjoyment and tearfulness. The respondents were asked "how you feel about things that happen around you" on each contributing item as being present in the last month. In this study, we considered all 12 items and summed the responses. We use a cut-off point of 3 symptoms to identify the people who are suffering severe depression; a method has been employed to measure depression severity in factor-analytic studies across Europe (Prince *et al*. 1999). The internal consistency reliability is tested by using Cronbach's Alpha. Within the sample, the scale reliability coefficients are 0.8 in wave 1, 0.82 in wave 2, 0.82 in wave 4, 0.8 in wave 5 and 0.72 in wave 6. The tests emphasise that EURO-D 12-item scale is conceptually relevant.

-Physical health:

In respect to a physical health condition, the variable is based on the limitations in activities of daily living, with a total of 10 symptoms (see Table 2.2). Only those who have suffered any of the symptoms for more than three months were defined as 1. In the analysis, we define more than two difficulties in mobility as having a functional limitation (Wahrendorf *et al*. 2017). The number of observations after controlling for health problems is 56,609.

3.5.2.5 Employment conditions

We distinguish between the salaried employed (i.e. hired by an organisation or an individual) and self-employed (i.e. work for their account). It is worth noting that the self-employed group has a mixed form of payment methods. It comprises persons who did paid work and those who worked for a family business or own business account but were unpaid. Activities without pay, such as voluntary work, are not included in our sample. This measurement is consistent with a categorical social-economic class schema known as the European Socio-economic Classification (ESeC) (Rose *et al*. 2007). After controlling for self-employment, there were 57,298 observations.

3.5.2.6 Additional variables

In addition to the factors described above, we also adjusted for several control variables, including health-care coverage, out-of-pocket medical payment, educational background and demographic details, such as marital status, gender and age. We draw on the differences in the delayed retirement decision concerning health-care coverage. Based on data availability, we create a dummy variable equals one if an individual receives either home health care or private health care, and 0 otherwise.

We consider the interaction between delayed retirement and out-of-pocket medical costs. Increasing out-of-pocket medical expenditure is likely to challenge the burden of retirement life. In our framework, out-of-pocket medical expenditure refers to the total payment from inpatient care, outpatient care, drugs, nursing home and home care. To compare with other parameters, we rescale the absolute value of the individual medical payment.

Homeownership bases on current tenure. Respondents were asked to report household occupancy of the dwelling they currently live. There are five options in the original questionnaire covering various type from “fully owned” to “completely rent-free”. We aggregate the five options into three categories, “entire ownership”, “tenant” and “rent-free”, to increase the reasonable number of observations in each category. In particular, “entire ownership” comprises houses fully owned and those “member of a cooperative”. “tenant” contains the respondents who declared themselves “tenant” or “subtenant”. “rent-free” covers those who report themselves free of rent in the current dwelling. The question is uniformly set across sample waves.

Educational background refers to the level of education or vocational training the respondents have obtained. The various degree categories in sample countries means that education levels need to adapt to a standard classification. Therefore, SHARE applied the International Standard Classification of Education (ISCED) to help standardise educational statistics in accordance with internationally agreed indicators and concepts. Based on the available information in SHARE, we regrouped the full sample into three categories (i.e. low, medium and high). Specifically, "low" education covers people with a pre-primary, primary or lower secondary education background. "Medium" contains respondents who have an upper secondary education or a post-secondary but non-tertiary education. Those individuals with the first and second stage of tertiary education are classified as "high" education.

There are five options on current marital status: (1) married; (2) registered partnership; (3) divorced; (4) widowed; (5) never married. In the regression, option (1) is set as base category. Family size is given by the number of people living in one housing unit. After controlling all variables, the total number of observations drops to 31,213. A full list of variable construction and description is in Table 3A.1.

Table 3.1: Construction of labour market status (delayed retirement)

Construct	Age	Elements	Wave 1		Wave 2		Wave 4		Wave 5		Wave 6	
			N	Prevalence (%)	N	Prevalence (%)	N	Prevalence (%)	N	Prevalence (%)	N	Prevalence (%)
still working	65-80	employed	63	0.9	82	1.11	171	1.5	312	1.95	345	2.23
		self-employed	96	1.37	92	1.25	217	1.91	289	1.8	294	1.89
retired		retired	6,846	97.73	7,194	97.64	10,998	96.59	15,440	96.25	14,859	95.88
Overall			7,005	100	7,368	100	11,386	100	16,041	100	15,498	100

Source: Survey on Health, Ageing and Retirement in Europe (release 6.0).

3.5.3 Analytical strategy

In this study, the analysis takes place on five waves of SHARE (waves 1 to wave 2 and waves 4 to wave 6), restricting the sample to those countries which have participated in all waves and results in a balanced panel data with a total of nine countries[28]. As a first step, Table 3.1 presents an overview of the data description by retirement status for all sample waves. Additionally, Table 3.2 provides the country-specific sample descriptions sorted by retirement status. Table 3.3 shows the descriptive statistics in each sample wave. We separate our analyses into two sections. The two subsamples are bounded by the financial crisis of 2007, which assumes that there is a change in the factors affecting the retirement decision. For each country analysis, the panel covers all waves.

We estimated random intercept multilevel models because of the multilevel structure in the dataset. All models comprise two components: fixed effect and random effect. Fixed effect covers individual-specific time-invariant characteristics. Random effect refers to unobserved differences across entities. In this study, all parameters are estimated by applying the adaptive Gauss-Hermite quadrature to compute the log-likelihood and its derivatives. In the results section, we first compare the outcomes from pre-crisis and post-crisis regressions. There are three consecutive models in each section. All models have

[28] The choice of balanced data depends on frequency and the reasons for missing data. The characteristics of SHARE cannot get rid of additional disturbances from the missing data being random. In other words, the exogeneity assumption cannot hold in unbalanced data, which results in a biased sample data. Also, the frequent missing data generates considerable loss in efficiency which can significantly reduce observations (Baltagi 2005; Cameron *et al*. 2010).

adjusted homeownership, educational background, marital status and demographic variables. Model (1) focuses on the effects of wealth-based variables on delayed retirement. Model (2) estimates of health and well-being indicators. In model (3), we integrate model (1) and model (2) to investigate the association of all covariates. Second, Table 3.7 and Table 3.8 present country-specific analysis. In this part, the variables include housing value, non-housing value, housing mortgage, financial debt, health status and socioeconomic positions. The marginal effects were estimated for all models.

3.6 Statistical Description

3.6.1 Distribution of dependent variables by retirement

From Table 3.2, we can see that the percentages of each delayed retirement group vary across the nine sample countries. In particular, delayed retirement groups are a small proportion in Austria (1.45%), France (1.14%) and Belgium (1.5%), which are far below than the average level of all SHARE countries (4.02%), while the percentages for the self-employed are higher. In contrast, the employed proportion of the elderly was higher than the self-employed in Denmark (4.32% vs 1.89%), although the country holds the second place of the late retired population (6.21%) among nine sample countries. Residents in Switzerland present the highest percentage of delayed retirement (7.92%) with more self-employees (4.53%). For other sample countries, people in Germany, Spain, and Italy show a higher percentage of self-employment while Sweden has a larger number in employed position within the late retirement group.

Table 3.2: Labour market participation by each sample country (delayed retirement)

Country	**Delayed Retirement**		**Retired**	
	Employed (%)	Self-employed (%)	Retired (%)	Total (%)
Austria	0.66	0.79	98.55	100
Germany	1.52	1.66	96.82	100
Sweden	2.51	2.07	95.42	100
Spain	1.03	1.36	97.61	100
Italy	0.73	1.94	97.33	100
France	0.44	0.70	98.86	100
Denmark	4.32	1.89	93.79	100
Switzerland	3.39	4.53	92.08	100
Belgium	0.56	0.94	98.50	100
SHARE total	2.32	1.70	95.98	100

Note: Each type of labour market participation is based on the current status. SHARE total is the average percentage of all countries in each sample wave. All percentages in the table are the average numbers of all sample waves.

Source: Survey on Health, Ageing and Retirement in Europe (release 6.0).

3.6.2 Multivariable description

3.6.2.1 Descriptive statistics by wave

In this study, variables are characterised as ordinal. Therefore, we calculate Spearman's correlation between the dependent and independent variables. Table 3.3 presents a description of covariates according to delayed retirement in each wave. Given the description, wealth-based indicators present low *p*-values throughout sample waves. It indicates that wealth variables, represented by housing assets, non-housing assets, housing mortgage and financial debt in this chapter, have strong correlations with delayed retirement. The high values for housing and non-housing assets dominate. Concerning health conditions, which are measured by depression symptoms and limitations, people who have suffered additional health problems in recent years are less likely to extend their working life into older age. The retired group generally presents over twice the percentage as the delay retired group. The *p*-value is smaller than 0.001 for both emotional health problem and for physical health problem in all waves, which demonstrate that adverse health status can significant influence working life. Turning to pension income, $p < 0.001$ appearing in all waves indicates that retirement behaviour could depend on the generosity of pension benefits. Regarding employment status, people who choose to retire late tend to work in self-employment. The percentages of self-employment are dominant in both the absolute scale within the delayed retirement group and the percentage points compared with the retired group. The *p*-values for self-employment effect are lower than

0.001 and stable across different waves. Also, those who have a longer working life tend to be highly educated respondents. The percentages of men who stay in the labour market beyond the “standard” retirement age (i.e. 65 years old) are slightly more than the numbers in the retired group. Also, people who are younger or living as a single person would be more likely to continue working over a certain age.

Table 3.3: Sample description of covariates by labour market status in each wave: Observations (no.) and percentage (%) or mean and standard deviation (SD)

Variables	Wave 1				Wave 2			
	Delayed Retirement		**Retired**		**Delayed Retirement**		**Retired**	
	Prevalence (%) or mean (SD)	N	Prevalence (%) or mean (SD)	N	Prevalence (%) or mean (SD)	N	Prevalence (%) or mean (SD)	N
Sex								
Male	55.97	89	53.75	3,680	62.07	108	54.34	3,909
Female	44.03	70	46.25	3,166	37.93	66	45.66	3,285
p value	0.58	159		6,846	0.04	174		7,194
Age years	68.21 (3.79)	159	71.53 (4.48)	6,846	68.43 (3.39)	174	71.56 (4.49)	7,194
p value	<0.001				<0.001			
Marital status								
Married	66.67	106	68.76	4,708	70.68	123	71.01	5,059
Registered partnership	3.14	5	2.97	203	4.59	8	3.97	283
Divorced	7.55	12	4.62	316	8.62	15	4.58	326
Widowed	15.72	25	18.43	1,262	8.62	15	16.16	1,151
Never married	6.92	11	5.22	357	7.49	13	4.28	305
p value	0.55	159		6,846	0.99	174		7,124
Education								
High	37.11	59	56.76	3,886	30.46	53	17.04	1,226
Medium	33.33	53	27.61	1,890	37.93	66	30.15	2,169
Low	29.56	47	15.63	1,070	31.61	55	52.81	3,799
p value	<0.001	159		6,846	<0.001	174		7,194

Net housing value								
High	57.23	91	31.48	2,155	56.32	98	30.58	2,200
Medium	32.08	51	43.73	2,994	33.33	58	45.33	3,261
Low	10.69	17	24.79	1,697	10.35	18	24.09	1,733
p value	<0.001	159		6,846	<0.001	174		7,194
Net non-housing value								
High	50.31	80	28.44	1,947	51.15	89	28.94	2,082
Medium	25.79	41	37.28	2,552	24.14	42	36.67	2,638
Low	23.80	38	34.28	2,347	24.71	43	34.39	2,474
p value	<0.001	159		6,846	<0.001	174		7,194
Housing mortgage								
High	29.56	47	11.93	817	32.76	57	14.40	1,036
Low	70.44	112	88.07	6,029	67.24	117	85.6	6,158
p value	<0.001	159		6,846	<0.001	174		7,194
Non-housing debt								
High	18.24	29	9.99	684	18.39	32	10.19	733
Low	81.76	130	90.01	6,162	81.61	142	89.81	6,461
p value	<0.001	159		6,846	<0.001	174		7,194
Homeownership								
Rent free	4.62	6	6.09	297	4.76	6	5.27	261
Tenant	13.08	17	23.89	1,165	15.87	20	22.19	1,100
Entire ownership	82.30	107	70.02	3,415	79.37	100	72.54	3,596
p value	0.004	130		4,877	0.10	126		4,957
Pension income	0.17 (0.18)	128	0.28 (0.33)	6,075	0.26 (1.09)	144	0.24 (0.25)	6,485
p value	<0.001				<0.001			

Out-of-pocket medical payment	0.03 (0.05)	159	0.03(0.08)	6,846	0.03 (0.08)	174	0.03 (0.09)	7,194
p value	0.48				0.75			
Health care								
Yes	0.13	21	0.16	1,065	0.18	32	0.17	1,240
No	0.87	138	0.84	5,781	0.82	142	0.83	5,954
p value	0.42	159		6,846	0.69	174		7,194
Emotional health problem								
Yes	8.18	13	24.07	1,639	12.07	21	22.06	1,577
No	91.82	146	75.93	5,169	87.93	153	77.94	5,573
p value	<0.001	159		6,808	0.002	174		7,150
Physical health problem								
Yes	10.69	17	25.92	1,774	7.51	13	24.85	1,787
No	89.31	142	74.08	5,070	92.49	160	75.15	5,405
p value	<0.001	159		6,844	<0.001	173		7,192
Self-employed								
Yes	60.37	96	1.91	131	52.87	92	2.89	208
No	39.62	63	98.09	6,715	47.13	82	97.11	6,986
p value	<0.001	159		6,846	<0.001	174		7,194
Family size	1.97 (0.86)	159	1.90 (0.74)	6,846	2.06 (0.89)	174	1.93 (0.73)	7,194
p value	0.40				0.10			
Overall	100	≤159	100	≤6,846	100	≤174	100	≤7,194

p values base on analysis of Spearman's correlation.

Source: Survey on Health, Ageing and Retirement in Europe (release 6.0).

Table 3.3: Sample description of covariates by labour market status in each wave: Observations (no.) and percentage (%) or mean and standard deviation (SD) (continued)

Variables	Wave 4				Wave 5			
	Delayed Retirement		Retired		Delayed Retirement		Retired	
	Prevalence (%) or mean (SD)	N	Prevalence (%) or mean (SD)	N	Prevalence (%) or mean (SD)	N	Prevalence (%) or mean (SD)	N
Sex								
Male	54.64	212	53.09	5,839	64.56	388	52.16	8,053
Female	45.36	176	46.91	5,159	35.44	213	47.84	7,387
p value	0.55	388		10,998	<0.001	601		15,440
Age years	68.49 (3.67)	388	71.66 (4.46)	10,998	68.16 (3.39)	601	71.56 (4.46)	15,440
p value	<0.001				<0.001			
Marital status								
Married	68.95	262	70.74	7,666	74.83	443	72.23	11,021
Registered partnership	9.47	36	4.17	452	6.93	41	4.76	726
Divorced	8.16	31	6.03	653	8.78	52	5.91	902
Widowed	7.63	29	14.43	1,564	4.89	29	12.84	1,959
Never married	5.79	22	4.63	502	4.57	27	4.26	650
p value	0.43	380		10,837	0.07	592		15,258
Education								
High	37.11	144	20.03	2,203	40.93	246	22.50	3,474
Medium	37.11	144	34.37	3,780	34.61	208	34.48	5,324
Low	25.78	100	45.60	5,015	24.46	147	43.02	6,642
p value	<0.001	388		10,998	<0.001	601		15,440

Net housing value								
High	49.23	191	33.32	3,664	52.91	318	33.98	5,246
Medium	34.28	133	45.23	4,974	33.78	203	45.79	7,071
Low	16.49	64	21.45	2,360	13.31	80	20.23	3,123
p value	<0.001	388		10,998	<0.001	601		15,440
Net non-housing value								
High	49.23	191	31.96	3,515	54.41	327	31.17	4,813
Medium	30.15	117	35.53	3,908	25.96	156	36.11	5,576
Low	20.62	80	32.51	3,575	19.63	118	32.72	5,051
p value	<0.001	388		10,998	<0.001	601		15,440
Housing mortgage								
High	31.70	123	14.68	1,614	38.94	234	16.39	2,532
Low	68.30	265	85.32	9,384	61.06	367	83.61	12,908
p value	<0.001	388		10,998	<0.001	601		15,440
Non-housing debt								
High	13.40	52	9.77	1,074	18.14	109	10.38	1,602
Low	86.60	336	90.23	9,924	81.86	492	89.62	13,838
p value	0.02	388		10,998	<0.001	601		15,440
Homeownership								
Rent free	4.15	12	5.76	439	3.23	13	5.24	541
Tenant	27.34	79	21.69	1,652	18.66	75	21.23	2,192
Entire ownership	68.51	198	72.55	5,525	78.11	314	73,53	7,590
p value	0.21	289		7,616	0.03	402		10,323
Pension income	0.27 (0.51)	329	0.29 (0.38)	9,984	0.22 (0.31)	503	0.27 (0.29)	14,095
p value	<0.001				<0.001			

Out-of-pocket medical payment	-[29]	-	-	-	0.05 (0.09)	601	0.05 (0.09)	15,440
p value					0.23			
Health care								
Yes	-	-	-	-	0.03	19	0.10	1,574
No	-	-	-	-	0.97	582	0.90	13,866
p value					<0.001	601		15,440
Emotional health problem								
Yes	17.05	66	24.73	2,701	14.33	86	23.34	3,575
No	82.95	321	75.27	8,220	85.67	514	76.66	11,741
p value	<0.001	387		10,921	<0.001	600		15,316
Physical health problem								
Yes	10.31	40	24.30	2,672	7.17	43	22.78	3,517
No	89.69	348	75.70	8,323	92.83	557	77.22	11,923
p value	<0.001	388		10,995	<0.001	600		15,440
Self-employed								
Yes	55.93	217	3.70	407	48.09	289	4.25	656
No	44.07	171	96.3	10,591	51.91	312	95.75	14,784
p value	<0.001	388		10,998	<0.001	601		15,440
Family size	1.99 (0.88)	388	1.90 (0.72)	10,998	1.97 (0.70)	601	1.91 (0.69)	15,440
p value	0.09				0.02			
Overall	100	≤388	100	≤10,998	100	≤601	100	≤15,440

p values base on analysis of Spearman's correlation.

Source: Survey on Health, Ageing and Retirement in Europe (release 6.0).

[29] Out-of-pocket medical payment and health care are not available in wave 4.

Table 3.3: Sample description of covariates by labour market status in each wave: Observations (no.) and percentage (%) or mean and standard deviation (SD) (continued)

Variables	Wave 6			
	Delayed Retirement		**Retired**	
	Prevalence (%) or mean (SD)	N	Prevalence (%) or mean (SD)	N
Sex				
Male	60.72	388	51.92	7,715
Female	39.28	251	48.08	7,144
p value	<0.001	639		14,859
Age years	68.23 (3.48)	639	71.62 (4.45)	14,859
p value	<0.001			
Marital status				
Married	72.83	461	70.73	10,503
Registered partnership	8.53	54	5.14	755
Divorced	9.32	59	6.37	936
Widowed	5.69	36	12.61	1,852
Never married	3.63	23	4.37	643
p value	0.12	633		14,689
Education				
High	38.18	244	24.34	3,616
Medium	37.25	238	34.83	5,175
Low	24.57	157	40.83	6,068
p value	<0.001	639		14,859
Net housing value				
High	51.02	326	35.12	5,219
Medium	28.64	183	38.40	5,706

Low	20.34	130	26.48	3,934
p value	<0.001	639		14,859
Net non-housing value				
High	49.77	318	32.81	4,875
Medium	29.73	190	35.16	5,224
Low	20.50	131	32.03	4,760
p value	<0.001	639		14,859
Housing mortgage				
High	38.18	244	16.29	2,422
Low	61.82	395	823.71	12,437
p value	<0.001	639		14,859
Non-housing debt				
High	17.06	109	10.40	1,545
Low	82.94	530	89.60	13,314
p value	<0.001	639		14,859
Homeownership				
Rent free	1.77	8	5.32	528
Tenant	23.06	104	20.43	2,026
Entire ownership	75.17	339	74.25	7,363
p value	0.40	451		9,917
Pension income	0.24 (0.36)	521	0.28 (0.37)	13,551
p value	<0.001			
Out-of-pocket medical payment	0.06 (0.10)	639	0.06 (0.09)	14,859
p value	0.004			
Health care				
Yes	0.04	23	0.10	1,452
No	0.96	616	0.90	13,407
p value	<0.001	639		14,859

Emotional health problem				
Yes	8.53	54	18.44	2,666
No	91.47	579	81.56	11,795
p value	<0.001	633		14,461
Physical health problem				
Yes	7.51	48	22.16	3,292
No	92.49	591	77.84	11,565
p value	<0.001	639		14,857
Self-employed				
Yes	46.01	294	5.39	801
No	53.99	345	94.61	14,058
p value	<0.001	639		14,859
Family size	1.98 (0.74)	639	1.91 (0.69)	14,859
p value	0.007			
Overall	100	≤639	100	≤14,859

p values base on analysis of Spearman's correlation.

Source: Survey on Health, Ageing and Retirement in Europe (release 6.0).

3.6.2.2 Descriptive statistics by country

Table 3.4 presents a description of covariates by labour market participation sorted by each country. We can see delayed retired people only occupy a small part of the population among people who reached the standard retirement age. Denmark and Sweden have significant pairwise correlation between wealth-base indicators (i.e. housing assets and non-housing assets) and retirement status with *p*-values smaller than 0.001. Outstanding debts (i.e. housing mortgage and non-housing debt) show a strong correlation with delayed retirement in Germany, Italy, Spain and Sweden with low *p*-values. It demonstrates that the high values of outstanding debts can significantly influence retirement decision among older people. Concerning health functioning, which are measured by depression symptoms (i.e. emotional health problem in Table 3.4) and limitations (i.e. physical health problem in Table 3.4), people who have adverse health status are less likely to extend their working life into older age. The evidence can be found in all nine countries based on Spearman's correlations. Although the observations are generally higher in the retired group, retired people have much higher percentages in adverse health status than people who delayed retired. Turning to pension income, $p < 0.001$ appearing in all countries demonstrates that retirement decisions could depend on the access to pension benefits. The retired group generally have a large amount of pension income compared with delayed retirement group. Also, people who choose to have a longer working life are generally self-employed. The percentages of self-employment are dominant in both the absolute scale within the delayed retirement group and the percentage points compared with the retired group. The *p*-values for self-employment effect are lower than 0.001 and stable in all nine countries providing significant correlation between self-employment and retirement decisions.

Table 3.4: Sample description of covariates by labour market status sorted by each country: Observations (no.) and percentage (%) or mean and standard deviation (SD)

Variables	Austria				Belgium			
	Delayed Retirement		Retired		Delayed Retirement		Retired	
	Prevalence or mean (SD)	N	Prevalence or mean (SD)	N	Prevalence or mean (SD)	N	Prevalence or mean (SD)	N
Sex								
Male	0.45	36	0.44	2,976	0.60	62	0.46	3,819
Female	0.55	44	0.56	3,856	0.40	41	0.54	4,485
p value	0.79	80		6,832	0.004	103		8,304
Age years	68.58 (3.46)	80	71.43 (4.28)	6,832	68.77 (4.06)	103	71.65 (4.58)	8,304
p value	<0.001				<0.001			
Marital status								
Married	0.61	49	0.61	4,144	0.46	47	0.67	5,501
Single	0.39	31	0.39	2,640	0.54	56	0.33	2,766
p value	0.98	80		6,784	<0.001	103		8,267
Education								
High	0.43	34	0.24	1,662	0.50	52	0.28	2,300
Medium	0.44	35	0.47	3,205	0.22	23	0.23	1,903
Low	0.13	11	0.29	1,965	0.28	28	0.49	4,101
p value	<0.001	80		6,832	<0.001	103		8,304
Net housing value								
High	0.60	48	0.48	3,252	0.56	58	0.46	3,838
Low	0.40	32	0.52	3,580	0.44	45	0.54	4,466

p value	0.03	80		6,832	0.04	103		8,304
Net non-housing value								
High	0.59	47	0.31	2,115	0.43	44	0.31	2,556
Medium	0.23	18	0.38	2,600	0.32	33	0.35	2,885
Low	0.18	15	0.31	2,117	0.25	26	0.34	2,863
p value	<0.001	80		6,832	0.008	103		8,304
Housing mortgage								
High	0.08	6	0.06	398	0.07	7	0.02	207
Low	0.92	74	0.94	6,434	0.93	96	0.98	8,097
p value	0.53	80		6,832	0.006	103		8,304
Non-housing debt								
High	0.13	10	0.06	438	0.11	11	0.08	670
Low	0.87	70	0.94	6,394	0.89	92	0.92	7,634
p value	0.03	80		6,832	0.33	103		8,304
Homeownership								
Rent free	0.05	3	0.17	850	0.05	4	0.04	227
Tenant	0.38	23	0.32	1,544	0.24	21	0.19	1,099
Entire ownership	0.57	35	0.51	2,490	0.71	63	0.77	4,385
p value	0.09	61		4,884	0.26	88		5,711
Pension income	0.19 (0.20)	71	0.25 (0.19)	6,370	0.45 (1.50)	81	0.40 (0.62)	7,567
p value	<0.001				<0.001			
Emotional health problem								
Yes	0.10	8	0.19	1,285	0.13	13	0.26	2,143
No	0.90	72	0.81	5,368	0.87	90	0.74	6,110
p value	0.04	80		6,653	0.002	103		8,253

Physical health problem								
Yes	0.12	10	0.27	1,841	0.07	7	0.28	2,319
No	0.88	70	0.73	4,989	0.93	96	0.72	5,985
p value	0.004	80		6,830	<0.001	103		8,304
Self-employed								
Yes	0.60	48	0.04	268	0.64	66	0.03	237
No	0.40	32	0.96	5,834	0.36	37	0.97	6,945
p value	<0.001	80		6,102	<0.001	103		7,182
Overall	100%	<80	100%	<6,832	100%	<103	100%	<8,304

p values base on analysis of Spearman's correlation.

Source: Survey on Health, Ageing and Retirement in Europe (release 6.0).

Table 3.4: Sample description of covariates by labour market status sorted by each country: Observations (no.) and percentage (%) or mean and standard deviation (SD) (continued)

Variables	Denmark				France			
	Delayed Retirement		Retired		Delayed Retirement		Retired	
	Prevalence or mean (SD)	N	Prevalence or mean (SD)	N	Prevalence or mean (SD)	N	Prevalence or mean (SD)	N
Sex								
Male	0.72	251	0.47	2,238	0.52	43	0.44	3,208
Female	0.28	97	0.53	2,540	0.48	40	0.56	4,116
p value	<0.001	348		4,778	0.14	83		7,324
Age years	67.93 (3.06)	348	71.46 (4.49)	4,778	68.53 (3.63)	83	71.83 (4.59)	7,324
p value	<0.001				<0.001			
Marital status								
Married	0.72	252	0.68	3,248	0.55	44	0.64	4,666
Single	0.28	96	0.32	1,509	0.45	36	0.36	2,585
p value	0.11	348		4,757	0.08	80		7,251
Education								
High	0.54	187	0.33	1,567	0.37	31	0.17	1,271
Medium	0.37	130	0.42	2,024	0.30	25	0.28	2,057
Low	0.09	31	0.25	1,187	0.33	27	0.55	3,996
p value	<0.001	348		4,778	<0.001	83		7,324
Net housing value								
High	0.74	256	0.48	2,314	0.64	53	0.48	3,547
Low	0.266	92	0.52	2,464	0.36	30	0.52	3,777
p value	<0.001	348		4,778	0.01	83		7,324

Net non-housing value								
High	0.59	204	0.28	1,321	0.55	46	0.34	2,493
Medium	0.24	83	0.36	1,702	0.30	25	0.35	2,568
Low	0.17	61	0.36	1,755	0.15	12	0.31	2,263
p value	<0.001	348		4,778	<0.001	83		7,324
Housing mortgage								
High	0.53	184	0.36	1,721	0.06	5	0.04	302
Low	0.47	164	0.64	3,057	0.94	78	0.96	7,022
p value	<0.001	348		4,778	0.39	83		7,324
Non-housing debt								
High	0.23	80	0.12	593	0.24	20	0.16	1,136
Low	0.77	268	0.88	4,185	0.76	63	0.84	6,188
p value	<0.001	348		4,778	0.03	83		7,324
Homeownership								
Rent free	0.004	1	0.004	13	0.09	6	0.04	223
Tenant	0.15	35	0.27	900	0.19	12	0.18	906
Entire ownership	0.846	201	0.726	2,406	0.72	44	0.78	4,021
p value	<0.001	237		3,319	0.14	62		5,160
Pension income	0.14 (0.13)	291	0.25 (0.15)	4,323	0.15 (0.15)	76	0.26 (0.18)	6,728
p value	<0.001				<0.001			
Emotional health problem								
Yes	0.06	22	0.13	631	0.18	15	0.32	2,344
No	0.94	326	0.87	4,119	0.82	67	0.68	4,909
p value	<0.001	348		4,750	0.01	82		7,253
Physical health problem								

Yes	0.05	19	0.17	828	0.11	9	0.27	1,955
No	0.95	329	0.83	3,950	0.89	74	0.73	5,369
p value	<0.001	348		4,778	<0.001	83		7,324
Self-employed								
Yes	0.30	106	0.02	110	0.61	51	0.02	130
No	0.70	242	0.98	4,608	0.39	32	0.98	6,825
p value	<0.001	348		4,718	<0.001	83		6,955
Overall	100%	<348	100%	<4,778	100%	<83	100%	<7,324

p values base on analysis of Spearman's correlation.

Source: Survey on Health, Ageing and Retirement in Europe (release 6.0).

Table 3.4: Sample description of covariates by labour market status sorted by each country: Observations (no.) and percentage (%) or mean and standard deviation (SD) (continued)

Variables	Germany				Italy			
	Delayed Retirement		Retired		Delayed Retirement		Retired	
	Prevalence or mean (SD)	N	Prevalence or mean (SD)	N	Prevalence or mean (SD)	N	Prevalence or mean (SD)	N
Sex								
Male	0.59	111	0.51	3,506	0.72	119	0.49	3,984
Female	0.41	78	0.49	3,321	0.28	47	0.51	4,211
p value	0.05	189		6,827	<0.001	166		8,195
Age years	68.30 (3,73)	189	71.45 (4.39)	6,827	68.61 (3.83)	166	71.49 (4.40)	8,195
p value	<0.001				<0.001			
Marital status								
Married	0.74	139	0.75	5,111	0.79	128	0.77	6,301
Single	0.26	48	0.25	1,664	0.21	33	0.23	1,833
p value	0.73	187		6,775	0.54	161		8,134
Education								
High	0.38	72	0.28	1,893	0.21	35	0.05	433
Medium	0.44	84	0.56	3,846	0.30	50	0.15	1,255
Low	0.18	33	0.16	1,088	0.49	81	0.80	6,507
p value	0.05	189		6,827	<0.001	166		8,195
Net housing value								
High	0.65	123	0.49	3,413	0.64	107	0.47	3,871
Low	0.35	66	0.51	3,414	0.36	59	0.53	4,324

p value	<0.001	189		6,827	<0.001	166		8,195
Net non-housing value								
High	0.42	79	0.26	1,756	0.56	93	0.31	2,533
Medium	0.26	49	0.40	2,764	0.25	41	0.42	3,447
Low	0.32	61	0.34	2,307	0.19	32	0.27	2,215
p value	0.003	189		6,827	<0.001	166		8,195
Housing mortgage								
High	0.24	45	0.09	601	0.05	8	0.02	172
Low	0.76	144	0.91	6,226	0.95	158	0.98	8,023
p value	<0.001	189		6,827	0.02	166		8,195
Non-housing debt								
High	0.17	33	0.09	617	0.10	16	0.06	524
Low	0.83	156	0.91	6,218	0.90	150	0.94	7,671
p value	<0.001	189		6,827	0.09	166		8,195
Homeownership								
Rent free	0.06	8	0.09	401	0.07	7	0.07	366
Tenant	0.22	31	0.31	1,379	0.09	9	0.09	498
Entire ownership	0.72	100	0.60	2,652	0.84	88	0.84	4,420
p value	0.004	139		4,432	0.79	104		5,284
Pension income	0.13 (0.15)	152	0.23 (0.33)	6,139	0.13 (0.13)	142	0.16 (0.18)	7,590
p value	<0.001				<0.001			
Emotional health problem								
Yes	0.13	25	0.19	1,336	0.17	27	0.34	2,752
No	0.87	163	0.81	5,440	0.83	136	0.66	5,308
p value	0.03	188		6,776	<0.001	163		8,060

Physical health problem								
Yes	0.09	17	0.26	1,750	0.07	12	0.33	2,741
No	0.91	170	0.74	5,074	0.93	154	0.67	5,452
p value	<0.001	187		6,824	<0.001	166		8,193
Self-employed								
Yes	0.54	102	0.03	217	0.73	121	0.06	395
No	0.46	87	0.97	6,287	0.27	45	0.94	6,165
p value	<0.001	189		6,504	<0.001	166		6,560
Overall	100%	<189	100%	<6,827	100%	<166	100%	<8,195

p values base on analysis of Spearman's correlation.

Source: Survey on Health, Ageing and Retirement in Europe (release 6.0).

Table 3.4: Sample description of covariates by labour market status sorted by each country: Observations (no.) and percentage (%) or mean and standard deviation (SD) (continued)

Variables	Sweden				Spain			
	Delayed Retirement		Retired		Delayed Retirement		Retired	
	Prevalence or mean (SD)	N	Prevalence or mean (SD)	N	Prevalence or mean (SD)	N	Prevalence or mean (SD)	N
Sex								
Male	0.62	247	0.47	3,472	0.60	81	0.48	4,070
Female	0.38	149	0.53	3,906	0.40	53	0.52	4,438
p value	<0.001	396		7,378	0.004	134		8,508
Age years	67.61 (3.08)	396	71.53 (4.39)	7,378	68.11 (3.59)	134	72.17 (4.60)	8,508
p value	<0.001				<0.001			
Marital status								
Married	0.71	277	0.70	5,102	0.83	110	0.79	6,504
Single	0.29	111	0.30	2,159	0.17	23	0.21	1,768
p value	0.64	388		7,261	0.25	133		8,272
Education								
High	0.39	157	0.24	1,782	0.31	42	0.06	525
Medium	0.28	112	0.27	1,960	0.09	12	0.05	481
Low	0.33	137	0.29	3,636	0.60	80	0.89	7,502
p value	<0.001	396		7,378	<0.001	134		8,508
Net housing value								
High	0.69	275	0.51	3,731	0.67	90	0.49	4,230
Low	0.31	121	0.49	3,647	0.33	44	0.51	4,278

p value	<0.001	396		7,378	<0.001	134		8,508
Net non-housing value								
High	0.07	218	0.33	2,462	0.51	69	0.28	2,399
Medium	0.27	110	0.36	2,626	0.25	33	0.39	3,397
Low	0.66	68	0.31	2,290	0.24	32	0.33	2,712
p value	<0.001	396		7,378	<0.001	134		8,508
Housing mortgage								
High	0.56	220	0.40	2,967	0.07	10	0.04	323
Low	0.44	176	0.60	4,411	0.93	124	0.96	8,185
p value	<0.001	396		7,378	0.03	134		8,508
Non-housing debt								
High	0.65	103	0.19	1,412	0.09	12	0.06	503
Low	0.35	293	0.81	5,966	0.91	122	0.94	8,005
p value	<0.001	159		7,378	0.14	134		8,508
Homeownership								
Rent free	0.003	1	0.008	41	0.03	2	0.03	177
Tenant	0.18	51	0.22	1,096	0.12	9	0.05	253
Entire ownership	0.817	235	0.772	3,880	0.85	63	0.92	4,860
p value	0.07	287		5,017	0.04	74		5,290
Pension income	0.24 (0.21)	316	0.31 (0.17)	6,389	0.079 (0.21)	123	0.13 (0.09)	8,015
p value	<0.001				<0.001			
Emotional health problem								
Yes	0.11	44	0.16	1,203	0.17	22	0.32	2,600
No	0.89	352	0.84	6,137	0.83	110	0.68	5,642
p value	0.01	396		7,340	<0.001	132		8,242

Physical health problem								
Yes	0.06	24	0.16	1,206	0.10	14	0.35	3,007
No	0.94	372	0.84	6,170	0.90	120	0.65	5,499
p value	<0.001	396		7,376	<0.001	134		8,506
Self-employed								
Yes	0.45	178	0.05	366	0.54	73	0.04	243
No	0.55	218	0.95	6,985	0.45	61	0.96	5,797
p value	<0.001	396		7,351	<0.001	134		6,040
Overall	100%	<396	100%	<7,378	100%	<134	100%	<8,508

p values base on analysis of Spearman's correlation.

Source: Survey on Health, Ageing and Retirement in Europe (release 6.0).

Table 3.4: Sample description of covariates by labour market status sorted by each country: Observations (no.) and percentage (%) or mean and standard deviation (SD) (continued)

Variables	Switzerland			
	Delayed Retirement		Retired	
	Prevalence or mean (SD)	N	Prevalence or mean (SD)	N
Sex				
Male	0.62	220	0.48	2,174
Female	0.38	137	0.52	2,363
p value	<0.001	357		4,537
Age years	68.72 (3.64)	357	71.65 (4.46)	4,537
p value	<0.001			
Marital status				
Married	0.68	242	0.71	3,195
Single	0.32	112	0.29	1,291
p value	0.25	354		4,486
Education				
High	0.30	108	0.12	531
Medium	0.57	205	0.61	2,777
Low	0.13	44	0.27	1,229
p value	<0.001	357		4,537
Net housing value				
High	0.65	233	0.52	2,369
Low	0.35	124	0.48	2,168

p value	<0.001	357		4,537
Net non-housing value				
High	0.46	166	0.30	1,379
Medium	0.27	98	0.35	1,577
Low	0.27	93	0.35	1,581
p value	<0.001	357		4,537
Housing mortgage				
High	0.55	197	0.47	2,119
Low	0.45	160	0.53	2,418
p value	0.002	357		4,537
Non-housing debt				
High	0.08	29	0.04	183
Low	0.92	328	0.96	4,354
p value	<0.001	357		4,537
Homeownership				
Rent free	0.04	11	0.04	139
Tenant	0.29	82	0.36	1,120
Entire ownership	0.67	186	0.60	1,887
p value	0.03	279		3,146
Pension income	0.48 (0.65)	275	0.54 (0.48)	3,953
p value	<0.001			
Emotional health problem				
Yes	0.10	36	0.15	692
No	0.90	321	0.85	3,835
p value	0.008	357		4,527

Physical health problem				
Yes	0.05	19	0.13	575
No	0.95	338	0.87	3,961
p value	<0.001	357		4,536
Self-employed				
Yes	0.59	212	0.08	357
No	0.41	145	0.92	3,897
p value	<0.001	357		4,254
Overall	100%	<357	100%	<4,537

p values base on analysis of Spearman's correlation.

Source: Survey on Health, Ageing and Retirement in Europe (release 6.0).

3.7 Empirical Results

Table 3.5 to Table 3.8 show the estimated values in Equation (6) and Equation (7). Specifically, the estimated general model is presented for the pre-crisis era (Table 3.5), and the post-crisis period (Table 3.6)[30]. In both Table 3.5 and Table 3.6, Model (1) investigates the wealth effect, accounting for pension income. Model (2) focuses on the effect of health-related and well-being factors on delayed retirement behaviour. Model (3) contains all covariates. We aim to find out the potential partial correlation between any two control variables. The regression results for each country are shown in Table 3.7 and Table 3.8. The model takes into account wealth-based variables and health-related indicators simultaneously. All regressions have adjusted employment status, homeownership and demographic factors, such as marital status, education background, age and gender. Marginal effects were estimated in all models.

3.7.1 Regression analysis for all nine countries

The multivariable findings confirm hypothesis 1 and sample descriptions in that adverse health status generates significant negative association in delayed retirement. Our results verify the finding in Brown *et al*. (2011), where poor health positively relates to labour market exit. As mentioned in the work of Brown *et al*. (2011), physical illness problems explain the continued withdrawal from the labour market. In our models, the effect is

[30] We have used interaction terms to make sure the effects of relevant variables before and after the crisis are statistically significantly different. Based on the regression results, the differences in the effects of financial assets, mortgage, education, self-employment, pension benefits, and tenant are statistically significant (see Table 3A.2).

strong and stable before and after the financial crisis (Model (2) in Table 3.5 and Table 3.6). That is to say, the occurrence of 2 or more symptoms since the last interview on the disability scale is associated with a decrease in the probability of delayed retirement. In line with Brown *et al*. (2011), mental impairments link to shorter working life. In the pre-crisis period, with three more symptoms since the last interview decreasing delayed retirement by 40% on average (Model (2) in Table 3.5). Regarding the level of wealth, housing assets generates a significant role in the labour market with a higher value indicating a higher probability of delayed retirement. The results are consistent with hypothesis 4, while our findings are different from the work of Bloemen (2002, 2006) where the level of assets is associated with negative influence on the probability of staying in employment. It is worth noting that, although Bloemen (2002, 2006) consider housing value in the assets measure and distinguish total wealth with debt outstanding. The work does not use housing wealth and financial wealth as two separate variables. Also, the dependent variable in the study of Bloemen (2002) is labour market transition from unemployment to employment which is different from our analysis. Bloemen (2006) focuses on early retirement and does not provide a constant positive significant effect of wealth on early job exit. In our analysis, the positive relationship between high housing wealth and longer working life can be found in both the pre-crisis and post-crisis periods (Model (1) and Model (3) in Table 3.5 and Table 3.6). For example, before the 2007-2008 financial crisis, it generated a 48 per cent higher probability of delayed retirement when respondents have net housing value located in the top terciles in each corresponding country, compared with lower classes. Regarding financial wealth, the results show a greater effect in extending working life into old age after the 2007-2008 financial crisis. In the post-crisis period, a household with a higher net value of financial assets is more likely to stay in the labour market. The marginal effect is 42% on average from bottom terciles to the top terciles in the corresponding country (Model (1) and Model (3) in Table 3.6). Mortgage and financial debt both generate positive effects on delayed retirement behaviour, which confirms the hypothesis 3 and confirm the findings made by Bloemen (2006). Specifically, in the post-crisis period, people who have a mortgage classified into the upper half of the distribution in the corresponding country is associated with approximately 47 per cent higher probability to retire late (Model (1) in Table 3.6). A higher value of financial debt is associated with an increased 20 per cent probability of delayed retirement in the post-crisis period (Model (1) in Table 3.6) and an increased 30 per cent in the pre-crisis period (Model (1) in Table 3.5). Model (3) in Table 3.5 and Table 3.6 contain wealth-based variables and health-related indicators, significant effects of wealth-based variables still exist. However, attenuated effects appear in both wealth indicators and health factors. It demonstrates a partial correlation of the association between non-housing values and delayed retirement behaviour by a serious health problem.

Our results highlight the fact that higher pension income does not help for continued employment. The result responds to hypothesis 2 and verify the findings made by Laun *et al*. (2016), where generous social benefits reduce the incentives of working longer. The negative effect tends to become smaller after the financial crisis (Model (1) to Model (3) in Table 3.5 and Table 3.6), this may be caused by pronounced pension reform in the public security systems. The prevalence of generous pension benefits indeed dampens retirement postponement in most European countries. Furthermore, in both pre- and post-financial crisis periods, people with a higher educational attainment, younger, never married and in self-employment are more likely to have a longer working life (Model (1) to Model (3) in Table 3.5 and Table 3.6). The effects are constant and statistically significant different from zero in all estimations. The results confirm the findings in the literature mentioned previously (Komp *et al*. 2010; Wahrendorf *et al*. 2017). The evidence shows that people who entirely own the property are less likely to extend their working life, compared with free renters and tenants, though the effects vary across the two periods, they are consistent in direction.

It is worth noting that the marginal effect of self-employment is 2.67 on average in Table 3.5 and Table 3.6. In other words, holding all other regressors constant, the probability of staying in the labour market among self-employed people is 2.67 higher than employees. The significant effects of self-employment on delayed retirement appear in all waves. They have the flexibility to continue working. Our results verify the arguments made by McNair *et al*. (2004) and Wahrendorf *et al*. (2017), where people in self-employment tend to extend working life.

Table 3.5: Associations of covariates in delayed retirement in 9 European countries and wave 1-2: results of multilevel Probit regression models: incidence marginal effects and significance level

Variables	Model (1) Delayed Retirement	Model (2) Delayed Retirement	Model (3) Delayed Retirement
adjhomewealth			
D1 (ref.)[a] low			
D2[b].medium	0.189		0.169
	(0.203)		(0.206)
D3.high	0.498**		0.475**
	(0.228)		(0.231)
adjffwealth			
D1 (ref.) low			
D2.medium	-0.149		-0.257
	(0.158)		(0.157)
D3.high	0.084		-0.051
	(0.167)		(0.162)
adjhsmort			
D1 (ref.) low			
D2.high	0.349*		
	(0.183)		
adjfinancldebt			
D1 (ref.) low			
D2.high	0.304*		
	(0.183)		
hlthcare			
D1 (ref.) no			
D2.yes	-0.303	-0.207	-0.218
	(0.186)	(0.188)	(0.188)
adjmedicexp	-2.704	-2.004	-2.191
	(1.657)	(1.647)	(1.673)
adjpensioninc	-2.414***	-2.482***	-2.545***
	(0.504)	(0.519)	(0.519)
education			
D1 (ref.) low			
D2.medium	0.343**	0.359**	0.197
	(0.163)	(0.164)	(0.141)
D3.high	0.396**	0.378**	0.265*
	(0.188)	(0.189)	(0.157)
slfemploy			
D1 (ref.) no			

D2.yes	2.858***	2.876***	2.876***
	(0.303)	(0.310)	(0.310)
home ownership			
D1 (ref.) rent free			
D2.tenant	-0.544*	-0.540*	-0.569*
	(0.295)	(0.299)	(0.299)
D3.entire ownership	-0.462	-0.174	-0.391
	(0.283)	(0.268)	(0.285)
ragey	-0.089***	-0.096***	-0.096***
	(0.019)	(0.019)	(0.019)
ragender			
D1 (ref.) male			
D2.female	0.266*	0.344**	0.354**
	(0.143)	(0.148)	(0.149)
rmstat			
D1 (ref.) married			
D2. registered partnership	-0.042	-0.028	-0.041
	(0.399)	(0.404)	(0.408)
D3. Divorced	0.376	0.385	0.401*
	(0.239)	(0.241)	(0.221)
D4. Widowed	0.024	-0.011	-0.016
	(0.206)	(0.210)	(0.187)
D5. never married	0.529**	0.466*	0.483**
	(0.243)	(0.243)	(0.221)
hhhhres	-0.016	0.023	
	(0.096)	(0.099)	
depressive			
D1 (ref.) no			
D2.yes		-0.462**	-0.293*
		(0.202)	(0.165)
disability			
D1 (ref.) no			
D2.yes		-0.319	-0.441**
		(0.202)	(0.185)
Cons	2.511**	3.132**	3.194**
	(1.274)	(1.279)	(1.271)
Obs	8,604	8,582	8,582

Source: Survey on Health, Ageing and Retirement in Europe (release 6.0)

All estimates of Model are controlled country fixed effect and time fixed effect

Standard errors in parentheses

* p < 0.10, ** p < 0.05, *** p < 0.01

[a] Base level

[b] Difference between medium and low level

Table 3.6: Associations of covariates in delayed retirement in 9 European countries and wave 4-6: results of multilevel Probit regression models: incidence marginal effects and significance level

Variables	Model (1) Delayed Retirement	Model (2) Delayed Retirement	Model (3) Delayed Retirement
adjhomewealth			
D1 (ref.)[a] low			
D2[b].medium	0.066 (0.124)		0.029 (0.125)
D3.high	0.364** (0.141)		0.324** (0.142)
adjffwealth			
D1 (ref.) low			
D2.medium	0.203* (0.107)		0.129* (0.106)
D3.high	0.476*** (0.115)		0.384*** (0.113)
adjhsmort			
D1 (ref.) low			
D2.high	0.471*** (0.118)		
adjfinancldebt			
D1 (ref.) low			
D2.high	0.202* (0.117)		
hlthcare			
D1 (ref.) no			
D2.yes	-0.505*** (0.194)	-0.207 (0.188)	-0.313 (0.199)
adjmedicexp	0.002 (0.433)	-2.004 (1.647)	0.088 (0.434)
adjpensioninc	-1.068*** (0.189)	-2.482*** (0.519)	-1.064*** (0.190)
education			
D1 (ref.) low			
D2.medium	-0.094 (0.114)	-0.019 (0.114)	-0.085 (0.115)
D3.high	0.134 (0.120)	0.273** (0.119)	0.129 (0.121)
slfemploy			
D1 (ref.) no			
D2.yes	2.431*** (0.176)	2.526*** (0.149)	2.447*** (0.178)

home ownership			
D1 (ref.) rent free			
D2.tenant	0.014	-0.078	-0.058
	(0.231)	(0.235)	(0.236)
D3.entire ownership	-0.477**	-0.182	-0.353*
	(0.234)	(0.225)	(0.235)
ragey	-0.161***	-0.168***	-0.168***
	(0.016)	(0.016)	(0.016)
ragender			
D1 (ref.) male			
D2.female	-0.038	-0.027	-0.008
	(0.089)	(0.089)	(0.089)
rmstat			
D1 (ref.) married			
D2. registered partnership	0.196	0.169	0.195
	(0.186)	(0.187)	(0.187)
D4. divorced	0.467***	0.359**	0.343**
	(0.159)	(0.158)	(0.140)
D5. widowed	-0.062	-0.164	-0.209
	(0.158)	(0.160)	(0.144)
D6. never married	0.198	0.060	0.008
	(0.187)	(0.188)	(0.172)
hhhhres	0.128*	0.122	
	(0.077)	(0.079)	
depressive			
D1 (ref.) no			
D2.yes		-0.077	-0.056
		(0.119)	(0.119)
disability			
D1 (ref.) no			
D2.yes		-0.677***	-0.651***
		(0.153)	(0.154)
Cons	6.288***	7.089***	7.215***
	(0.996)	(1.011)	(0.996)
Obs	18,126	18,011	18,011

Source: Survey on Health, Ageing and Retirement in Europe (release 6.0)

All estimates of Model are controlled country fixed effect and time fixed effect

Standard errors in parentheses

* p < 0.10, ** p < 0.05, *** p < 0.01

[a] Base level

[b] Difference between medium and low level

3.7.2 Separate regression analysis by country

Table 3.7 and Table 3.8 present the empirical results for nine sample countries. The estimates demonstrate that an adverse health status generates strong and negative effects for longer working lives. The results confirm hypothesis 1 and the work made by Brown *et al*. (2011), where adverse health status has negative association with delayed retirement. If people have got additional health problems in health, they are less likely to extend their working lives into older age. In particular, physical health problem produces a significant effect on labour supply patterns in Germany, Sweden, Italy, Denmark, Switzerland and Belgium, while this effect is more moderate in France, Austria and Spain (Table 3.7 and Table 3.8).

The statistically significant effects of pension income on delayed retirement carry over in country-specific analysis. The negative relationship between high pension income and low incentive of delayed retirement can be found in almost all sample countries, except that Austria, Switzerland and Belgium, the correlation is weaker but consistent in direction (Table 3.7 and Table 3.8). Our results are consistent with the arguments made by Gruber *et al*. (1999, 2004). Notably, in France and Spain, high pension income is associated with greater incentives to retire on time. In line with the literature summarised previously, our findings verify the results in Laun *et al*. (2016) to the extent that the old-age pension scheme creates large incentives for early retirement in France.

In line with the work of Bloemen (2002, 2006), higher mortgage and debt stimulate people to extend their working life. The significant effects can be found in Austria, Germany, Sweden, Spain and Italy (Table 3.7 and Table 3.8). The results emphasise the fact that people who have made commitments to service the mortgage or debt in the future are more likely to have a longer working life, which confirms hypothesis 3. Similar to the arguments made by Bloemen (2006), housing value does not constantly generate statistically significant effects. Among nine sample countries, most countries present a positive relationship between a high housing value and delayed retirement, which is consistent with hypothesis 4 and the estimates containing all nine countries. In particular, people living in Germany, Denmark and Sweden are more likely to extend their working life if their net housing values are in the upper 50% of the corresponding country. The probability is approximately 44 per cent higher in Germany (Table 3.7), nearly 67 per cent higher in Denmark (Table 3.8) and 35 percentage points higher in Sweden (Table 3.7) respectively. The results show that housing assets can compensate pension income in retirement. Also, housing assets can help to maintain lifetime incomes. On one hand, people could make loans by using houses as collateral. They can realise the value of houses immediately. On the other hand, heavy loans will force workers to work longer for maintaining the ability of loan repayment, especially for those parents who are planning to transfer their house to children. In times of house price inflation, these people will hold a big house rather than switch to a smaller one. In turn, a big house requires higher loan repayment and more maintenance services. The fact is that Germans usually rent their homes rather than buy a house. The homeownership rate in Germany remains low. It was 43% in 2013[31]. The rates are even lower in Denmark and Sweden with Sweden's homeownership rate ranks the lowest as 10%. While in Spain, around 82% of people live in owner-occupied housing[32]. Therefore, the high housing values in Denmark, Germany and Sweden play no role in compensating the loss of working salaries.

Regarding non-housing assets, the results are inconsistent across 9 countries. The results partly go against hypothesis 4. Only Sweden, France and Denmark show a positive and significant relationship between longer working life and high net non-housing assets (see Table 3.7 and Table 3.8). Large investment in the financial market is associated with high leverage and large debt, and thus, serious financial commitment to undertake. One implication of the longer working life in association with high housing equity and high non-housing equity is that it is difficult to explain empirically. Cultural environment and something outside of our model influences the delayed retirement arising purely from the tradition inherent with a person.

Moreover, as the results demonstrated in McNair *et al*. (2004), Komp *et al*. (2010) and Wahrendorf *et al*. (2017), a strong educational background will promote a longer length of working life (see Table 3.7 and Table 3.8), except for the Germans, who reduce the

[31] The German Socioeconomic Panel (GSOEP) for Germany (2014). Last updated 15th December 2016.
[32] OECD calculations based on European Survey on Income and Living Conditions (EU SILC) 2014 except Germany. Last updated 15th December 2016.

likelihood of late retirement if they have a higher education degree. Women are more likely to extend their working life beyond age 65 than men even though women in some countries (e.g. Austria) can retire at 60. Consistent with all country estimation, people who choose to stay in the labour market beyond 65 years old are generally younger, living individually, free renters and self-employed.

Table 3.7: Associations of covariates in delayed retirement in each sample country: results of multilevel Probit regression models: incidence marginal effects and significance level

Variables	(Austria) Delayed Retirement	(Germany) Delayed Retirement	(Sweden) Delayed Retirement	(Spain) Delayed Retirement	(Italy) Delayed Retirement
adjhouseequity					
D1 (ref.)[a] low					
D2[b].high	0.283	0.441*	0.357**	0.277	0.114
	(0.458)	(0.227)	(0.154)	(0.224)	(0.364)
adjffwealth					
D1 (ref.) low					
D2.medium	-0.089	-0.072	0.303*	-0.206	-0.104
	(0.369)	(0.165)	(0.168)	(0.237)	(0.444)
D3.high	0.571	-0.019	0.411**	-0.441	0.621
	(0.358)	(0.192)	(0.175)	(0.277)	(0.445)
adjhsmort					
D1 (ref.) low					
D2.high	-0.436	0.071***	0.341**	0.998***	1.184*
	(0.556)	(0.213)	(0.146)	(0.367)	(0.763)
adjfinancldebt					
D1 (ref.) low					
D2.high	0.780**	0.115	-0.042	-0.329	0.459
	(0.392)	(0.205)	(0.152)	(0.367)	(0.519)
depressive					
D1 (ref.) no					
D2.yes	-0.607	0.092	0.021	0.114	-0.119
	(0.476)	(0.176)	(0.183)	(0.251)	(0.369)
disability					
D1 (ref.) no					
D2.yes	-0.452	-0.378*	-0.458**	-0.190	-0.813*
	(0.429)	(0.197)	(0.229)	(0.277)	(0.444)
adjpensioninc	-0.590	-2.561***	-2.086***	-12.392***	-8.155***
	(0.635)	(0.589)	(0.416)	(2.320)	(2.252)
education					
D1 (ref.) low					
D2.medium	-0.529	-0.648***	0.013	0.804**	0.879**
	(0.436)	(0.192)	(0.160)	(0.339)	(0.449)
D3.high	0.083	-0.739***	0.140	1.062***	2.349***
	(0.433)	(0.232)	(0.162)	(0.325)	(0.656)

slfemploy					
D1 (ref.) no					
D2.yes	3.271***	1.895***	1.797***	2.613***	4.897***
	(0.852)	(0.236)	(0.191)	(0.463)	(1.039)
homeownership					
D1 (ref.) rent free					
D2.tenant	0.877	0.332	0.439	0.794	0.620
	(0.609)	(0.304)	(0.203)	(0.718)	(0.748)
D3.entire owner	0.358	-0.094	-0.020	0.338	-0.412
	(0.666)	(0.336)	(0.868)	(0.673)	(0.612)
ragey	-0.194***	-0.079***	-0.186***	-0.094***	-0.088**
	(0.064)	(0.019)	(0.025)	(0.027)	(0.043)
ragender					
D1 (ref.) male					
D2.female	0.848**	0.126	-0.110	0.249	1.459***
	(0.394)	(0.151)	(0.135)	(0.214)	(0.486)
mstat					
D1 (ref.) single					
D2. married	0.182	0.127	-0.079*	0.068	0.506
	(0.343)	(0.157)	(0.142)	(0.224)	(0.403)
Cons	7.528**	3.327**	9.612***	3.776**	0.724
	(3.629)	(1.335)	(1.578)	(1.883)	(3.037)
Obs	4,005	3,671	4,165	3,290	3,765

Source: Survey on Health, Ageing and Retirement in Europe (release 6.0)

All estimates of Model are controlled country fixed effect and time fixed effect

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

[a] Base level

[b] Difference in the probability of delayed retirement between high and low

Table 3.8: Associations of covariates in delayed retirement in each sample country: results of multilevel Probit regression models: incidence marginal effects and significance level

Variables	(France) Delayed Retirement	(Denmark) Delayed Retirement	(Switzerland) Delayed Retirement	(Belgium) Delayed Retirement
adjhouseequity				
D1 (ref.)[a] low				
D2[b].high	0.461	0.675**	0.059	-0.288
	(0.512)	(0.264)	(0.196)	(0.223)
adjffwealth				
D1 (ref.) low				
D2.medium	1.510**	0.4999*	-0.274	0.124
	(0.698)	(0.299)	(0.167)	(0.207)
D3.high	1.444**	1.193***	0.112	0.067
	(0.705)	(0.333)	(0.172)	(0.231)
adjhsmort				
D1 (ref.) low				
D2.high	0.415	0.239	0.003	0.224
	(0.791)	(0.236)	(0.213)	(0.397)
adjfinancldebt				
D1 (ref.) low				
D2.high	-0.058	0.814***	0.429	-0.053
	(0.460)	(0.280)	(0.271)	(0.304)
depressive				
D1 (ref.) no				
D2.yes	-0.514	-0.323	-0.174	-0.366
	(0.464)	(0.359)	(0.205)	(0.231)
disability				
D1 (ref.) no				
D2.yes	-1.064	-0.668*	-0.611**	-0.514*
	(0.799)	(0.371)	(0.291)	(0.263)
adjpensioninc	-10.386***	-8.229***	-0.178	0.001
	(3.359)	(1.214)	(0.143)	(0.155)
education				
D1 (ref.) low				
D2.medium	0.557	0.347	0.461**	-0.063
	(0.521)	(0.357)	(0.210)	(0.234)
D3.high	0.978	0.743**	0.855***	0.054
	(0.613)	(0.370)	(0.275)	(0.209)

slfemploy				
D1 (ref.) no				
D2.yes	5.135***	2.753***	2.028***	2.493***
	(1.697)	(0.392)	(0.208)	(0.348)
homeownership				
D1 (ref.) rent free				
D2.tenant	-1.144	-1.685	-0.454	0.036
	(0.787)	(1.031)	(0.353)	(0.404)
D3.entire owner	-2.125**	-2.050**	-0.432	-0.145
	(0.983)	(1.041)	(0.402)	(0.393)
ragey	-0.209**	-0.229***	-0.114***	-0.056***
	(0.086)	(0.042)	(0.019)	(0.022)
ragender				
D1 male (ref.)				
D2.female	0.447	-0.570**	0.146	0.117
	(0.468)	(0.244)	(0.159)	(0.186)
mstat				
D1 (ref.) single				
D2. married	0.189	0.225	-0.056	-0.445**
	(0.483)	(0.257)	(0.161)	(0.211)
Cons	9.936**	14.560***	5.243***	0.699
	(5.065)	(3.045)	(1.331)	(1.531)
Obs	4,408	3,000	2,606	4,465

Source: Survey on Health, Ageing and Retirement in Europe (release 6.0)

All estimates of Model are controlled country fixed effect and time fixed effect

Standard errors in parentheses

* p < 0.10, ** p < 0.05, *** p < 0.01

[a] Base level

[b] Difference in the probability of delayed retirement between high and low

3.8 Discussion and Conclusion

In this study, we explored the determinants of delayed retirement behaviour among people aged 65 to 80. The sample covers 9 European countries which were involved in waves 1, wave 2, wave 4, wave 5, and wave 6 in SHARE. The multilevel models comprise health-related indicators, pension income, wealth-based variables, employment situation and demographic details. We estimate a binary response model for the delayed retirement concerning relevant control variables. The regression results support our hypotheses in that higher pension income dampens the incentives of a longer working life. The negative association is prevalent in most European countries. Adverse health status will stop people from working into older age. The limitations in doing daily activities removes the option of delayed retirement. Housing value and net non-housing value generate different effects in retirement behaviour across the nine countries, even though people locate in the same stratification in the corresponding country. Some countries show a positive effect of high housing value and net non-housing value in delayed retirement. The phenomenon could be explained by the fact that large repayment loans required when holding a big house. Our findings demonstrate that people with heavier mortgage burdens and financial debt in the corresponding country are more likely to extend their working life in older age. It partially reflects the problems of servicing loans. The evidence also shows that the effects of self-employment on the delayed retirement are positive at all times. Also, people who are more likely to stay in the labour market are those who have a stronger education background are younger and renters. Given high longevity rates, the proportion of older people relative to working-age population is increasing rapidly (20 years to 64 years) across European countries, it is reasonable to defer the state retirement age. Based on a Cobb-Douglas production function, an increase in the labour force growth rate will increase total output. The lack of skilled labour force can hold the economic growth back. Policymakers should improve social care system and advocate a healthy lifestyle, so people have the ability to work in an advanced age. Also, the situation of family wealth can generate incentive to work longer. The authorities could carefully adjust interest rate to control the amount of debt repayment and keep the integrity of financial market.

Some restrictions need to be considered. Our study only considers the correlation between delayed retirement and the explanatory variables. The sample data does not capture extracurricular exposures or information on illness. In general, it takes time to diagnose a disease, and therefore, the effects of adverse health status on retirement behaviour can have a lagged response. It is reasonable to analyse the proxies of illness, such as heavy smoking and the frequency of drinking alcohol, at an early age which could produce a causal effect on the diagnosed diseases observed today and thus affect retirement behaviour. The information of the proxies is covered by SHARE wave 3, which focuses on the retrospective assessment of the participant's life courses.

Appendix 3A

Table 3A.1: Variables and descriptions

Variable name	Definition
delayed retirement	binary dependent variable=1 if respondents are employed/self-employed/do pay work in an age range of 65-80; 0 otherwise
adjhomewealth	the position of CPI-adjusted net housing wealth; 1=bottom terciles; 2=medium terciles; 3=top terciles
adjhouseequity	binary independent variable=1 if the CPI-adjusted housing equity is located in the upper 50% in the corresponding country; 0 otherwise
adjffwealth	the position of CPI adjusted net non-housing wealth; 1=bottom terciles; 2= medium terciles; 3=top terciles
adjhsmort	binary independent variable=1 if the CPI-adjusted housing mortgage is located in the upper 50% in the corresponding country; 0 otherwise
adjfinancldebt	binary independent variable=1 if the CPI-adjusted financial debt is located in the upper 50% in the corresponding country; 0 otherwise
depressive	binary independent variable=1 if respondents presented more than three symptoms in EURO-D scale; 0 otherwise
disability	binary independent variable=1 if respondents presented more than two symptoms in physical limitation symptoms; 0 otherwise
hlthcare	binary independent variable=1 if respondents receive either home health care or private health care; 0 otherwise

adjmedicexp	Rescaled value of the out-of-pocket medical payment
adjpensioninc	CPI-adjusted pension income
slfemploy	binary independent variable=1 if respondents reported self-employed; 0 otherwise
rmstat	marital satatus measurement one for all countries panel; 1=married; 2=registered partnership; 3= divorced; 4=widowed; 5=never married
mstat	marital status measurement two for cohort study of each country; binary independent variable=1 if respondents were married and living together with spouse; 0 otherwise
education	educational grade; 1=low; 2=medium; 3=high
homeownership	homeownership; 1= rent free; 2= tenant; 3=entire ownership
hhhhres	the number of people living in the house
ragey	age years in the contemporaneous survey year
ragender	binary independent variable=1 if respondents are female; 0 otherwise

Table 3A.2: Associations of covariates in delayed retirement in 9 European countries: Effect modification based on interactions

Variables	Model (1) Delayed Retirement	(2) Delayed Retirement	(3) Delayed Retirement
adjhomewealth			
D1 (ref.)[a] low			
D2[b].medium	0.126		0.090
	(0.113)		(0.115)
D3.high	0.400***		0.356***
	(0.127)		(0.129)
adjhomewealth#beforecrisis			
D2#beforecrisis	0.128		0.138
	(0.223)		(0.229)
D3#beforecrisis	0.169		0.188
	(0.251)		(0.256)
adjffwealth			
D1 (ref.) low			
D2.medium	0.163*		0.101
	(0.097)		(0.097)
D3.high	0.431***		0.355***
	(0.102)		(0.101)
adjffwealth#beforecrisis			
D2#beforecrisis	-0.284		-0.300
	(0.189)		(0.189)
D3#beforecrisis	-0.347*		-0.346*
	(0.196)		(0.194)
adjhsmort			
D1 (ref.) low			
D2.high	0.510***		
	(0.103)		
adjhsmort#beforecrisis			
D2#beforecrisis	-0.317*		
	(0.186)		
adjfinancldebt			
D1 (ref.) low			
D2.high	0.139		
	(0.106)		
adjfinancldebt#beforecrisis			
D2#beforecrisis	0.130		
	(0.209)		

hlthcare			
D1 (ref.) no			
D2.yes	-0.586***	-0.392**	-0.380**
	(0.183)	(0.189)	(0.189)
hlthcare#beforecrisis			
D2#beforecrisis	0.352	0.258	0.233
	(0.261)	(0.269)	(0.268)
adjmedicexp	-0.076	0.182	0.019
	(0.409)	(0.411)	(0.412)
adjmedicexp#beforecrisis	-2.699	-2.460	-2.556
	(1.672)	(1.682)	(1.708)
adjpensioninc	-1.368***	-1.293***	-1.340***
	(0.185)	(0.187)	(0.187)
adjpensioninc#beforecrisis	-1.185***	-1.416***	-1.462***
	(0.446)	(0.451)	(0.453)
education			
D1 (ref.) low			
D2.medium	0.085	0.167	0.112
	(0.102)	(0.103)	(0.103)
D3.high	0.295***	0.436***	0.303***
	(0.108)	(0.109)	(0.110)
education#beforecrisis			
D2#beforecrisis	0.374**	0.367**	0.343*
	(0.181)	(0.181)	(0.183)
D3#beforecrisis	0.173	0.087	0.121
	(0.204)	(0.204)	(0.208)
slfemploy			
D1 (ref.) no			
D2.yes	2.160***	2.272***	2.185***
	(0.128)	(0.133)	(0.131)
slfemploy#beforecrisis			
D2#beforecrisis	0.681***	0.667***	0.702***
	(0.171)	(0.173)	(0.174)
home ownership			
D1 (ref.) rent free			
D2.tenant	0.012	-0.056	-0.030
	(0.208)	(0.215)	(0.214)
D3.entire ownership	-0.455**	-0.103	-0.296
	(0.209)	(0.205)	(0.211)
home ownership#beforecrisis			
D2#beforecrisis	-0.772**	-0.748**	-0.810**
	(0.358)	(0.370)	(0.369)
D3#beforecrisis	-0.202	-0.331	-0.374
	(0.346)	(0.337)	(0.350)
ragey	-0.132***	-0.139***	-0.138***
	(0.011)	(0.011)	(0.011)

ragender			
D1 (ref.) male			
D2.female	-0.078	-0.052	-0.034
	(0.071)	(0.073)	(0.073)
rmstat			
D1 (ref.) married			
D2. registered partnership	0.180	0.162	0.180
	(0.154)	(0.157)	(0.156)
D3. Divorced	0.418***	0.341***	0.357***
	(0.125)	(0.126)	(0.113)
D4. Widowed	-0.009	-0.092	-0.113
	(0.121)	(0.124)	(0.110)
D5. never married	0.330**	0.215	0.205
	(0.141)	(0.144)	(0.131)
hhhhres	0.068	0.075	
	(0.058)	(0.061)	
depressive			
D1 (ref.) no			
D2.yes		-0.085	-0.064
		(0.110)	(0.110)
depressive#beforecrisis			
D2#beforecrisis		-0.241	-0.240
		(0.228)	(0.2288)
disability			
D1 (ref.) no			
D2.yes		-0.690***	-0.668***
		(0.144)	(0.145)
disability#beforecrisis			
D2#beforecrisis		0.244	0.215
		(0.266)	(0.268)
Cons	4.705***	5.431***	5.372***
	(0.751)	(0.765)	(0.747)
Obs	26,824	26,685	26,685

Source: Survey on Health, Ageing and Retirement in Europe (release 6.0)

All estimates of Model are controlled country fixed effect and time fixed effect

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

[a] Base level

[b] Difference between medium and low level

CHAPTER 4 WHAT FACTORS DETERMINE LABOUR MARKET PARTICIPATION OF THE MIDDLE-AGED AND ELDERLY IN CHINA? EVIDENCE FROM THE CHINA HEALTH AND RETIREMENT LONGITUDINAL STUDY

This chapter explores the associations of retirement behaviour with chronic diseases and poor health among the elderly in China. Our study does both longitudinal analysis and treatment effects. The findings emphasise that labour market participation is strongly correlated with illness, *hukou* location and pension insurance in China. A reinforced medical care system, implemented household registration reform and developed pension networks are the focus for Chinese policymakers who aim at rebalancing social development, improving elderly welfare and, as a consequence, release social security pressure.

4.1 Introduction

People in developing and middle-income countries have been living longer. The increase in ageing population and demographic dynamics place significant burdens on the social security system. In 2015, China scrapped the decades-long one-child policy as the total fertility rate has been continually decreasing from 12.95‰ in 2016 to 10.94‰ in 2018 (National Bureau of Statistics 2019). In contrast, the proportion of Chinese people aged 60 years or over is 16.2 per cent of the total population in 2017, projected to increase to 35.1 per cent by 2050 (United Nations 2017). China's population pyramid is upside down.

According to the United Nations (2009), by 2050, the elderly population will grow more rapidly than almost any country in recent history. China's dependency ratio for retirees could rise as high as 44%[33]. The shrinking number of workers associated with China's expanding elderly population has become a problem. The Chinese government has focused on age structure variables. Nonetheless, the working-age population in China has the greater burden of supporting the elderly population through financial support as well as in-kind transfers (Lee *et al*. 2011). The increasing size of the ageing population is a real challenge facing China now and, in the future, pushing Chinese policymakers to form a new perspective on retirement rules. Although urban China was predicted to contribute more to the ageing population given increasing life expectancy and low birth rate (Zeng *et al*. 1989), the massive younger migrants from rural China to urban areas in recent decades will infuse the young adults and improve the demographic structure away from ageing in urban area. In turn, rural areas will probably experience an even greater proportion of elderly (Adamchak 2001). Among people aged 60 or older, 80% come from rural China.

The pension scheme and retirement policy differ between those who have an agricultural *hukou*[34] and those with a non-agricultural *hukou*. The difference is extreme in China.

[33] The dependency ratio is calculated by the number of people who are not in the labour force with those who are working or can work full-time.

[34] *Hukou* is a system of household registration in China. It is the policy of population management and has origins in ancient China. *Hukou* system is more properly to be called *huji*. *Hukou* officially identifies a person as a resident of an area and includes identifying information such as name, parents, spouse, and date of birth. *Hukou* system incorporated with enrolment in education systems, employment systems and Social Security systems highly control the mobility of the Chinese population.

Most urban residents with formal working units can get access to the more reliable pension scheme. Particularly, the urban elderly who worked for the government, a state-owned firm or private institutions have more generous support in retirement than those who worked in farming (Adamchak 2001). The statutory retirement age is imposed strictly in the formal sectors in urban areas. Therefore, urban residents retire at a relatively younger age. Rural areas, by contrast, lack financial protection from a social security system. People who are long-term residents in rural China heavily rely on family support from younger generations in old age and are more likely to continue doing agricultural-related activities until an older age (Giles *et al*. 2011).

Increasing retirement age is proposed as a feasible method to handle the rising age structure of the population. The feasibility of reshaping labour market participation depends on individual health functioning, socioeconomic conditions, working productivities and policy implementation. The status defined as personal chronic disease has found to have a relationship with the retirement decision and the ability to remain in the labour market into older age (Bazzoli 1985; Tanner 1998; Deschryvere 2004; Lindeboom 2006).

In Asia, many developing countries are experiencing a rapid change in the population structure. The elderly population has become a prominent group nationwide, and the nature of health problems have changed from infectious to chronic disease. The Chinese government has implemented a rapid expansion in the provision of health insurance. The most successful one is the New Cooperative Medical Scheme (NCMS), which was introduced in 2003 for the rural areas. The Ministry of Health of China claims that more than 97% of the rural population of the country participated in the NCMS in 2011[35]. However, the changes in these social-security policies have unknown implications for the welfare of the elderly. Studying the effects of these policies will yield insights that may be relevant for other developing countries (Banks *et al*. 2012)

This chapter aims to find out the determinants of retirement in China for both early exit and delayed retirement. Due to unbalanced economic development and social environment in China, this chapter divides the whole sample into three regions: the western region, the central region and the coastal regions. Furthermore, this chapter identifies rural-urban disparities in the labour market by controlling *hukou* location in the regressions. While previous studies focus on the effects of pension schemes and health status on retirement decisions in China, none of them has examined treatment effect among diseases. Our study uses panel data to examine the treatment effect for health issues, which can take the advantage of the unbiased estimation of treatment effect. Also, panel data allows us to cover both individual characteristics and their changes over time. Our framework also includes wealth status, which hasn't been covered in Chinses case. In our empirical equation, we control health functioning, financial situations,

[35] The Central People's Government of the People's Republic of China. Online available: http://www.gov.cn/xwfb/2012-02/27/content_2077409.htm (20th September 2018, date last accessed).

socioeconomic status, pension policies and demographic details to explore individual behaviour in the labour market across urban and rural areas in China. The reason for doing this is trying to explain as much of the spurious correlation between health status and retirement decisions as possible. To my knowledge, no literature has done this work for Chinese case.

While chronic diseases will pull "retirees" at a younger age, the effect of mental health problems on labour market participation may be unclear. Significant numbers of the workforce which reached the statutory retirement age are in self-employment or farming. As a consequence of different default retirement age for men and women in China, labour market participation would vary across genders before and after the default retirement age, with important differences in social security status, household wealth and personal background.

We firstly review the data source and the measurements of variables. After the statistical description, we lay out the empirical regression model regarding the associations of labour market participation with health-related status, eligible pension, household-level wealth status, and demographic circumstance. The chapter specifies two clusters according to the statutory retirement age, one is for men below 60 and women below 55, and the other one is for men at the age range of 60-80 and women at the age range of 55-80. This study presents comparative analyses for two subgroups and highlights important issues of the Chinese labour market that may be addressed using an up-to-date panel framework.

The remainder of this chapter is as follows: Section 4.2 reviews previous studies on early retirement and late retirement. Section 4.3 raises hypotheses that we will examine in this chapter. In Section 4.4, we describe the data source. Section 4.5 explains the methodologies used in this study. Section 4.6 provides variable definitions as well as target respondents used in CHARLS. Section 4.7 reports descriptive statistics for both key variables and control variables. Section 4.8 delivers the results, with the final section discussing them and offers a conclusion.

4.2 Literature Review

Population ageing will place a significant burden on working-age populations shortly. In Chinese Social Security systems, with equivalent defined contribution programmes, working-age adults will face an increasing burden supporting the elderly through both financial and in-kind transfers (Lee *et al*. 2011). Many economies are in the process of extending the retirement age, viewed as one feasible way to ease the burden on working-age people. However, it is argued that the existence of the productivity among elderly population is limited due to based on the ability to learn new skills. Also, retirement decisions can be shaped by household wealth, individual preferences, as well as policies (Giles *et al*. 2011).

4.2.1 Pension scheme and labour supply patterns

Following the introduction of the New Rural Social Pension Insurance (NRSPI) programme[36], existing studies on retirement patterns in China are concerned with the impact of the new pension scheme on labour supply among the elderly. Shu (2018) uses the first two waves of CHARLS and investigates retirement behaviour within the context of the NRSPI programme. The study demonstrates the negative effect of the NRSPI programme on the probability of retirement among rural elderly. The research also points out that the introduction of NRSPI programmes significantly reduces working hours among women. The research also shows that NRSPI programme can significantly increase the likelihood of retirement and reduce working hours among women even though the benefit from NRSPI programme is far below the minimum living cost in rural China. Rather than using compulsory retirement age, Shu (2018) defines "retirement" based on weekly working hours per person. According to the description, a less than two working hours in a week is defined as "retired". Shu (2018) explains this consideration by providing the fact that 35% of the people who have completed normal retirement procedures claim that they are still working. By contrast, our study uses compulsory retirement age to distinguish retirement status. There is a mismatch between retirement procedures and the actual working status in China. Pension income could generate a

[36] Chinese government introduced the New Rural Social Pension Insurance (NRSPI) program in 2009. It is a voluntary pension programme aiming to benefit China's rural elderly. The program was expanded nationwide in 2012. The basic pension benefit from NRSPI program is CNY660 annually (GBP1 equaled approximately CNY8.69 on 16 December 2018), which is far below the minimum living cost in rural China.

different impact on a person's profile. Individuals involved in pension schemes are entitled to receive pension benefits upon the retirement age (i.e. pensioner), while workers before retirement age are contributors in the pension scheme. In our framework, individuals who are younger than compulsory retirement age but claim retired are defined as "early retirement". Those who have completed the retirement procedure but still working are defined as "delayed retirement". It is necessary to examine the determinants of early retirement and delayed retirement in two separate sections since factors determining early retirement are not going to be the same as those of delayed retirement. Also, Zhang *et al*. (2014) and Chen *et al*. (2015a, b) investigate the causal effect of the NRSPI programme on labour supply patterns in China by using fuzzy regression discontinuity (FRD) models. Ning *et al*. (2016) apply an FRD model, as well as difference-in-difference (DID) estimation, to examine the impact of the new rural pension scheme on labour supply. While the advantage of FRD model is the unbiased estimate of local treatment effect (Rubin 1977), which is similar to estimates from randomised experiments (Shadish *et al*. 2008; Moss *et al*. 2014), the application of a FRD model limits the sample selection to those communities which have access to the new pension scheme. Also, the sample collection must focus on those observations lying close to the cut-off age or around the threshold. Our study examines retirement patterns in a wider age group, which allows us to investigate the effects of various factors on both early retirement and delayed retirement. Moreover, our study uses panel data, which is better to cover the effects which can change over time. In this aspect, the procedure is superior to Zhang *et al*. (2014) and Chen *et al*. (2015a, b) using cross-sectional data, and Ning *et al*. (2016), merging two waves of the dataset. Lin *et al*. (2018) also examine the effect of NRSPI programme on retirement patterns by using the FRD method. On 2013 CHARLS. The main contribution of their study is that they distinguish rural areas in western China with the rest of the country. Their analysis demonstrates a severe problem of "ceaseless toil" in western rural areas compared to other regions of China. The new pension payment significantly decreases the informal labour supply in rural western China but has no impact on the formal labour supply. Lin *et al*. (2018) conclude that there was an improvement of "ceaseless toil" situation in western, rural areas as the result of the NRSPI programme. Compared with Lin *et al*. (2018), our study further looks at the western region, the central region and the coastal region separately. Moreover, our study considers pension income, as well as wealth and health in one multi-variable framework.

4.2.2 Health effects on retirement patterns

Most existing papers on retirement patterns in China concentrate on health effects. Benjamin *et al*. (2003) use physical limitations as the proxy for measuring health status. The research builds a panel dataset based on three waves of China Health and Nutrition Survey (CHNS). By looking at gender differences in the labour market, the findings provide a significant reduction in labour supply among men aged from 60 to 70 with health issues, while there are no significant results for women. Some studies gave more attention to the implication of social pensions and health status. These studies exploit the income change induced by pension reform and its impact on health status among the Chinese elderly. Cheng *et al*. (2018) examine the causal effect of the new pension income on health based on the Chinese Longitudinal Healthy Longevity Survey (CLHLS). The two waves used in the study are released before and after the introduction of the NRSPI programme in 2009. The findings suggest that the newly acquired pension income largely enhance nutrition intake and the accessibility of health care among rural residents, which in turn improve both physical health and cognitive function of the rural elderly.

4.2.3 Household registration and retirement

In contrast to the developed world, the Chinese *hukou* system is highly linked with the pension schemes[37], so as retirement age. Earlier research on Chinese labour supply mainly focused on selected areas. These studies concentrate on either rural or urban areas as the object of the study. Lacking studies have analysed rural-urban disparities in the labour market. Rural and urban residents face significantly different retirement patterns and financial support[38]. Urban residents with formal sector employment can receive pension benefit upon retirement but need to follow mandatory retirement policy and retire at a

[37] With considerable migrants from rural areas to urban areas in China, Chinese governments have made large efforts to extend Social Security systems to migrants living in the cities in recent years. However, migrants are much less likely to have formal employment contracts and are more common with employers who do not make mandated contributions to pension, basic medical and disability insurance (Giles *et al*. 2011).

[38] New pension programme in urban China is first introduced in 2011. The program is designed to provide financial support to non-working urban residents in old age. The program has full coverage in national wide by the end of 2012.

relatively younger age. Rural residents generally accumulate lower wealth throughout their working lives (Kanbur *et al*. 1999; Ravallion *et al*. 2007). In rural China, residents are more likely to remain actively working until much later in their lives due to income insecurity. Agricultural production on the family farm is the main source of employment among rural residents in China (Giles *et al*. 2011). However, even for urban residents who work in formal sectors, the welfare provision can be uncertain. Appleton and Song (2008) identify that the anxiety about insufficient medical insurance coverage exists widely in Chinese urban citizens. Therefore, it is necessary to control for Social Security programme in the empirical regressions.

4.2.4 Wealth status and retirement

The literature of retirement decisions of the Chinese elderly so far has mainly concentrated on the effects of pension schemes and health status. With the rapid wealth accumulation among Chinese residents, it is interesting to find out how different assets portfolios have different influences on labour market participation. Some studies have examined the wealth impact on retirement behaviour, although not for China. Bloemen (2006) measures various wealth, including net liquid wealth, net illiquid wealth, debt outstanding and mortgage debt. The study focuses on the male workers in the Netherlands in the age range of 48 to 64 and provides clear results on retirement decisions with wealth accumulation. Empirical results prove that individuals with heavier debt are less likely to retire early (Bloemen 2006). Nevertheless, the data used in the study was from 1995 to

2002. It is observable that, the financial market has experienced considerable changes in the past decade, incorporated with credit market imperfections, the impact of wealth accumulation on retirement decisions need not necessarily be the same with the situation years ago. Also, given the different designs of questionnaires and data collection, the definition of retirement routes can be various. In the research of Bloemen (2006), the state of early exit comprises four categories: (1) unemployment; (2) disability; (3) (early) retirement or living of one's investments; (4) other reasons which are not suitable to the first three categories. Individuals who are in the working group contain employees only. In our study, for both early retirement and delayed retirement sections, the working group merges employees, self-employees and individuals with family business into one category. Due to individuals with their own business are often able to accumulate larger wealth than salaried workers, we allow for differences in the impacts of net worth and debt on retirement decisions. Furthermore, we measure various wealth and health factors. Our framework also includes pension income, *hukou* location, homeownership and education level as explanatory variables. Our framework considers these factors which are likely to influence the level of wealth and health status and are likely to influence retirement decisions.

4.2.5 Contribution

Our study contributes to the existing literatures as follows: first, we estimate health status in more detail. While Benjamin *et al*. (2003) measure health status using only limitations, we provide three dimensions. They are severe chronic diseases, limitations (i.e. physical health problem) and mental health problem. Second, we examine wealth impact on retirement in China, which has not shown in previous studies for Chinese case. We further distinguish net worth and debt for both housing and non-housing wealth. Third, compared with Lin *et al*. (2018), our framework assesses retirement behaviours in three Chinese regions separately. They are the western region, the central region and the coastal region. Also, we analyse rural-urban disparities in the labour market. It is necessary to examine regional differences because of significant divergence of macroeconomics within China.

4.3 Hypotheses

We use this section to present four hypotheses which are examined in this chapter. Pension programmes generate different effects among the middle-aged and elderly. Those entitled to receive pension benefit at aged 60 or above, namely pensioners, can continue working. Pension benefits will purely produce income effect on this group of people. The contributors who are below statutory retirement age and are enrolled in a pension programme can accumulate savings through the plan. Therefore, there should have different effects of pension programme between contributors and pensioners.

Hypothesis 1*: There should be a strong negative relationship between high pension income and the probability of delayed retirement, while the involvement in a pension scheme should have a significantly negative impact on early retirement.*

Health is an important human capital for people of all ages. Health not only has a direct impact on the retirement decision among the elderly but also can influence labour productivity and wage income. Existing studies have proved that health can produce a significant impact on labour income not only for non-agricultural labour (Baldwin *et al*. 1994; Wei 2004) but also for rural residents who work on agricultural production (Zhang 2003). Based on this, we are going to examine the direct impact of health problems on retirement patterns. Also, it should have significant differences among various diagnosed diseases on retirement decisions.

Hypothesis 2*: Health problem should generate positive effects on early retirement and negative effects on delayed retirement. Moreover, retirement decisions should be different corresponding to various diagnosed diseases.*

A high stock of wealth could generate financial incentives. Lack of studies have looked at the wealth effect on retirement in Chinese case. It is interesting to gain an insight into the empirical impact of wealth status on retirement decisions among the Chinese middle-aged and elderly.

Hypothesis 3*: There should be a significantly positive effect of high wealth (i.e. housing values and non-housing values) on early retirement. And a significantly negative effect of high wealth status on delayed retirement.*

In China, rural residents are far more likely to continue working after the compulsory retirement age until they are no longer physically capable of working (Davis-Friedmann 1991; Benjamin *et al*. 2003; Pang *et al*. 2004; Ning *et al*. 2016). Based on CHARLS dataset, in 2008, 86 per cent of rural men in the age range of 60 to 64 were still working, while only 45 per cent urban men were in employment for the same age group. The differences in employment between rural and urban women aged 60 to 64 was even larger, with 57 per cent of rural women and 16 per cent of urban women in employment. Also, there are substantial differences in economic development in different regions of China. In light of this, we are going to examine regional differences in retirement decisions and investigate the dominant factors in different regions of China.

Hypothesis 4*: Hukou location (i.e. rural and urban, western, central and coastal) should generate considerable different effects on retirement. Urban residents should associate with more likely of early retirement and less likely of delayed retirement compared with rural residents.*

4.4 The Data

The China Health and Retirement Longitudinal Study (CHARLS) is a cohort survey study for people aged 45 and above in China. CHARLS is an on-going study which is designed to provide a variety of micro-survey information on cohort and demographic analyses and policy implications on elderly-related issues. CHARLS conducted its first nationwide data collection in 2011-2012. The first wave covered 28 provinces, 150 districts or units, 450 villages or urban communities across China. It involved 17,708 individuals and 10,257 households. The follow-up face-to-face interviews take place every two years. The final sample comprises 10,257 households with 17,708 respondents; 10,069 were main participants, and 7,639 were spouses of main participants. In cases where main respondents were unable to provide answers because of diseases or migration, a proxy would be interviewed to provide answers on behalf of the originally designed main participants.

4.5 Analytical Methods

4.5.1 Analytical strategy

In this study, we aim to understand labour market participation in China by merging all three waves of CHARLS. It is an update of the work made by Shu (2018), who used the first two waves of CHARLS and investigates the relationship between NRSPI program and retirement behaviours. In our framework, we combine pension income, health status and wealth in one framework. A partial correlation can be found by controlling different variables in one regression equation. There should be a negative association on pension contributor in early retirement group, and a negative association between high pension income and the probability of delayed retirement. Chronic diseases and physical health problem should increase the probability of early retirement and reduce the probability of delayed retirement. A high wealth level should positively associate with early retirement and negatively relate to delayed retirement.

In the regression model, we separated the whole sample data into two panels, one for men aged below 60 and women age below 55, and another one for men at the age of 60 and above, as well as the women at the age of 55 and above, where the cut-off age point is the current default retirement age in China. We undertake regression equations for early retirement and late retirement separately. This procedure is used to explore to what extent the factors will influence an individual's decision in the labour market. In each section, we compare the regression results by region. The dependent variable is a binary dummy variable based on whether or not the individual was retired or not. Explanatory variables include net housing wealth, net non-housing wealth, chronic diseases, and limitations in doing living activities, psychological health problem, pension plan, individual educational background, marital status, homeownership, *hukou* location, age and gender.

Also, by using Propensity Score Matching (PSM) technique, we explore the average treatment effect on the treated (ATET), which presents the different outcomes between the treated group and the comparison group given certain background characteristics among individuals.

4.5.2 Probit model

This study estimates Probit regression models with random effects. It is because our regression has a binary dependent variable to account whether or not the person retired. The model works on the effect of health-related indicators on labour market participation controlling for wealth-based parameters, pension income, *hukou* location and demographics.

4.5.3 Propensity Score Matching methodology

Propensity Score Matching (PSM) is a technique used to estimate the effect of a treatment or programme when we do not have randomised experiments (Angrist *et al*. 2009; Guo *et al*. 2015). We follow the work made by Zhang *et al*. (2014) and Chen *et al*. (2015a, b), who applied fuzzy regression discontinuity (FRD) model to examine the causal effect of NRSPI program on labour supply patterns in China. Both FRD and PSM require estimating a propensity score. In particular, our study tests the balancing conditions to make sure the pre-existing characteristics are match between the treated group and the control group. The advantage of PSM is that it can provide unbiased estimation of a disease which is exogenous conditional on the variables and similar to a randomised experiment. Each single disease in our sample data should generate significant effect on retirement behaviour. The theoretical analysis of the PSM method is summarised as follows, based on the interpretation made by Katchova (2013) and the notation used in this study is similar to the specifications provided by Katchova (2013).

We assigned the observations into two groups: the treated group and the comparison group (i.e. the control group). Whether or not the members received the treatment is a binary variable *T* that determines if the observation has the treatment or not, where T=1 for treated observations that got treatment, and T=0 for the comparison group. In our sample, we have respondents who received treatment and also have a set of background characteristics. Our outcomes will depend on whether or not the treated group retire early or late.

The following 15 treatments were implemented in this study: (1) *hukou* location is urban; (2) respondents are currently participating/receiving in at least one kind of pension insurances[39]; (3) respondents were diagnosed with mental health problems; (4) respondents with hypertension; (5) respondents with diabetes; (6) respondents with a heart problem; (7) respondents diagnosed with cancer; (8) respondents who suffered a stroke; (9) respondents diagnosed with lung problems; (10) respondents with memory problems; (11) respondents diagnosed with asthma; (12) respondents were diagnosed with a liver problem; (13) respondents were diagnosed with a kidney problem; (14) respondents were diagnosed with a stomach problem; (15) respondents with high cholesterol. The complete information for 13 diagnosed chronic diseases was described in Table 4A.1.

The treatment setting is based on the fact that residence living standard vary between different regions, which is reflected in the *hukou* location. Also, the Chinese *hukou* system highly is linked with the pension schemes and national medical care system. For health-based treatments, we utilise as many health problems in CHARLS as possible and try to

[39] The treatment for early retirement section is pension participants. The treatment for delayed retirement study is pension receiver.

explain as much of the spurious correlation between health status and retirement decisions as possible by testing each disease independently.

4.5.3.1 Strategy of the study

We are interested in evaluating the effects of particular variables on labour market participation, which is the outcome of interest. The variables include *hukou* location, pension schemes, and different types of diagnosed chronic diseases on labour market participation before and after the default retirement age in China. The treated group consists of the respondents who received treatment, and the control group those that did not. PSM accounts for differences of underlying characteristics that are correlated with the treatment itself when estimating the impact of the treatments on the outcomes.

Our study is based on an observational study where the interventions on the treated and control groups are not random. In other words, certain respondents have received treatment in their real life and others not. Because the background characteristics of respondents who did receive treatment may be different from those that did not receive treatment, it is hard to compare the outcomes for these two groups directly. Therefore, we need to match them as much as possible and then compare their outcomes. By doing this, we can effectively reduce selection bias for this outcomes-based study and achieve a balance between the treated and the comparison group.

4.5.3.2 Assumptions

Several assumptions are required for the Propensity Score Matching (PSM) method.

(1) Conditional independence assumption

First, for observational studies, the outcomes y_0 and y_1 for the control group and the treated group separately are independent of the treatment, conditional on pre-existing characteristics *X*s:

$$y_0,\ y_1 \perp T \mid X\text{s} \tag{8}$$

Second, the treatment or assignment needs to be exogenous. In our study, for example, no respondents are eager to get a chronic disease.

(2) Unconfoundedness assumption

First, conditional independence of the control group outcome and treatment.

Second, a weaker assumption than the conditional independence assumption. In other words, comparing with assumption (1), at least, the treatment does not affect the outcomes of the control group.

$$y_0 \perp T \mid X\text{s} \tag{9}$$

(3) Matching or overlap assumption

First, for each value of *X*, there are both treated and control observations.

Second, for each treated observation, there is a matched control observation with similar characteristics *X*s. In other words, both the treated group and control group consist of similar characteristics. No group in our sample has any particular characteristics that do not exist in another group.

$$0 < prob(T=1|Xs) < 1 \tag{10}$$

(4) Balancing condition

First, the assignment or treatment is independent of the *X*s characteristics, given the same Propensity Score (PS). Once the score condition is satisfied, then we would be able to match on those pre-existing characteristics *X*s which would be similar in the two groups.

$$T \perp Xs|ps(Xs) \tag{11}$$

Second, the balancing condition is testable.

4.5.3.3 The advantages of the Propensity Score Matching (PSM) method

First, PSM is not as sensitive to the functional form of the model, so there is no need to worry about how we control for covariates, such as cubic, interactions, or categorising variables. Second, PSM is straightforward to assess how good the match is by addressing differences in background characteristics of the two groups. Third, if the treatment is fairly rare, matching can exclude the irrelevant observations completely, for example, respondents who got cancer only occupied 1.06% of the overall sample, while the majority of respondents in our sample were assigned into the control group, and hence the observations are not comparable. We are interested in examining the effect of a specific treatment on retirement decisions. It is reasonable to compare treated group with those who have similar demographic characteristics or financial situation. Those observations included in the general regression model are very different from the treated group in characteristics but are not the group we are interested. Therefore, they should be excluded from our analysis. Fourth, with PSM, it can be easier to model key determinants of programme placement (the effect of specific treatment) rather than the determinants of actual outcomes. Fifth, the PSM technique allows us to provide a more straightforward explanation on the intuition behind the results.

4.5.3.4 Estimation

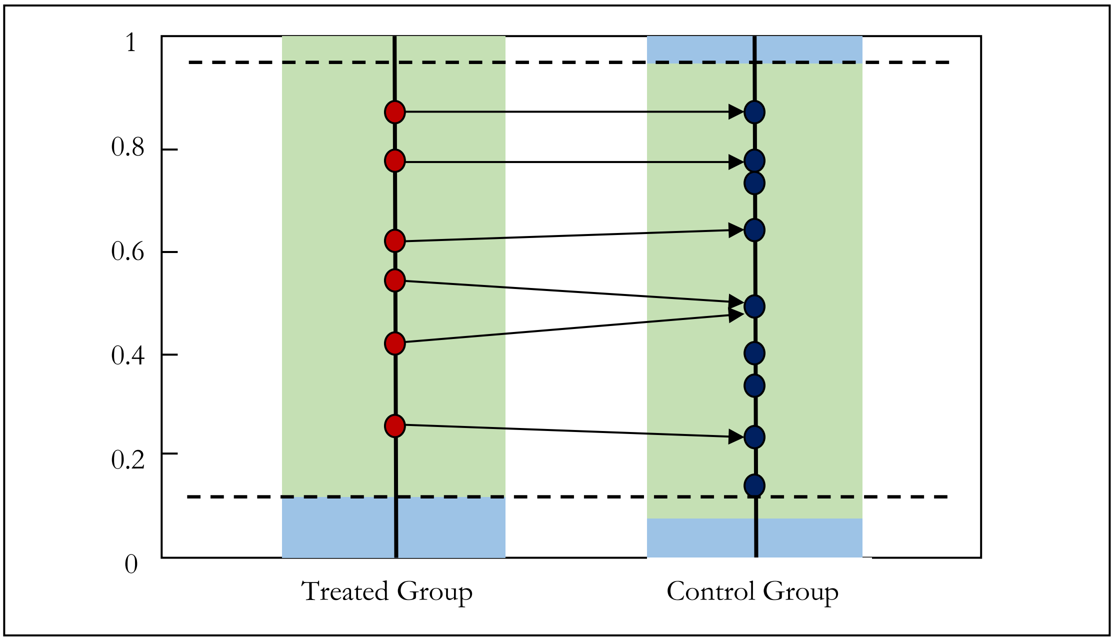
The propensity score gives the conditional probability of receiving treatment given pre-existing characteristics. The Probit model is used to estimate the propensity of individuals being assigned to the treated group. The estimation is based on the following equation:

$$ps(x) = prob(T=1 \mid X_1, X_2, \ldots, X_s) \tag{12}$$

where *ps* represented the propensity scores. *T* would be a binary dependent variable equal to 1 if the observations received the treatment and T=0 for otherwise. The variables X_1-X_s are all pre-existing characteristics (i.e. underlying characteristics) that may influence the selection of the respondent being assigned to the treated group. For example, X_1-X_s are variables that can affect the likelihood of respondents being diagnosed as having a disease. In more detail, X_1-X_s represent net housing wealth, net non-housing wealth, homeownership, marital status, educational grade, age and gender in our study.

We then match observations from the treated group and control group based on their propensity scores. The goal is to find the best possible match for each of the treated observations and, as a consequence, not all of the observations in the control group would be used as matches for the treated observations. For each observation *m* in the treated group, we need to find matches of control observation *n* based on all underlying characteristics. In this chapter, we use the nearest neighbour matching method to find the match. The propensity score is then used as the closest match based on the pre-existing characteristics between the treated group and the comparison group (see Figure 4.1).

Figure 4.1: Nearest Neighbour Matching



Note: (1) Nearest neighbour matching is a matching with replacement, that is, each control observation $\underline{n}$ can be used as a match to several treated observations $\underline{m}$s based on the closest pre-existing characteristics Xs: $\min\|ps_m - ps_n\|$.

(2) The propensity score is in a value range of [0,1].

(3) The circles colored in red represent observations in treated group. The circles colored in blue represent the observations in the control groups.

(4) We restrict the matching only based on the common rate of propensity scores. In other words, we drop the observations which have too high propensity score to get a good match in the control group. For exampe, in this figure (i.e. Figure 4.1), we only use the observations in the treated group that are up to the top dash line, and we will throw away those observations that have the propensity scores that are lower than the bottom propensity score in the treated group. That is, in this sample figure (i.e. Figure 4.1), we only use the observations in the control group that are above the bottom dash line.

(5) Blue color covered the areas that have no observations in two groups. Two dash lines restrict the common support area in two groups.

(6) A similar figure and descriptions was initially posted by Katchova (2013).

After matching on propensity scores, we then calculated the average treatment effect on the treated (ATET), which provides the different outcomes between the treated group and treated observations if they had not been treated. The PSM provides a way to find a good approximation for the counterfactual term. As a consequence, we can compare the different outcomes between the treated group and the control group that are matching, which is the focus of interest. In other words, we want to compare the different effect between the treated group and control group on the outcome *y*, where *y* demonstrated labour market participation in our framework.

$$y = \begin{cases} y_1, & if \quad T = 1 \\ y_2, & if \quad T = 0 \end{cases} \tag{13}$$

and

$$ATET = E(\Delta|ps(x), T=1) = E(y_1|ps(x), T=1) - E(y_0|ps(x), T=0) \tag{14}$$

Using nearest neighbour matching method, each treated observation <u>*m*</u> is matched to <u>*n*</u> control observation and their outcomes y_0.

$$ATET = Average \ \{\textstyle\sum_{m \in \{T=1\}} [y_{1,m} - y_{0,n}]\} \tag{15}$$

4.5.3.5 Empirical analysis

In this part, we will be using PSM to look at the relationship between each type of intervention and labour market participation. The propensity score gives the predicted probability of treatment using the underlying characteristics for both the treated group and the control group. A higher propensity score means for certain background characteristics of a respondent, the more likely that this member would get the treatment. We will be matching on a series of wealth indicators as well as the category of pension income and a set of demographic details. These are independent variables in our Probit regression equation. Based on the technique described above, we conducted the procedure as follows:

First, we created a new control group to mimic the counterfactual term since the outcomes of the treated observations if they had not been treated are counterfactual, and therefore, not observable. For each observation in the treated group, we select the control observations that look most like the members of the treated group based on the selected variables, known as underlying characteristics. Second, we compared the average outcome in the treatment group with the average outcome in the new control group, called the treatment effect. Third, we computed the average probability of early retirement and delayed retired separately in the control group regarding a set of pre-existing background characteristics and compare the average chance of still working in the treated group regarding the same set of underlying characteristics and see the treatment effect on labour market participation.

4.5.3.6 Justification of the matches

The histograms of propensity scores in the treated group and control observations can provide the balancing property, where the similar characteristics between the treated group and the control group are satisfied (see Table 4A.3, Table 4A.4 and Figure 4A.1 - Figure 4A.30). Based on the distributions, we can conclude that our newly generated control groups are similar to the treated group based on the pre-existing background characteristics. Therefore, we obtain a good match between the treated group and the comparison group in our sample.

4.5.4 Regression model

We present two regression equations. Equation (16) is for early retirement and Equation (17) is for delayed retirement.

$$\begin{aligned} Earlyretired_{it} = {} & \alpha_0+\alpha_1 Housewealth_{it}+\alpha_2 NHwealth_{it}+\alpha_3 Chronics_{it} \\ & +\alpha_4 Limitations_{it}+\alpha_5 MentalHealth1_{it}+\alpha_6 Pension_{it} \\ & +\alpha_7 Hukou_{it}+\alpha_8 Homeownership_{it}+\alpha_9 \boldsymbol{X}_{it}+\omega_{it} \end{aligned} \quad (16)$$

where subscript *i* denotes individuals, *t* denotes current survey years.

Earlyretired is a binary variable equal to 1 if respondents currently not working before default retirement age and 0 otherwise. *Housewealth* is a categorical variable estimating the stratification of a household’s housing assets. *NHwealth* estimates the stratification of a household’s non-housing assets. *Chronics* measures a standardised score of chronic diseases. *Limitations* present a standardised score of limitations in doing daily activities. *MentalHealth* estimates a standardised score of psychological health status. *Pension* is a dummy to measure the participation in a pension scheme, where 1 for participating in at least one kind of pension programs, and 0 otherwise. *Hukou* refers to urban residents having a *hukou* at the permanent address. *Homeownership* measures the housing tenure of the current residence with 1 being for homeownership. ***X*** is a vector of cohort characteristics which contains household demographics, including educational level, current marital status, age and gender. ω is the residual term containing time and country fixed effects.

α_1 presents the association of housing assets and the probability of early retirement. α_2 measures the effect of non-housing assets on early retirement. Based on the findings made by Bloemen (2006), both α_1 and α_2 should be positive for hypothesis 3 to hold. α_3, α_4 *and* α_5 are of particular interests in the analyses. The coefficients estimate the association between adverse health status and early retirement. The signs should be positive under hypothesis 2 for confirming the results in Benjamin *et al*. (2003). The sign of α_6 corresponds to hypothesis 1. Based on the discussion about pension programme and retirements provided by Shu (2018), α_6 should be negative for pension contributors. In light of the discussion made by Kanbur *et al*. (1999) and Ravallion *et al*. (2007), α_7 demonstrates the association of urban residents and early retirement. It should be positive and significant for hypothesis 4 to hold.

$$\begin{aligned} Delayretired_{it} = \beta_0 &+ \beta_1 Housewealth_{it} + \beta_2 NHwealth_{it} + \beta_3 Chronics_{it} \\ &+ \beta_4 Limitations_{it} + \beta_5 MentalHealth1_{it} + \beta_6 Pension_{it} \\ &+ \beta_7 Hukou_{it} + \beta_8 Homeownership_{it} + \beta_9 \boldsymbol{Z}_{it} + \mu_{it} \end{aligned} \tag{17}$$

where subscript i denotes individuals, t denotes current survey years.

Delayretired is a binary variable equal to 1 if respondents currently engaging in agricultural work/employment/self-employment/unpaid family business, and 0 otherwise. *Housewealth* is a categorical variable estimating the stratification of a household's housing assets. *NHwealth* estimates the stratification of a household's non-housing assets. *Chronics* measures a standardised score of chronic diseases. *Limitations* present a standardised score of limitations in doing daily activities. *MentalHealth* estimates a standardised score of psychological health status. *Pension* measures the current annual pension income received by the respondents. *Hukou* refers to urban residents in the permanent address. *Homeownership* measures the actual owner tenant of current residence. ***Z*** is a vector of cohort characteristics which contains household demographics, including educational level, current marital status, age and gender. μ is the residual term containing time and country fixed effects.

β_1 presents the association of housing assets and the probability of delayed retirement. β_2 measures the effect of non-housing assets on delayed retirement. In light of Bloemen (2006), both β_1 and β_2 should be negative for hypothesis 3 to hold. β_3, β_4 *and* β_5 are of particular interests in the analyses. The coefficients estimate the association between adverse health status and delayed retirement. Based on the discussions made by Benjamin *et al*. (2003), the signs should be negative under hypothesis 2. The sign of β_6 corresponds to hypothesis 1, and it should be negative in high pension income. β_7

demonstrates the association of urban residents and delayed retirement. It should be negative and significant for hypothesis 4 to hold.

Based on Appleton *et al*. (2002) and Giles *et al*. (2006), men and the young generally have longer working life. The signs corresponding to gender should be negative in Equation (16) (early retirement), and positive in Equation (17) (delayed retirement). The signs in front of age should be positive in estimating (16) and negative in estimating (17). Giles *et al*. (2011) include a control variable for marital status. However, they do not present appreciable difference in the coefficients of interest. This leads us to concern about the estimation on marital status introduced by various selection. We expected the signs of married group to be negative in Equation (16) and positive in Equation (17). Additionally, Giles *et al*. (2011) observe a declined probability of working with each additional year of education through the completion of middle school, and then people who are in higher levels of education are associated with a longer working life. Therefore, we expect the signs in front of middle level of education to be positive in estimating (16) and negative in estimating (17). Conversely, the coefficients of the top level of education provide negative sign in early retirement and positive sign in delayed retirement.

4.6 Variable Selection and Creation

4.6.1 Respondents

The age-eligible of the survey is 45 to 80 years of age for both men and women. People aged above 80 are excluded from our sample because the average life expectancy in China is 76 in 2015 (World Health Organization 2016). Therefore, people aged above 80 may have particular longevity situations and can be considered outliers of the panel. The sample was drawn from the main respondents who provided information on employment status. CHARLS collected a broad range of questions on working status. To construct our sample data, we merge all released waves in CHARLS. In the final sample, the total number of individuals is 52,826. The subsequent group for the early retirement study (i.e. women aged 45 to 54 years, men aged 45 to 59 years) contains 23,236 respondents. The number of individuals is 28,982 for the delayed retirement study (i.e. women aged 55 to 80 years, men aged 60 to 80 years).

4.6.2 Measurement

4.6.2.1 Labour market participation

In this study, we classified retirement status according to respondents' contribution in the labour market and age. It is because rural residents generally keep doing agricultural-related activities until older age while most urban residents were forced to stop working at the statutory retirement age.

-Early retirement:

Since the default retirement age in China is 60 for men and 55 for women, the data for early retirement focused on men in the age range of 45-59 and women in the age range of 45-54. The total observation in this group is 23,236.

-Delayed retirement:

The delayed retirement group comprises men aged 60 to 80 and women aged 50 to 80[40]. The number of observations is 28,982 for delayed retirement group.

4.6.2.2 Health-related variables

CHARLS provided extensive information on health, including self-reported health status, diagnosed with chronic diseases, limitations in doing daily activities and mental health problem. The measurement of self-perceived health status in CHARLS is purely subjective and previous studies have indicated that self-reported health status has a potential justification bias. Those who reported themselves suffering from chronic diseases or having difficulties in doing certain activities were more likely to report a worse health status to justify their general health conditions (Dwyer *et al*. 1999; McGarry 2004). Therefore, we apply more objective measures to identify individual

[40] To make it clear, in later sections, "younger group" and "older group" represent age eligible individuals for early retirement and delayed retirement sections respectively.

health situation. These are the existence of a chronic diseases, limitations in doing daily activities and mental health status.

-Chronic diseases:

The measure of chronic diseases is based on diagnoses by doctors and we use all 13 symptoms listed, which were hypertension, dyslipidaemia (cholesterol), diabetes or high blood sugar, cancer, chronic lung diseases, liver disease, heart problems, stroke, kidney disease, stomach or other digestive diseases, memory-related disease, and asthma. After controlling chronic diseases, the observation for early retirement group drops to 20,655, and 27,815 for the delayed retirement group. The labels and descriptions for the 13 chronic diseases are presented in Table 4A.1. For comparison purposes, we rescale the sum of the score into a range from 0 to 1 for chronic disease.

-Limitations in doing daily activities:

Regarding physical health conditions, we use limitations in doing living activities as the indicator. The dataset contains information for a set of items based on difficulty in doing activities of daily living (ADL) and instrumental activities of daily living (IADL). Similar to chronic diseases, we calculated the sum of the score for limitation indicators and rescaled the estimation into a range between 0 and 1. This result to 23,208 for early retirement group, and 28,954 for delayed retirement group.

-Mental health status:

The mental health status predominantly focuses on psychological health problems. In CHARLS, the Centre for Epidemiologic Studies Depression Scale (CES-D)[41] 10-item was incorporated into the questionnaire for measuring mental health status. The CES-D 10 designation is reported in Table 4.1. In this study, we assigned the score to each of the stratifications based on the metric suggested by Radloff (1977). As a result, we calculate composite scores for CES-D 10-item with a higher score indicating a worse situation in mental health. To measure of scale quality, we estimate internal consistency reliability across CES-D 10 scale by using Cronbach's Alpha. Boey (1999) reported scale reliability coefficients ranging from 0.78 to 0.80 of a short form of CES-D 10-item among older adults. The test scale of Cronbach's Alpha in our sample is 0.808 in wave 1, 0.762 in wave 2 and 0.795 in wave 3. Therefore, we can conclude that the 10 CES-D items in our sample are conceptually related to each other. Again, we rescaled the total sum of the score into a range of 0 and 1 for mental health indicators. The observation is 21,334 for early retirement group, and 27,128. 11% of total observation in early retirement group and 6.4% of total observation in the delayed retirement group are dropped out of our sample after controlling three severe health problems.

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[41] Centre for Epidemiologic Studies Depression Scale (CES-D). Online available: https://counsellingresource.com/quizzes/depression-testing/cesd/.

Table 4.1: CES-D 10-item

Item
1. I was bothered by things that don't usually bother me.
2. I had trouble keeping my mind on what I was doing.
3. I felt depressed.
4. I felt everything I did was an effort.
5. I felt hopeful about the future.
6. I felt fearful.
7. My sleep was restless.
8. I was happy.
9. I felt lonely.
10. I could not get "going".

Note: The answers to these questions are based on the feelings and behaviours during the last week.

4.6.2.3 Wealth

We split up the measure of household wealth into housing assets and non-housing assets. In order to permit comparisons in values across all waves, the money-based variables are deflated by the consumer price index (CPI) using with 2015 as the baseline.

-Housing assets:

The starting point of calculating housing value is summing up the share of the current residential property owned by the household. The total amount of housing assets combines the net values of both the primary property and other residential properties owned by household, excluding the outstanding amount of mortgage or loan on both primary residence and other residential properties. The net value of the house is then transformed into a category variable sorted by city and *hukou* location. The property value, which falls into the upper 33% in the corresponding city and *hukou* location is defined as high housing wealth and assigned a score equal to 3. We tapered off the scores from 2 to 1 for property value, which locates in the middle tertile and the bottom 33%. We use the level of wealth rather than absolute values in wealth due to the considerable regional gap in economic growth in China. The same values of property in western and coastal China can generate significantly different financial incentives and living standard. Given the fact that the compulsory retirement age is consistent across different regions in China, it is reasonable to compare the level of wealth, which is considered to generate relatively similar motivation in labour market participation in the corresponding region. The observation after controlling housing assets is 14,045 for early retirement group and 16,961 for delayed retirement group. Therefore, approximately 40% of observations have dropped out of the sample in early retirement group. For delayed retirement group, it drops around 42% of observation after controlling housing assets.

-Non-housing assets:

Non-housing assets comprises durable assets, fixed capital assets, land values, livestock and fisheries and cash and noncash financial assets, excluding the outstanding amount of loan. Financial assets covered current and saving account, individual government bonds, stocks and mutual funds, deposits, public housing funds, *Jizikuan*[42] held by the respondent, unpaid salary to the respondent and other financial assets held in another person's name. Again, we created a categorical variable with the amount falling into the upper quartile in the corresponding city, and *hukou* location was assigned a score = 4. The bottom quartile was assigned a score = 1. This results to 23,236 for early retirement group and 28,982 for delayed retirement.

4.6.2.4 Pension programme

In this study, we estimate the pension account in two ways. The annual total amount received from the pension account is used for delayed retirement analysis. There are 21,957 out of 28,982 observations in our final sample. The pension dummy is generated for early retirement and the matching framework with 23,152 out of 23,236 observation in our final sample.

-Pension benefit:

General knowledge tells us only retirees are entitled to withdraw money from a pension account. Therefore, we calculate annual pension income received by respondents for delayed retirement study. We expect to observe a negative relationship between pension amount received and delayed retirement. We aim to verify these

[42] *Jizikuan* is fund individuals provided to the work unit for the purpose of investment, building apartments, etc.

predictors in the analysis and expose the difference between higher amounts received and lower amount received.

All questions relating to the pension amount were provided on a monthly base in original questionnaires. In this study, we undertake the analysis using yearly pension income in RMB unit. In wave 1, the total pension contained pension benefits received from the government or institutes, a previous work unit, supplement pension insurance of the firms, commercial pension benefits, rural pension, residents pension, urban residents pension, pension subsidy for the elderly, New Rural Social Pension Insurance (NRSPI) and benefits from other pension programmes. Besides the general pension programmes, wave 1, wave 2 and wave 3 took into account two other types of pension benefits, which are life insurance and endowment insurance for the land-losing farmers[43].

For comparison, we then created a dummy variable. The value 1 is assigned to those respondents whose total pension income fell into the upper half of pension benefit sorted by corresponding city and *hukou* location.

[43] Land-losing (*shidi*) farmers are those farmers without land. The reasons for losing land can be: (1) contracted land was taken (*chengbao tudi bei zhengyong*); (2) private plot of land has been taken (*tudi zhengyong*) (Heurlin 2018).

-Pension dummy:

Pension contribution plays a significant role in labour market participation decision-making. There is a big difference in retirement decision between pension contributors and workers without pension contributions. To make observations more comparable across waves, in early retirement study, we defined a binary dummy = 1 as long as the respondent is a contributor in at least one kind of pension programme provided in the questionnaire before retirement.

4.6.2.5 Socio-economic positions

The following control variables were used in the empirical analyses in this study. After controlling all independent variables, the total observation is 14,045 for early retirement group and 16,961 for delayed retirement group.

-Education level:

Education level refers to the highest grade of education attained by the time of the interview, not including adult education[44]. We created a categorical variable with three stages: 1 = completed less than middle school; 2 = completed high school or above; 3 = completed two-/three-year college/associated degree or above. Dummy variables have been set for each category. A higher score indicated a stronger education

[44] The adult education in China contains literacy education, adult higher education, cultural learning or technical training.

background. For those respondents had no change in their educational qualifications, the information is derived from previous waves.

-Marital status:

For marital status, our study creates three dummies variables based on four categories provided in the questionnaire directly[45].

-Homeownership:

Homeownership is based the primary residence and other properties. We created a categorical variable with three stages: 1 = no ownership; 2 = partly owned residents; 3 = entire ownership. Dummy variables have been set for each category.

-Hukou location:

In this study, *hukou* location refers to rural (i.e. *agri-hukou*) or urban (i.e. *non-agri-hukou*) in the permanent address. We set a binary variable with 1 for individuals with urban *hukou*, and 0 otherwise.

-Other demographic variables:

The other control variables are age and gender.

[45] The four categories are: (1) never married; (2) married; (3) divorced or no longer living together as a couple; (4) widowed.

The complete set of dependent variable and covariates were summarised with labels and descriptions in Table 4A.2.

4.7 Statistical Analyses

4.7.1 Labour market participation by waves

The sample data consists of all three released waves of the China Health and Retirement Longitudinal Study (CHARLS). Table 4.2 and Table 4.3 present data description on labour market participation by each wave in CHARLS. Table 4.2 presents labour market participation for men below 60 and women below 55 (i.e. younger group). Table 4.3 shows the information for men over 60 and women aged 55 and above (i.e. older group), with the cutoff age for the two subsamples based on the current default retirement age in China. Only respondents who have given information on employment status, either in agricultural work or non-agricultural work or those who have declared themselves not working at all are considered in the data analysis.

Table 4.2: Construction of labour market participation by waves in CHARLS (early retirement)

Current age	Construction	Elements	Wave 1 N	Wave 1 Prevalence (%)	Wave 2 N	Wave 2 Prevalence (%)	Wave 3 N	Wave 3 Prevalence (%)
Women:45-54s Men:45-59s	early retirement	currently not working	1,245	16.20	1,164	15.55	1,264	15.68
	still working	engage in agricultural work	4,528	58.90	2,916	38.95	2,644	32.80
		employed	1,353	17.60	2,326	31.07	2,922	36.24
		self-employed	509	6.62	896	11.97	1,004	12.45
		unpaid family business employed	52	0.68	185	2.47	228	2.83
Total			7,687	100	7,487	100	8,062	100

Source: China Health and Retirement Longitudinal Study (CHARLS)

Table 4.3: Construction of labour market participation by waves in CHARLS (delayed retirement)

Current age	Construction	Elements	Wave 1		Wave 2		Wave 3	
			N	Prevalence (%)	N	Prevalence (%)	N	Prevalence (%)
Women:55-80s Men:60-80s	delayed retirement	engage in agricultural work	4,398	49.81	4,285	43.61	4,061	39.32
		employed	318	3.60	707	7.20	1,086	10.52
		self-employed	157	1.78	383	3.90	356	3.45
		unpaid family business employed	45	0.51	180	1.83	216	2.09
	retired	currently not working	3,911	44.30	4,271	43.47	4,608	44.62
Total			8,829	100	9,826	100	10,327	100

Source: China Health and Retirement Longitudinal Study (CHARLS)

4.7.2 Sample description

Table 4.4 and Table 4.5 show statistical descriptions of all independent variables by waves. This study applied Spearman's correlation technique to measure the correlation between covariates and the dependent variable. The technique is considered as a better estimation for categorical variables in the application.

-Early retirement study:

Based on Table 4.4, we can see that the majority of men and women choose to stay in the labour market before the default retirement age. Age seems to influence early retirement. The average age among early retired people is 51.59 years, while the active working group is slightly younger, with an average age of 51.02 years. Based on the correlation between these pairs of variables, $p < 0.001$ indicates that age and labour market participation have a statistically significant correlation. That is to say, if there is no correlation existing between age and the retirement decisions, the probability of seeing the observed or the same correlation is very low.

For housing wealth, the percentage of households whose housing values belonging to the upper 33% is higher than those locating in bottom 33%. Similarly, respondents with a top-level of non-housing values occupied the largest frequency among all observations. The number is 30% on average. Compared with the non-housing assets, housing assets may generate an unclear effect on early retirement due to inconsistent pairwise correlation.

Homeownership and *hukou* location both have a *p*-value < 0.001. Rural residents are less likely to exit from the labour market early comparing with urban residents. The descriptive statistics verified our expectation, where only 40% of early retirees were rural residents. The association of pension income can be significant based on *p*-values in the table. However, the observations for pension income is relatively small, meaning that the number of respondents who have reported pension income is smaller than other variables. Due to the *p*-value is determined by the observed correlation and the sample size, the plausible relationship in Spearman's rank correlation could be got by chance. Therefore, we need to check whether pension income and retirement decisions have a statistically significant relationship in the later section. All three variables have significant effects on labour market participation. After comparing standardised scores between early retirement and late retirement, we observe that people who exit from the labour market before the statutory retirement age have more severe health problems.

-Delayed retirement study:

Table 4.5 provides data description for people aged above the default retirement age. In the older group, the proportion of retired people and those who are still working are relatively balanced compared with the younger group. If we compare the absolute number of men and women within the age group in Table 4.5, we find that the number of male observations is smaller than female, which may be due to females retiring five years earlier and have a longer life expectancy[46]. Even with smaller observations in the older group, the proportion of men who are still working is much larger than women. It suggests that men were more likely to stay in the labour market after the default retirement age than women in China. Be the same as the group in early retirement study, gender may generate a statistically significant effect on delayed retirement. Individuals who are above retirement age and still working are 3.24 years younger on average than those who are in the same age group but completely retired. Both marital status and educational grade give a p-value < 0.001 in all waves, meaning a strong correlation between marital status, educational level and retirement decisions. Married people are more likely to extend their working lives compared with other groups. It can be observed by comparing delay retired numbers with those not working within each category. For education background, people with a higher degree are less likely to remain in the labour market after the default retirement age. For example, the observations in the working group are smaller than the retired group for higher educated members, whereas the observations are reversed for the lower educated group. For housing value and non-housing value, the distributions across different levels are relatively balanced compared with the younger group. A p-value $<$ 0.001 for non-housing value are smaller than 0.01. P-values are generally small for housing value. Therefore, we can expect a significant effect of both housing values and

[46] Chinese women have much longer life expectancy than men in urban areas. Mortality difference is 6 years between men and women in the age range of 60 to 79 which contributes the main reason for life expectancy gap (Le *et al*. 2015).

non-housing values in the delayed retirement. Compared with respondents with no home, those who own the properties outright are more likely to extend their working lives. Based on the statistics in the table, the differences between the late retirees and those not working are considerable among entirely owned respondents. By contrast, the numbers between the delay retired, and the retired individuals are quite the same in the no ownership group. Individuals who are currently participating in pension schemes are less likely to retire early. Regarding *hukou* location, rural residents show a much higher likelihood to extend their working age in both absolute value and the percentage. Rural residents who stay in the labour market after the retirement age is twice the number of rural residents who leave the labour market. Similar to the younger group, we observe a p-value < 0.001 across waves in the older group. Regarding the health-related indicators, chronic diseases and physical limitation provided a consistently significant effect on labour market participation in each wave, while the effect of mental health problems varies in different waves. In general, those who delayed retirement have better health status.

Table 4.4: Statistical description of covariates by wave and labour market participation in CHARLS (early retirement): Observations (no.) and percentage (%) or mean and standard deviation (SD)

Variables	Wave 1				Wave 2				Wave 3			
	Early Retirement		Still working		Early Retirement		Still working		Early Retirement		Still working	
	Prevalence(%) or mean(SD)	N	Prevalence(%) or mean(SD)	N	Prevalence(%) or mean(SD)	N	Prevalence(%) or mean(SD)	N	Prevalence(%) or mean(SD)	N	Prevalence(%) or mean(SD)	N
Gender												
male	41.77	520	61.69	3,974	40.72	474	60.41	3,820	37.10	469	40.03	2,721
female	58.23	725	38.31	2,468	59.28	690	39.59	2,503	62.90	795	59.97	4,077
p value	<0.001	1,245		6,442	<0.001	1,164		6,323	<0.001	1,264		6,798
Age years	51.59 (3.94)	1,245	50.99 (4.12)	6,442	51.72 (3.74)	1,164	51.15 (3.89)	6,323	51.46 (3.68)	1,264	50.91 (3.83)	6,798
p value	<0.001				<0.001				<0.001			
Marital status												
never married	2.17	27	0.85	55	1.81	21	0.74	47	1.74	22	0.53	36
married	91.32	1,136	95.44	6,148	91.83	1,068	95.66	6,045	92.01	1,163	95.79	6,505
divorced or separated	3.05	38	1.07	69	2.92	34	1.25	79	3.09	39	1.44	98
widowed	3.46	43	2.64	170	3.44	40	2.35	148	3.16	40	2.24	152
p value	0.033	1,244		6,442	0.013	1,163		6,319	0.056	1,264		6,791
Education												
high	3.14	39	3.06	197	1.98	23	3.56	225	2.11	22	4.05	218
medium	20.61	256	15.40	992	23.45	273	15.72	993	17.79	186	14.76	794
low	76.25	947	81.54	5,252	74.57	868	80.72	5,100	80.10	837	81.19	4,369
p value	<0.001	1,242		6,441	<0.001	1,164		6,318	0.606	1,045		5,381
Net housing value												
high	34.20	385	34.95	2,059	33.08	299	35.67	1,759	15.09	32	14.49	142
medium	39.96	450	45.15	2,660	44.36	401	44.17	2,178	73.11	155	69.29	679
low	25.84	291	19.90	1,173	22.56	204	20.16	994	11.80	25	16.22	159
p value	0.01	1,126		5,892	0.06	904		4,931	0.224	212		980
Net non-housing value												

very high	26.27	327	31.19	2,009	26.55	309	31.88	2,016	27.06	342	34.35	2,335
high	27.39	341	29.65	1,910	25.77	300	29.01	1,834	28.96	366	29.59	2,012
low	23.69	295	21.64	1,394	24.14	281	20.72	1,310	26.11	330	20.17	1,371
very low	22.65	282	17.52	1,129	23.54	274	18.39	1,163	17.87	226	15.89	1,080
p value	<0.001	1,245		6,442	<0.001	1,164		6,323	<0.001	1,264		6,798
Homeownership												
no ownership	8.37	103	3.36	215	8.22	92	5.07	312	10.79	131	8.35	554
partly owned	3.50	43	3.41	218	4.11	46	3.33	205	3.31	40	2.41	160
entire ownership	88.13	1,084	93.23	5,961	87.67	981	91.60	5,642	85.90	1,042	89.24	5,919
p value	<0.001	1,230		6,394	<0.001	1,119		6,159	<0.001	1,213		6,633
Pension contributor												
yes	36.55	455	40.39	2,602	64.47	742	71.56	4,477	100	1,263	100	6,795
no	63.45	790	59.61	3,840	35.53	409	28.44	1,779	0	0	0	0
p value	0.01	1,245		6,442	<0.001	1,151		6,256	-	1,263		6,795
Urban residents												
yes	64.09	798	36.25	2,322	58.91	684	38.25	2,309	56.29	711	38.60	2,623
no	35.91	433	63.75	4,084	41.09	477	63.43	4,005	43.71	552	61.40	4,172
p value	<0.001	1,231		6,406	<0.001	1,161		6,314	<0.001	1,263		6,795
Standardized chronic diseases	0.11 (0.11)	1,245	0.08 (0.09)	6,439	0.11 (0.11)	1,113	0.07 (0.09)	6,037	0.12 (0 .11)	974	0.09 (0.10)	4,847
p value	<0.001				<0.001				<0.001			
Standardized limitations	0.09 (0.21)	1,244	0.03 (0.09)	6,439	0.09 (0.20)	1,164	0.02 (0.08)	6,306	0.08 (0.19)	1,263	0.03 (0.08)	6,792
p value	<0.001				<0.001				<0.001			
Standardized mental health	0.28 (0.22)	1,145	0.25 (0.20)	5,773	0.28 (0.21)	1,038	0.24 (0.18)	5,724	0.28 (0.23)	1,174	0.23 (0.20)	6,480
p value	<0.001				<0.001				<0.001			
Total	100	≤1,245	100	≤6,442	100	≤1,164	100	≤6,323	100	≤1,264	100	≤6,798

p statistics base on analysis of Spearman's correlation.

Source: China Health and Retirement Longitudinal Study (CHARLS)

Table 4.5: Statistical description of covariates by wave and labour market participation in CHARLS (delayed retirement): Observations (no.) and percentage (%) or mean and standard deviation (SD)

Variables	Wave 1				Wave 2				Wave 3			
	Delayed Retirement		Not working		Delayed Retirement		Not working		Delayed Retirement		Not working	
	Prevalence(%) or mean(SD)	N	Prevalence(%) or mean(SD)	N	Prevalence(%) or mean(SD)	N	Prevalence(%) or mean(SD)	N	Prevalence(%) or mean(SD)	N	Prevalence(%) or mean(SD)	N
Gender												
male	43.51	2,140	36.95	1,445	44.45	2,469	39.06	1,629	46.98	2,687	38.78	1,787
female	56.49	2,778	63.05	2,466	55.55	3,086	60.94	2,642	53.02	3,032	61.22	2,821
p value	<0.001	4,918		3,911	<0.001	5,555		4,271	<0.001	5,719		4,608
Age years	63.61 (5.71)	4,918	67.15 (6.89)	3,911	64.08 (5.58)	5,555	67.38 (6.89)	4,271	64.62 (5.50)	5,719	67.50 (6.70)	4,608
p value	<0.001				<0.001				<0.001			
Marital status												
never married	0.77	38	0.87	34	0.88	49	0.70	30	0.77	44	0.91	42
married	87.59	4,308	77.19	3,019	87.52	4,854	77.94	3,328	87.04	4,969	78.28	3,605
divorced or separated	1.02	50	1.41	55	0.87	48	1.12	48	0.65	37	1.13	52
widowed	10.62	522	20.53	803	10.73	595	20.24	864	91.54	659	19.68	906
p value	<0.001	4,918		3,911	<0.001	5,546		4,270	<0.001	5,709		4,605
Education												
high	0.55	27	3.51	137	0.63	35	3.42	146	0.64	35	3.02	128
medium	2.91	143	8.61	336	4.14	230	9.34	399	5.27	286	10.16	431
low	96.54	4,741	87.88	3,429	95.23	5,287	87.24	3,725	94.09	5,109	86.82	3,682
p value	<0.001	4,911		3,902	<0.001	5,552		4,270	<0.001	5,430		4,241
Net housing value												
high	23.34	1,030	26.70	921	23.45	962	26.46	826	12.86	124	7.36	67
medium	42.09	1,858	40.16	1,385	45.81	1,879	40.29	1,258	82.26	793	86.48	787
low	34.57	1,526	33.14	1,143	30.74	1,261	33.25	1,038	4.88	47	6.16	56
p value	0.007	4,414		3,449	0.899	4,102		3,122	<0.001	964		910
Net non-housing value												

very high	19.32	950	18.74	733	20.74	1,152	17.93	766	18.34	1,049	24.85	1,145
high	27.25	1,340	22.37	875	28.73	1,596	23.60	1,008	31.63	1,809	31.03	1,430
low	29.12	1,432	27.03	1,057	28.59	1,588	28.38	1,212	29.79	1,704	25.63	1,181
very low	24.31	1,196	31.86	1,246	21.94	1,219	30.09	1,285	20.24	1,157	18.49	852
p value	<0.001	4,918		3,911	<0.001	5,555		4,271	<0.001	5,719		4,608
Homeownership												
no ownership	9.03	441	12.28	476	10.21	553	13.99	568	13.21	738	16.81	742
partly owned	5.08	248	4.30	167	4.14	224	3.91	160	3.61	202	2.60	115
entire ownership	85.89	4,196	83.42	3,234	85.65	4,640	82.10	3,333	83.18	4,647	80.59	3,558
p value	<0.001	4,885		3,877	<0.001	5,417		4,061	<0.001	5,587		4,415
Pension income												
high	26.78	1,317	48.35	1,891	22.42	798	38.35	1,247	33.62	1,138	43.18	1,266
low	73.22	3,601	51.65	2,020	77.58	2,761	61.65	2,005	66.38	2,247	56.82	1,666
p value	<0.001	4,918		3,911	<0.001	3,559		3,252	<0.001	3,385		2,932
Urban residents												
yes	24.31	1,189	58.51	2,275	25.82	1,433	57.99	2,474	26.70	1,527	56.80	2,617
no	75.69	3,702	41.49	1,613	74.18	4,118	42.01	1,792	73.30	4,192	43.20	1,990
p value	<0.001	4,891		3,888	<0.001	5,551		4,266	<0.001	5,719		4,607
Standardized chronic diseases	0.11 (0.10)	4,917	0.14 (0.12)	3,909	0.10 (0.10)	5,418	0.14 (0.12)	4,111	0.12 (0.11)	5,328	0.16 (0.13)	4,132
p value	<0.001				<0.001				<0.001			
Standardized limitations	0.07 (0.14)	4,916	0.13 (0.24)	3,906	0.06 (0.13)	5,543	0.13 (0.23)	4,264	0.07 (0.14)	5,718	0.14 (0.23)	4,607
p value	<0.001				<0.001				<0.001			
Standardized mental health	0.31 (0.22)	4,657	0.30 (0.22)	3,612	0.28 (0.20)	5,236	0.28 (0.20)	3,787	0.29 (0.22)	5,570	0.29 (0.23)	4,266
p value	<0.001				0.374				0.200			
Total	100	≤4,918	100	≤3,911	100	≤5,555	100	≤4,271	100	≤5,719	100	≤4,608

p statistics base on analysis of Spearman's correlation.

Source: China Health and Retirement Longitudinal Study (CHARLS)

4.8 Results

4.8.1 Analysis by location

The results of the Probit regressions for two panels are presented in Table 4.6 and Table 4.7, respectively. Table 4.6 shows the results of labour market participation associated with the covariates for men aged below 60 and women aged below 55 (i.e. early retirement group). Table 4.7 showed the findings for men aged 60 or above and women aged 55 or above (i.e. delayed retirement group). Each table provides the results by Chinese region.

- *Early retirement analysis:*

For respondents assigned to the younger group, health problems generated the most significant effect on early retirement. We found that respondents who had difficulties or limitations in doing daily activities were more likely to quit in middle-age (Table 4.6). Our findings confirm hypothesis 2 where health problem is associated with a higher probability of early retirement. The results consistent with the work done by Benjamin *et al*. (2003), who demonstrate the positive relationship between physical limitations and the reduction in labour supply. Coastal residents with one more unit in the limitation scale are associated with a higher probability of early retirement by 3.35 (Model (3) in Table 4.6). The smallest effect appears in the central part of China. However, the probability of exiting the labour force can still rise as high as 2.13, given a one-unit change in the limitation (Model (2) in Table 4.6). In line with the literature summarised previously (Bazzoli 1985; Tanner 1998; Deschryvere 2004; Lindeboom 2006), chronic disease can cause heath impairment and hence influence labour market participation. In western China, the likelihood of retirement is as high as 1.72 if the respondents had more than two chronic diseases (Model (1) in Table 4.6); a probability of 1.61 higher in coastal China (Model (3) in Table 4.6). By comparison, residents living in central China did not show a significant result in this aspect, although the parameter is consistent in direction. For entire homeowners, respondents are less likely to leave the labour market early. The difference between an entire homeowner and other tenures is 0.25 in average probability. The largest difference appeared in the coastal area with a probability of 0.43 lower compared with those who were not homeowners (Model (3) in Table 4.6). In term of current marital status, the married people were less likely to leave the labour market early. The probability of early retirement among married people is 0.76 lower in central China (Model (2) in Table 4.6), while the magnitude in probability is 1.22 in coastal China (Model (3) in Table 4.6). With regards to the pension schemes, the results confirm our hypothesis 1, where pension contributors are less likely to exit the labour market early. No previous papers have examined the effects of pension contributors on retirement behaviours. Residents participating in a pension scheme in the coastal area associate with a 23.4 per cent lower probability of early retirement (Model (3) in Table 4.6), compared with people who are not in pension scheme. The likelihood is 34.9 per cent lower in the central area and 11 per cent lower in the western region, respectively (Model (1) and Model (2) in Table 4.6).

Regarding the *hukou*, urban residences were more likely to leave the labour market in middle age. The results are statistically significant different from zero in all estimations. The findings verify hypothesis 4 and prove the arguments made by Davis-Friedmann (1991), Benjamin *et al*. (2003), Pang *et al*. (2004) and Ning *et al*. (2016) where rural residents are more likely to extend working life beyond the compulsory retirement age. Compared with rural residents, the differences in probability were 1.132 higher in coastal China (Model (3) in Table 4.6) to 1.06 higher in western China (Model (1) in Table 4.6). In line with the findings made by Appleton *et al*. (2002) and Giles *et al*. (2006), people who were older or female were more likely to exit from labour market early. The effects from these two characteristics retain statistically significant across different regions of China. Our findings do not support hypothesis 3 because neither net housing value nor net non-housing value has provided a statistically significant effects on early retirement. Some general traditions and policy restrictions built into the property which are outside our model have exerted an impact on labour supply. These factors are the will of intergenerational transfer, limits on the mortgage lending, and special properties restricted to trade[47]. Therefore, older people do not consider the value of the properties as a resource

[47] Special properties incorporate affordable housing (*Jingjishiyongfang*), houses with limited property rights (*Xiaochanquanfang*), housing on allocated land (*Huabotudi*).

to support their living standard in retirement. They will not realise the value to compensate living expenditure even though they own the property outright.

Table 4.6: Pooled estimates for the group before the default retirement age by region (early retirement)

	Western Model (1) Early Retired	Central Model (2) Early Retired	Coastal Model (3) Early Retired
housewealth			
low[a] (ref.)			
medium	-0.016	-0.065	-0.011
	(0.104)	(0.108)	(0.110)
high	0.111	0.063	0.139
	(0.118)	(0.119)	(0.121)
nhwealth			
very low (ref.)			
low	0.120	-0.061	-0.046
	(0.124)	(0.125)	(0.123)
high	-0.156	-0.225*	-0.108
	(0.118)	(0.120)	(0.116)
very high	-0.155	-0.079	-0.104
	(0.120)	(0.118)	(0.119)
stchronic	1.715***	0.461	1.608***
	(0.437)	(0.453)	(0.491)
stlimit	2.359***	2.126***	3.351***
	(0.316)	(0.344)	(0.443)
stmenthealth	0.099	0.217	0.286
	(0.233)	(0.216)	(0.228)
education			
low (ref.)			
medium	0.375***	0.261**	0.204*
	(0.135)	(0.113)	(0.113)
high	0.155	-0.107	-0.501**
	(0.285)	(0.234)	(0.243)
maritalstat			
never married (ref.)			
married	-0.160	-0.760*	-1.222**
	(0.437)	(0.457)	(0.490)
divorced	0.392	-0.263	-0.669
	(0.537)	(0.530)	(0.574)
widowed	0.152	-0.992*	-1.169**
	(0.486)	(0.535)	(0.542)

homeownership			
no ownership (ref.)			
partly owned	-0.191	-0.380	-0.338
	(0.252)	(0.237)	(0.239)
entire ownership	-0.162	-0.243*	-0.429***
	(0.160)	(0.143)	(0.162)
pension contributor	-0.110	-0.349***	-0.234***
	(0.090)	(0.086)	(0.085)
urban	1.055***	1.015***	1.132***
	(0.113)	(0.108)	(0.111)
age	0.084***	0.095***	0.079***
	(0.014)	(0.013)	(0.013)
gender	-0.984***	-1.167***	-1.028***
	(0.118)	(0.117)	(0.114)
2011.year (base year)			
2013.year	-0.012	0.044	-0.009
	(0.082)	(0.078)	(0.077)
2015.year	-0.088	0.326*	0.032
	(0.180)	(0.179)	(0.192)
Cons	-5.858***	-5.252***	-4.263***
	(0.839)	(0.832)	(0.818)
Obs	3,692	4,058	4,428

Source: The China Health and Retirement Longitudinal Study (CHARLS)

All estimates of Model are controlled time fixed effect

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

[a] Base level

- Delayed retirement analysis:

By comparison, we observed a significant effect of both net housing value and net non-housing value on delayed retirement. Among men over the age of 60 and women above 55, the higher housing value reduces the probability of delayed retirement, which is on the contrary of hypothesis 3. Comparing top stratification with lower stratifications in net housing value, the largest difference in marginal impact appears in the coastal area with 0.665 in magnitude (Model (3) in Table 4.7). For people in the second-highest quartile of net housing values, the probability is 0.363 lower in the coastal area (Model (3) in Table 4.7) and 0.134 lower in the western region (Model (1) in Table 4.7). If we focus on the relationship between net non-housing value and delayed retirement, the regression results verify hypothesis 3 where people with higher net non-housing value were more likely to stay in the labour market above the default retirement age. Comparing with the bottom stratification, the probability of staying in the labour market among older people in the top stratification is 0.26 higher in the coastal area (Model (3) in Table 4.7) and 0.25 higher in the central area (Model (2) in Table 4.7). Health issues have a significant impact on delayed retirement, which is consistent with hypothesis 2. People who have more difficulties in doing daily activities will reduce the likelihood of staying in the labour market by 2.56 in the coastal area (Model (3) in Table 4.7). In coastal area, there is an approximately 3.18 decreased probability of delayed retirement for a one-unit increase in the chronic diseases index (Model (3) in Table 4.7), which produces the largest effect on the labour market. In the central area, the effect of chronic disease is relatively smaller. One more unit in chronic disease is associated with a decreased probability of 1.94 for delayed retirement (Model (2) in Table 4.7). The probability of delayed retirement in the western area is 1.23 lower if the respondents suffered two or more chronic diseases (Model (1) in Table 4.7). The results again verify hypothesis 2 and are consistent with existing literatures. Also, people with a higher education background are associated with a reduced probability of delayed retirement. The difference between the top education level and the bottom one is 1.68 in the coastal area (Model (3) in Table 4.7), which produces the largest difference among the three areas. The differences tapered off to 1.25 in the western area (Model (1) in Table 4.7) and 0.49 in the central part (Model (2) in Table 4.7). The results for current marital status, *hukou* location, age and gender confirm the findings in early retirement analysis. People who were younger, male, married and rural residents were more likely to stay in the labour market above the default retirement age. The results confirm hypothesis 4.

Furthermore, higher pension income reduced the probability of delayed retirement. It particularly verifies the conclusion given by Shu (2018), who gave a negative association between NRSPI program and working hours among Chinese women. In our study, on average, the upper half of pension income is associated with a 0.44 lower probability of delayed retirement (Model (1) to Model (3) in Table 4.7). What’s more, homeowners are more likely to retire late.

Table 4.7: Pooled estimates for the group after the default retirement age by region (delayed retirement)

	Western Model (1) Delay Retired	Central Model (2) Delay Retired	Coastal Model (3) Delay Retired
housewealth			
low[a] (ref.)			
medium	-0.134*	0.146*	-0.363***
	(0.079)	(0.084)	(0.089)
high	-0.356***	-0.113	-0.665***
	(0.101)	(0.103)	(0.111)
nhwealth			
very low (ref.)			
low	0.123	0.211**	0.353***
	(0.087)	(0.083)	(0.095)
high	0.237***	0.277***	0.334***
	(0.091)	(0.089)	(0.100)
very high	0.105	0.250**	0.256**
	(0.098)	(0.103)	(0.114)
stchronic	-1.234***	-1.942***	-3.182***
	(0.335)	(0.347)	(0.435)
stlimit	-1.838***	-2.051***	-2.562***
	(0.186)	(0.220)	(0.285)
stmenthealth	0.310*	0.348**	0.157
	(0.172)	(0.172)	(0.201)
education			
low (ref.)			
medium	-1.094***	-0.650***	-1.082***
	(0.196)	(0.152)	(0.174)
high	-1.253***	-0.495*	-1.678***
	(0.374)	(0.274)	(0.353)
maritalstat			
never married (ref.)			
married	0.217	0.584	1.094**
	(0.369)	(0.513)	(0.431)
divorced	-0.532	0.369	1.331**
	(0.454)	(0.645)	(0.547)
widowed	-0.249	0.212	0.583
	(0.378)	(0.522)	(0.441)

home ownership			
no ownership (ref.)			
partly owned	0.325*	0.641***	0.232
	(0.170)	(0.169)	(0.177)
entire ownership	0.200*	0.032	0.400***
	(0.104)	(0.100)	(0.115)
pensioninc			
low (ref.)			
high	-0.438***	-0.482***	-0.394***
	(0.076)	(0.077)	(0.083)
urban	-1.361***	-1.680***	-1.782***
	(0.096)	(0.103)	(0.117)
age	-0.079***	-0.087***	-0.120***
	(0.007)	(0.008)	(0.008)
gender	0.482***	0.773***	0.870***
	(0.083)	(0.089)	(0.099)
2011.year (base year)			
2013.year	-0.026	0.033	-0.055
	(0.059)	(0.061)	(0.064)
2015.year	0.117	0.037	0.410***
	(0.122)	(0.128)	(0.143)
Cons	6.161***	6.109***	7.838***
	(0.612)	(0.713)	(0.734)
Obs	4,767	5,392	5,443

Source: The China Health and Retirement Longitudinal Study (CHARLS)

All estimates of Model are controlled time fixed effect

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

[a] Base level

4.8.2 Propensity Score Matching (PSM) analysis

We examine the effects of specific treatments on an individual's labour market participation using PSM analysis. The treatments are whether or not a person suffered from a chronic disease, or as urban residents, or receiving or participating in at least one type of pension programme. The treated observations would be those respondents that received treatments with the control observations not. Each treatment is a 0 or 1 dummy variable. The independent variables would be housing wealth, non-housing wealth, homeownership, educational grade, age, marital status and gender. The outcome variable would be whether the individual is working.

- *Early retirement analysis:*

Regarding urban treatment, the number of treated observations is 11,229, and the number of controls that happened to use is 6,668. For pension participants, there are 17,088 treated observations and 4,988 individuals in the comparison group.

- *Delayed retirement analysis:*

Regarding urban treatment, the number of treated observations is 11,229, and the number of the control group is 8,222. The number of observations in the pension receiver for delayed retirement study is 17,088 with 5,195 individuals assigned into the comparison group.

The detailed information for a full set of treatment effects is listed in Table 4.8 and Table 4.9.

We estimate the propensity of members to be assigned to the treated group. Based on the propensity score models, we then matched observations from the treated group and the comparison group. After the matching, we estimated average treatment effect on the treated (ATET). Note that we are estimating ATET, that is, the result is going to generalise the respondents that look like the treatment group, not like the overall population. The average treatment effect on treated between the treated group and the control group in each wave was estimated using one period data.

Table 4.8: Estimated average treatment effects on the treated (early retirement analysis)

Treatment	n.treat.	n.cont.	Common Support	ATET	Std.Err.	t-stat.	Significance
urban	11229	6668	[0.29,0.93]	0.153	0.009	16.23	***
pension contributor	17088	4988	[0.395,0.874]	-0.023	0.007	-3.30	***
hypertension	6976	7855	[0.12,0.59]	0.077	0.007	10.66	***
diabetes	1654	5081	[0.03,0.17]	0.102	0.014	7.45	***
heart problem	3522	6971	[0.05,0.37]	0.093	0.010	9.38	***
cancer	279	2086	[0.003,0.024]	0.160	0.032	4.93	***
stroke	669	2508	[0.007,0.081]	0.228	0.023	9.73	***
lung problem	3000	6804	[0.038,0.276]	0.023	0.010	2.45	**
memory problem	437	1106	[0.002,0124]	0.277	0.031	8.98	***
mental health problem	375	1800	[0.005,0.027]	0.171	0.030	5.71	***
asthma	1085	3455	[0.006,0.149]	0.060	0.016	3.75	***
liver problem	1172	5497	[0.028,0.063]	-0.018	0.013	-1.41	
kidney problem	1880	6622	[0.046,0.093]	0.039	0.012	3.39	***
stomach problem	6520	7602	[0.119,0.331]	-0.002	0.007	-0.34	
cholesterol	2673	6911	[0.054,0.328]	0.097	0.011	8.78	***

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The numbers of treated and controls refer to nearest neighbour matches.

Table 4.9: Estimated average treatment effects on the treated (delayed retirement analysis)

Treatment	n.treat.	n.cont.	Common Support	ATET	Std.Err.	t-stat.	Significance
urban	11229	8222	[0.288,0.927]	-0.317	0.009	-33.66	***
pension receiver	17088	5195	[0.395,0.874]	0.054	0.010	5.22	***
hypertension	6976	8873	[0.123,0.589]	-0.126	0.009	-13.94	***
diabetes	1654	7206	[0.026,0.172]	-0.187	0.015	-12.48	***
heart problem	3522	8838	[0.046,0.373]	-0.193	0.011	-17.50	***
cancer	279	1927	[0.003,0.024]	-0.133	0.035	-3.81	***
stroke	669	4376	[0.007,0.081]	-0.262	0.021	-12.37	***
lung problem	3000	8552	[0.038,0.276]	-0.029	0.012	-2.45	**
memory problem	437	2897	[0.002,0124]	-0.147	0.028	-5.332	***
mental health problem	375	2947	[0.005,0.027]	-0.079	0.030	-2.65	***
asthma	1085	5708	[0.010,0.145]	-0.037	0.018	-1.99	**
liver problem	1172	5601	[0.028,0.063]	-0.090	0.018	-5.015	***
kidney problem	1880	7108	[0.046,0.093]	-0.029	0.014	-1.98	**
stomach problem	6520	8886	[0.120,0.331]	0.031	0.009	3.42	***
cholesterol	2673	7938	[0.054,0.328]	-0.174	0.013	-13.752	***

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The numbers of treated and controls refer to nearest neighbour matches.

4.8.2.1 Hukou location

- Early retirement analysis:

In this part, we used data on people aged below 60 for men and below 55 for women and considered whether they were rural or urban residents. After evaluating the match with statistical tests, we specified the variables that we want to balance, which are the same covariates used above in the pooled estimation. Table 4A.3 shows the matches on a series of variables and the balancing property where the similar characteristics between the treated and control observations are satisfied.

Based on the output comparing the mean of the treated group and the control group on each of factors, and statistical indicators of to what extent bias has been reduced (Table 4A.3), the *t*-test on matching variables (i.e. net housing values, net non-housing wealth, demographics and so forth) are not statistically significant between the treated estimates and control estimates. The *t*-statistics are small, and the corresponding *p*-values are above 0.05. Accordingly, the selection bias has been reduced, and we have achieved a balance between the treated and the comparison group across observable covariates. It would allow us to have some faith in the results from the PSM. The pairs of the treatment group and the control group are well set to estimate the relationship between *hukou* location and labour market participation.

The effect of *hukou* location on labour market participation is presented in Table 4.8. ATET tells us if someone has an urban *hukou*, their likelihood of early exit from the labour market would increase by 0.153. The *t*-statistic is 16.23, indicating that a significant difference existing between the treated observations and the control observations. The propensity score (i.e. the region of common support) varies between 0.29 and 0.93 in this case. In sum, respondents who were living in an urban area were associated with a 0.153 higher probability of labour market participation. This result is consistent of our findings in the regression analysis.

- Delayed retirement analysis:

The propensity scores demonstrated a good match between these treated and control groups with *p*-values on most matching variables being larger than 0.05. In other words, the underlying characteristics turn to be similar after matching in our sample. Also, the values in %bias[48] are below 5% (Table 4A.3). Look at the treatment estimation in Table 4.9, ATET is -0.317, which means that the urban residents could reduce the likelihood of staying in the labour market by 31.7% if they were at the age above default retirement age.

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[48] %bias measures how much differences the means are in the treated group and the control group. The closer is the mean in the treated group and the control group, the good match we have, the smaller of absolute value of %bias. If the means in treated group and the control group are exactly the same, %bias would be 0, and p=1. We cannot reject the null hypothesis of a matching characteristics in the treated group and the control group.

4.8.2.2 Pension schemes

From Table 4A.3 and Table Table 4A.4, we find that *p*-values are generally small in both the early exit group and the late retired group, which means that the background characteristics in the treated group and the comparison group are significantly different from each other. In other words, the matching for pension treatment did not perform well. One reason could be that the number of observations in the pension scheme is relatively small as presented in Table 4.4, that is, in PSM, one observation in the control group may have been used so many times for matching, and insufficient observations in the control group to select a good match with the treated group. Although the underlying characteristics may differ in the treated group and the comparison group to some extent, the significance of ATET in both cases demonstrated that pension schemes produce a large impact on labour market participation.

- Early retirement analysis:

Figure 4A.27 shows the evidence of the matching for the early exit group. For the younger group, if respondents were covered by at least one kind of pension insurance, the probability of early retirement can reduce by 0.023. If respondents were in the pension plan, they might be willing to work longer and, in return, get more benefits after retirement.

- Delayed retirement analysis:

Figure 4A.28 shows the evidence of the matching for the delayed retirement section. The probability of delayed retirement will increase by 0.054 if respondents are entitled to receive at least one kind of pension benefits. Convincingly, pension benefits received after retirement depends on the contribution amount and the contribution years before retiring. It is worth noting that, the signs in ATET are opposite to findings with the pooled estimates in the delayed retirement analysis.

4.8.2.3 Chronic diseases

-Hypertension:

With regards to diagnosed hypertension, we can see from Table 4A.3 and Table 4A.4 that the balancing condition is satisfied for both panels. *P*-values are greater than 0.1, and the values of %bias are below 5%. After testing the balancing property, we can go to check ATET in Table 4.8 for the younger group and Table 4.9 for the older group. For men below 60 and women below 55, the ATET of 0.077 means that the likelihood of early retirement can be higher if the respondents were diagnosed with hypertension. The *t*-statistics is 10.66 in this group, meaning people who were diagnosed such disease behaved significantly different in the labour market from those who did not. For men in an age range of 60-80 and women in an age range of 55-80, the ATET equals -0.126, which means that respondents who had hypertension can decrease the probability of extending their working lives into old age by 0.126 compared with those who did not suffer such a disease. The *t*-statistic is -13.94, indicating a significant result in this case.

-Diabetes:

Table 4A.3 and Table 4A.4 show the statistical tests for the impact of diabetes on an individual's life. In both panels, *p*-values are all larger than 0.1, and the numbers of %bias are all below 5%, indicating that the distributions of propensity score are matching in the treated group and comparison group. For respondents below the statutory retirement age, a positive ATET means that respondents who were diagnosed with diabetes were more likely to exit from the labour market at a younger age, the probability can increase by 0.102 comparing with those who did not have such disease (Table 4.8). The result is significant at the 5% level (t = 7.45). By comparison, diabetes can reduce the likelihood of extending working life into older age with a probability of 0.187. Again, this result is statistically different from zero at the 5% level (t = -12.48) (Table 4.9).

-Heart problems:

Based on Table 4A.3 and Table 4A.4, the treated group and control group are a good match (i.e. all *p* values are larger than 0.05, and all values of %bias are below 5%). The ATET and *t*-statistics in Table 4.8 showed that heart problems can increase the probability of leaving the labour market at an early age by 0.093, while this disease can reduce the probability of extending retirement age into later by 0.193 (Table 4.9).

-Cancer:

Concerning cancer, again, we have a good match between the treated group and the comparison group (see *p*-values and %bias in Table 4A.3 and Table 4A.4). The ATET is 0.160 for the younger panel and -0.133 for the older panel. Therefore, the probability of early exit from the labour market will increase by 0.16 if the respondents were diagnosed with cancer, with *t*-statistics equals 4.93 in the younger group. The probability of continue working in older age can decrease by 0.133 if the respondents were diagnosed with cancer, *t*-statistics equals to -3.81 in this case.

-Stroke:

Regarding a stoke, the treated group and the comparison group are matching with each other in our sample (see *p*-values and %bias in Table 4A.3 and Table 4A.4). A value of 0.228 for the ATET with a *t*-statistics equal to 9.73 for the younger panel, indicating that a stoke can increase the probability of exiting from labour market early by 0.228. A value of -0.262 for the ATET with a *t*-statistic equal to -12.37 for the elderly group indicated that stoke disease can decrease the probability of staying in the labour market in old age.

-Lung problems:

Focusing on the impact of lung problems, the treated group and the comparison group have a good match on underlying characteristics (see *p*-values and %bias in Table 4A.3 and Table 4A.4). For the younger cohort, the ATET is 0.023 with a *t*-value equal to 2.45, meaning that lung problems can increase the probability of dropping out of the workforce early by 0.023. For the elderly panel, ATET is -0.029 with a *t*-value equal to -2.45, indicating lung problems reduces the probability of working in old age by 0.029.

-Memory problem:

P-value and numbers of %bias in Table 4A.3 and Table 4A.4 demonstrated a good match in the treated group and the comparison group. After matching, Table 4.8 showed that the ATET for the younger group is 0.277 with t = 8.98. Therefore, the probability of early exit from the labour market increases by 0.277. Table 4.9 shows that the ATET for the elderly is -0.147 with t = -5.332. That is, a memory problem is associated with a decreased probability of working in the older age by 0.147.

-Mental health problem:

Given the matching in the treated group and control group (see *p*-values and %bias in Table 4A.3 and Table 4A.4), the results indicate that respondents who were suffering from mental health problem are associated with a higher probability to exit from the labour market at an early age; the likelihood is 0.171, compared with those who did not. By contrast, the probability of continue working at an older age reduces by 0.079 with t = -2.65 (Table 4.8 and Table 4.9).

-Asthma:

Given the similar pre-existing background characteristics after matching, the balancing property between the treated group and control group is satisfied (see *p* values and %bias in Table 4A.3 and Table 4A.4). If asthma happened in an individual's life, people were more likely to exit from the labour market at an early age with an increased probability of 0.06 and t = 3.75. Whereas a decreased probability of 0.037 for delayed retirement if the respondents had asthma (Table 4.8 and Table 4.9).

-Liver problems:

For liver disease, we again have the balancing property in the treated group and the control group. However, the result for the younger group showed a decreased probability of not working if respondents did have liver problems, compared with those who did not. We notice that *t*-value in this situation is -1.41, which indicated that the difference is not statistically significant from zero. For the elderly group, the impact of suffering liver disease is still negative on delayed retirement. A value of -0.09 for ATET means that people with a liver problem are associated with a 0.09 lower probability of extending their working life; the difference between the ill group and the comparison group is statistically significant with t = -5.015 (Table 4.8 and Table 4.9).

-Kidney problems:

Concerning kidney disease, the balancing property between the treated group and control group is satisfied (see *p*-values and %bias in Table 4A.3 and Table 4A.4). Those with kidney problems were more likely to exit from the labour market with a probability of 0.039, whereas they are less likely to extend the working life. The probability of delayed retirement is lower by 0.029 (Table 4.8 and Table 4.9). Both results are statistically significant at 5% level.

-Stomach problem:

Table 4A.3 and Table 4A.4 provide the balancing property for treatment of stomach problems. After matching, the two groups perform the similar characteristics on each matching unit. Regressions are estimated to find out the effect of stomach problems on labour market participation. Table 4.8 and Table 4.9 provided a more compelling answer to the impact of stomach problems on labour market participation. For the elderly group, a diagnosed stomach disease is likely to increase the probability of longer working life by 0.031. Given the definition of stomach disease in CHARLS, it includes stomach or other digestive diseases (except for tumours or cancers). One explanation for this finding could be that patients often display a late onset of such health issues in old age. The ATET in the younger group was not statistically significant in our sample.

-Cholesterol:

Again, we first check the propensity scores with underlying characteristics. The results tell us the matching property is satisfied (Table 4A.3 and Table 4A.4). For the younger group, respondents who have diagnosed cholesterol-related diseases are associated with an increased 0.097 probability of early retirement (Table 4.8). By comparison, the ATET in the elderly group is -0.174, indicating a reduced probability of extending working lives if respondents suffer cholesterol in their old age (Table 4.9).

4.9 Discussion and Conclusion

In this section, we discuss further to support our findings. CHARLS provides detailed information on health functioning that is related to chronic diseases, limitations and mental health problems. Together with comprehensive data in employment status and wealth, we can look at the effects of these factors on labour market participation for all respondents in the dataset. We measured individual behaviour in the labour market by applying both regression equations and a matching framework. It is worth noting that, in the matching framework, each treatment must be a binary indicator, and therefore, we are not able to examine the correlation of labour market participation with a combination of various factors. In the regression models, we estimated the effect of all set of categorical variables in the regression. By doing this, we can assign different amounts of treatment to different individuals and compare each stratification with the baseline level. In other words, we can estimate the effect of all factors at the same time, rather than just examining one treatment on the outcomes at a time.

In the regression analysis, we found that older adults who had higher net value in houses were less likely to extend their retirement age, whereas a higher net value in non-housing assets was likely to increase the probability of extending the retirement age, with all other factors remaining the same. This relationship holds across different regions in China. One explanation could be that people with higher non-housing value are those who run their own business. Based on data statistics description in section 4.5, the frequency distribution in every four levels is relatively equal for non-housing observations. Further statistics showed that 54% of elderly members who were in self-employment have considerable non-housing assets, putting them in the top third of the population. Statutory retirement age does not apply strictly to those individuals in self-employment.

Regarding pension programmes, we find that pension participants will stay in the labour market until the retirement age. The reason for staying in the labour market could be that the pension entitlement in retirement depends on the contribution amount and the contribution years before retirement. Pension receivers are less likely to extend their working lives. By comparing the three geographical areas, for those above the default retirement age, the coastal area generated the largest effect on labour market participation given one unit increase in the scale of ill health. The central region occupied the second position with the western area producing the smallest difference. Also, people with an undergraduate degree or above tend to retire at the compulsory retirement age, neither retire early not retire late. One explanation for this could be that people with a stronger educational background have a higher chance to get skilled occupations and pay pension and national insurance contributions properly at working age, which would mean they are entitled to receive a benefit or get social security when they reach the state pension age.

In this chapter, we additionally study the effect of specific treatments on labour market participation. The analyses complement the pooled estimation discussed above, as the method effectively reduces the selection bias, especially for those diseases which are fairly rare for certain individuals in our dataset. By doing PSM, we can observe the similarity with underlying characteristics in the two comparison groups. Thus, the results are comparable. Also, the interpretations of these results are more straightforward.

Based on the results described above, among all diagnosed chronic diseases, the incident of a stroke has the largest effect on labour market participation in both cases, given the similar pre-existing background characteristics among respondents. In other words, respondents who have suffered a stroke have a higher probability of retiring early or lower probability to retire late. Memory problems stand at the second important condition on labour market participation among the younger group. Its impact on is much higher than cancer and diabetes in the younger group. Memory problem effects on labour market participation are smaller in the elderly, but they are still considerable. Among men older than 60 and women older than 55, the effect of memory problems is as high as heart problems, diabetes, and cancer. Previous studies have shown that, among all other symptoms in clinics, memory impairment is reported as the most common feature by patients who have Alzheimer's disease (AD). During the onset of AD pathology, the loss of working memory and long-run declarative memory is present at an early stage (Jahn 2013).

Furthermore, labour market participation is largely affected by the *hukou* location. Urban residents increase the probability of early retirement and decrease the probability of extending retirement age into older. The difference between urban residents and rural residents in the older cohort is almost three times as much as the effect in the younger group. One explanation for this could be that Chinese rural residents engage in agricultural work and are much less restricted by default retirement age.

Based on the analysis, the policymakers should continue to implement Social Security Reform and Medical System Reform. First, it is essential to reform the organisational structure of hospital providers and enhance the coverage of primary care at community levels. Second, the authorities should increase medical insurance funds to the demand side directly. It would offer great incentive for insureds to engage a regular check-up and find out potential severe diseases at early stage. Third, it is inevitable to build up harmonious social security system. The policymaker should identify most cost-effective models to benefit the retired people while encourage working people to involve in social security plan. It would provide a sufficient insurance funds in national-wide, maintain social stability and economic development.

Appendix 4A

Table 4A.1: Chronic diseases descriptions

Diagnosed disease	Definition
mental health problem	Emotional, nervous, or psychiatric problems
hypertension	Hypertension
diabetes	Diabetes or high blood sugar
heart problem	Heart attack, coronary heart disease, angina, congestive heart failure, or other heart problems
cancer	A cancer or a malignant tumour (excluding minor skin cancers)
stroke	Stroke
lung problem	Chronic lung diseases, such as chronic bronchitis, emphysema (excluding tumours, or cancer)
memory problem	Memory-related disease
asthma	Asthma
liver problem	Liver disease (except fatty liver, tumours, and cancer)
kidney problem	Kidney disease (except for a tumour or cancer)
stomach problem	Stomach or another digestive disease (except for a tumour or cancer)
cholesterol	Dyslipidemia (elevation of low-density lipoprotein, triglycerides (TGs), and total cholesterol, or a low high-density lipoprotein level)

Table 4A.2: Variables and descriptions

Variable name	Definition
early retired	binary dependent variable=1 if respondents currently not working before default retirement age; 0 otherwise
delay retired	binary dependent variable=1 if respondents currently engaging in agricultural work/employment/self-employment/unpaid family business; 0 otherwise
housewealth	net housing values; 1=bottom 33%; 2=middle tertile; 3= top 33%
nhwealth	net non-housing values; 1=bottom quarter; 2=second quarter; 3=third quarter; 4=top quarter
stchronic	a standardised score of 12 chronic diseases in a range of [0,1]
stlimit	standardised scores of limitations in a range of [0,1]
stmenthealth	standardised scores of mental health in a range of [0,1]
education	educational grade; 1=completed less than middle school; 2=completed high school or above; 3=completed two-/three-year college/associated degree or above
maritalstat	marital status; 1=never married; 2=married with spouse present or married but not living with spouse temporarily for a reason such as work; 3=divorced or no longer living together as a couple; 4=widowed
homeownership	homeownership; 1=no ownership; 2=partly owned; 3=entire ownership
pensioninc	yearly pension income; 1=upper half; 0 otherwise
pension contributor	1=participating in at least one kind of pension programs; 0 otherwise
urban	〝hukou〞 location; 1=urban; 0 otherwise
age	age years
gender	1=male; 0 otherwise
location	〝western〞; 〝central〞; 〝coastal〞

Table 4A.3: Evaluate match with statistical tests (Group: before default retirement age)

Treatment	Variable	Mean			t-test	
		Treated	Control	%bias	t	p>|t|
1. Urban	net housing wealth	2.68	2.67	1.3	0.63	0.53
	net non-housing wealth	2.72	2.74	-1.4	-0.68	0.49
	Homeowner	2.73	2.75	-3.4	-1.51	0.13
	education level	1.38	1.39	-1.8	-0.72	0.47
	Age	51.29	51.28	-0.5	0.24	0.81
	Gender	0.57	0.58	-2.9	-1.43	0.15
	marital status	2.06	2.03	8.8	4.85	0.00
2. Pension Receiver/Participant	net housing wealth	2.77	2.74	3.2	1.82	0.07
	net non-housing wealth	2.79	2.81	-2.0	-1.13	0.26
	Homeowner	2.78	2.82	-7.8	-4.38	0.00
	education level	1.26	1.29	-5.7	-2.96	0.00
	Age	51.63	51.63	-0.0	-0.00	0.99
	Gender	0.58	0.58	-0.6	-0.32	0.75
	marital status	2.05	2.03	6.0	4.00	0.00

Table 4A.3 (continued)

Treatment	Variable	Mean			t-test	
		Treated	Control	%bias	t	p>| t |
3. Diagnosed hypertension	net housing wealth	2.70	2.70	-0.4	-0.13	1.90
	net non-housing wealth	2.73	2.72	0.9	0.27	0.79
	Homeowner	2.80	2.81	-2.8	-0.90	0.37
	education level	1.27	1.27	1.7	0.54	0.59
	Age	51.00	51.05	-1.3	-0.40	0.69
	Gender	0.60	0.60	-0.2	-0.06	0.95
	marital status	2.06	2.04	6.6	2.25	0.03
4. Diagnosed diabetes	net housing wealth	2.72	2.70	1.2	0.19	0.85
	net non-housing wealth	2.74	2.76	-1.7	-0.27	0.79
	Homeowner	2.76	2.78	-4.2	-0.63	0.53
	education level	1.34	1.33	1.1	0.16	0.87
	Age	52.03	52.10	-1.7	-0.27	0.79
	Gender	0.59	0.59	2.1	0.33	0.75
	marital status	2.04	2.04	1.9	0.35	0.73

Table 4A.3 (continued)

Treatment	Variable	Mean: Treated	Mean: Control	%bias	t-test: t	t-test: p>| t |
5. Diagnosed heart problem	net housing wealth	2.63	2.64	-0.3	-0.07	0.95
	net non-housing wealth	2.67	2.67	0.1	0.02	0.98
	Homeowner	2.80	2.82	-2.6	-0.56	0.57
	education level	1.27	1.26	2.2	0.48	0.63
	Age	51.63	51.62	0.2	0.04	0.97
	Gender	0.47	0.47	0.8	0.18	0.86
	marital status	2.07	2.05	4.7	1.07	0.29
6. Diagnosed cancer	net housing wealth	2.69	2.69	0.0	0.00	1.00
	net non-housing wealth	2.70	2.70	0.0	-0.00	1.00
	Homeowner	2.87	2.88	-2.0	-0.17	0.86
	education level	1.15	1.16	-2.3	-0.19	0.85
	Age	51.01	51.06	-1.3	-0.09	0.93
	Gender	0.34	0.35	-2.0	-0.15	0.88
	marital status	2.02	2.00	6.9	1.00	0.32

Table 4A.3 (continued)

Treatment	Variable	Mean			t-test	
		Treated	Control	%bias	t	p>| t |
7. Diagnosed stroke	net housing wealth	2.66	2.59	5.6	0.49	0.63
	net non-housing wealth	2.46	2.49	0.0	0.0	1.00
	Homeowner	2.78	2.79	-1.1	-0.09	0.93
	education level	1.28	1.26	3.6	0.31	0.76
	Age	52.59	52.42	4.0	0.34	0.73
	Gender	0.63	0.59	6.5	0.58	0.57
	marital status	2.12	2.15	-7.5	-0.57	0.57
8. Diagnosed lung problem	net housing wealth	2.65	2.65	-0.1	-0.02	0.98
	net non-housing wealth	2.64	2.65	-0.6	-0.13	0.90
	Homeowner	2.78	2.80	-3.4	-0.70	0.48
	education level	1.15	1.13	3.1	0.75	0.46
	Age	52.03	51.98	1.3	0.26	0.79
	Gender	0.62	0.62	0.5	0.10	0.92
	marital status	2.08	2.06	5.7	1.16	0.25

Table 4A.3 (continued)

Treatment	Variable	Mean			t-test	
		Treated	Control	%bias	t	p>| t |
9. Diagnosed memory problem	net housing wealth	2.69	2.72	-3.2	-0.18	0.86
	net non-housing wealth	2.30	2.33	-2.7	-0.15	0.88
	Homeowner	2.88	2.88	0.0	0.00	1.00
	education level	1.23	1.28	-9.5	-0.51	0.61
	Age	53.55	53.57	-0.4	-0.02	0.98
	Gender	0.67	0.67	0.0	0.00	1.00
	marital status	2.09	2.11	-3.5	-0.18	0.86
10. Diagnosed mental health problem	net housing wealth	2.37	2.28	8.5	0.66	0.51
	net non-housing wealth	2.36	2.40	-3.7	-0.28	0.78
	Homeowner	2.71	2.69	2.7	0.19	0.85
	education level	1.13	1.14	-2.0	-0.19	0.85
	Age	51.46	51.38	1.9	0.15	0.88
	Gender	0.49	0.44	10.0	0.77	0.44
	marital status	2.00	2.06	-13.8	-1.07	0.29

Table 4A.3 (continued)

Treatment	Variable	Mean: Treated	Mean: Control	%bias	t-test: t	t-test: p>| t |
11.Diagnosed asthma	net housing wealth	2.65	2.61	4.7	0.52	0.60
	net non-housing wealth	2.57	2.49	7.7	0.86	0.39
	Homeowner	2.80	2.83	-4.8	-0.56	0.58
	education level	1.15	1.14	0.9	0.12	0.91
	Age	52.22	52.08	3.3	0.36	0.72
	Gender	0.65	0.63	4.8	0.55	0.59
	marital status	2.12	2.11	3.6	0.36	0.72
12.Diagnosed liver problem	net housing wealth	2.63	2.64	-0.4	-0.07	0.95
	net non-housing wealth	2.68	2.68	-0.8	-0.12	0.91
	Homeowner	2.79	2.80	-1.9	-0.28	0.78
	education level	1.23	1.20	7.0	1.12	0.26
	Age	51.70	51.58	3.0	0.47	0.64
	Gender	0.65	0.65	0.9	0.14	0.89
	marital status	2.09	2.10	-2.1	-0.29	0.77

Table 4A.3 (continued)

Treatment	Variable	Mean: Treated	Mean: Control	%bias	t-test: t	t-test: p>| t |
13. Diagnosed kidney problem	net housing wealth	2.59	2.59	-0.5	-0.10	0.92
	net non-housing wealth	2.68	2.70	-1.4	-0.28	0.78
	Homeowner	2.80	2.83	-5.1	-1.04	0.30
	education level	1.18	1.18	0.6	0.12	0.91
	Age	51.92	51.88	1.1	0.21	0.83
	Gender	0.60	0.58	4.8	0.93	0.35
	marital status	2.06	2.04	4.4	0.90	0.37
14.Diagnosed stomach problem	net housing wealth	2.70	2.69	0.5	0.19	0.85
	net non-housing wealth	2.72	2.71	0.2	0.09	0.93
	Homeowner	2.78	2.78	-0.8	-0.28	0.78
	education level	1.18	1.17	1.0	0.38	0.70
	Age	51.34	51.28	1.5	0.55	0.58
	Gender	0.55	0.55	-0.2	-0.06	0.96
	marital status	2.07	2.05	3.9	1.45	0.15

Table 4A.3 (continued)

Treatment	Variable	Mean Treated	Mean Control	%bias	t-test t	t-test p>| t |
15. Diagnosed cholesterol problem	net housing wealth	2.79	2.78	0.6	0.14	0.89
	net non-housing wealth	2.76	2.78	-2.1	-0.46	0.64
	Homeowner	2.78	2.77	1.3	0.26	0.79
	education level	1.43	1.44	-0.8	-0.14	0.89
	Age	51.92	51.93	-0.3	-0.06	0.95
	Gender	0.64	0.65	-2.4	-0.53	0.60
	marital status	2.07	2.04	9.1	2.19	0.03

Table 4A.4: Evaluate match with statistical tests (Group: after default retirement age)

Treatment	Variable	Mean		%bias	t-test	
		Treated	Control		t	p>|t|
1. Urban	net housing wealth	2.51	2.54	-3.7	-1.99	0.05
	net non-housing wealth	2.45	2.42	2.4	1.33	0.19
	Homeowner	2.57	2.58	-1.0	-0.56	0.58
	education level	1.18	1.18	0.0	-0.00	1.00
	Age	65.42	65.34	1.0	0.56	0.57
	Gender	0.41	0.41	-0.9	-0.47	0.64
	marital status	2.28	2.23	7.1	4.02	0.00
2. Pension Receiver/Participant	net housing wealth	2.50	2.39	10.9	7.83	0.00
	net non-housing wealth	2.44	2.47	-3.0	-2.17	0.03
	Homeowner	2.49	2.49	-0.0	-0.03	0.98
	education level	1.09	1.07	7.7	6.00	0.00
	Age	65.54	65.93	-6.0	-4.27	0.00
	Gender	0.43	0.46	-6.2	-4.33	0.00
	marital status	2.28	2.24	4.8	3.52	0.00

Table 4A.4 (continued)

Treatment	Variable	Mean			t-test	
		Treated	Control	%bias	t	p>| t |
3. Diagnosed hypertension	net housing wealth	2.46	2.46	0.2	0.11	0.91
	net non-housing wealth	2.38	2.38	0.5	0.26	0.80
	Homeowner	2.54	2.55	-1.1	-0.50	0.62
	education level	1.11	1.10	3.8	1.78	0.08
	Age	66.20	66.30	-1.6	-0.75	0.45
	Gender	0.40	0.40	-0.0	-0.02	0.98
	marital status	2.32	2.30	2.8	1.33	0.18
4. Diagnosed diabetes	net housing wealth	2.54	2.56	-2.2	-0.52	0.60
	net non-housing wealth	2.43	2.44	-0.3	-0.08	0.94
	Homeowner	2.56	2.56	-0.2	-0.05	0.96
	education level	1.16	1.16	1.8	0.37	0.71
	Age	65.43	65.31	1.8	0.44	0.66
	Gender	0.37	0.36	1.3	0.31	0.76
	marital status	2.27	2.24	3.6	0.89	0.37

Table 4A.4 (continued)

Treatment	Variable	Mean			t-test	
		Treated	Control	%bias	t	p>| t |
5. Diagnosed heart problem	net housing wealth	2.46	2.46	-0.2	-0.07	0.94
	net non-housing wealth	2.38	2.36	2.7	0.93	0.35
	Homeowner	2.53	2.53	-0.4	-0.14	0.89
	education level	1.15	1.14	0.4	0.13	0.90
	Age	66.04	65.90	2.3	0.79	0.43
	Gender	0.37	0.36	1.9	0.66	0.51
	marital status	2.31	2.29	3.2	1.10	0.27
6. Diagnosed cancer	net housing wealth	2.47	2.43	4.2	0.39	0.69
	net non-housing wealth	2.39	2.38	1.1	0.11	0.92
	Homeowner	2.94	2.43	8.0	0.69	0.49
	education level	1.15	1.14	3.2	0.27	0.79
	Age	65.28	65.16	1.9	0.16	0.87
	Gender	0.32	0.32	0.0	-0.00	1.00
	marital status	2.18	2.18	0.0	-0.00	1.00

Table 4A.4 (continued)

Treatment	Variable	Mean			t-test	
		Treated	Control	%bias	t	p>| t |
7. Diagnosed stroke	net housing wealth	2.45	2.46	-0.8	-0.13	0.90
	net non-housing wealth	2.21	2.18	2.6	0.41	0.68
	Homeowner	2.48	2.46	2.6	0.38	0.70
	education level	1.11	1.09	6.9	1.06	0.29
	Age	67.55	67.47	1.2	0.19	0.85
	Gender	0.52	0.53	-0.4	-0.07	0.95
	marital status	2.32	2.30	3.8	0.58	0.56
8. Diagnosed lung problem	net housing wealth	2.43	2.46	-3.7	-1.17	0.24
	net non-housing wealth	2.33	2.34	-1.1	-0.36	0.72
	Homeowner	2.51	2.53	-2.2	-0.69	0.49
	education level	1.09	1.08	2.9	0.98	0.33
	Age	67.11	67.15	-0.7	-0.22	0.83
	Gender	0.54	0.54	0.9	0.29	0.78
	marital status	2.30	2.29	1.0	0.30	0.76

Table 4A.4 (continued)

Treatment	Variable	Mean			t-test	
		Treated	Control	%bias	t	p>| t |
9. Diagnosed memory problem	net housing wealth	2.31	2.30	0.3	0.04	0.97
	net non-housing wealth	2.31	2.31	0.0	0.00	1.00
	Homeowner	2.44	2.43	0.8	0.09	0.93
	education level	1.13	1.07	15.1	1.99	0.05
	Age	68.94	69.06	-1.9	-0.24	0.81
	Gender	0.57	0.57	-0.6	-0.08	0.94
	marital status	2.28	2.28	0.0	0.00	1.00
10. Diagnosed mental health problem	net housing wealth	2.43	2.43	0.0	-0.00	1.00
	net non-housing wealth	2.30	2.33	-3.0	-0.34	0.73
	Homeowner	2.56	2.63	-9.0	-1.04	0.30
	education level	1.07	1.06	3.8	0.48	0.63
	Age	64.54	64.83	-4.8	-0.55	0.59
	Gender	0.32	0.30	4.2	0.49	0.63
	marital status	2.29	2.28	1.7	0.19	0.85

Table 4A.4 (continued)

Treatment	Variable	Mean			t-test	
		Treated	Control	%bias	t	p>| t |
11. Diagnosed asthma	net housing wealth	2.42	2.42	-0.4	-0.08	0.94
	net non-housing wealth	2.26	2.24	1.4	0.26	0.79
	Homeowner	2.49	2.49	0.2	0.03	0.98
	education level	1.07	1.05	6.2	1.41	0.16
	Age	67.62	67.47	2.4	0.47	0.64
	Gender	0.53	0.53	0.3	0.05	0.96
	marital status	2.37	2.36	0.5	0.10	0.92
12. Diagnosed liver problem	net housing wealth	2.43	2.41	1.6	0.30	0.77
	net non-housing wealth	2.46	2.45	0.1	0.03	0.98
	Homeowner	2.53	2.54	-1.7	-0.30	0.77
	education level	1.12	1.11	1.2	0.20	0.84
	Age	64.94	64.88	1.0	0.20	0.84
	Gender	0.45	0.45	0.0	0.00	1.00
	marital status	2.22	2.22	0.0	0.0	1.00

Table 4A.4 (continued)

Treatment	Variable	Mean			t-test	
		Treated	Control	%bias	t	p>| t |
13. Diagnosed kidney problem	net housing wealth	2.49	2.49	-0.8	-0.20	0.85
	net non-housing wealth	2.39	2.40	-1.6	-0.38	0.71
	Homeowner	2.51	2.55	-4.7	-1.08	0.28
	education level	1.10	1.08	6.1	1.47	0.14
	Age	65.24	65.08	2.6	0.61	0.54
	Gender	0.48	0.49	-1.9	-0.43	0.67
	marital status	2.26	2.25	1.5	0.36	0.72
14. Diagnosed stomach problem	net housing wealth	2.46	2.46	-0.1	-0.02	0.98
	net non-housing wealth	2.39	2.41	-1.6	-0.70	0.48
	Homeowner	2.49	2.51	-3.5	-1.47	0.14
	education level	1.08	1.07	3.6	1.73	0.08
	Age	64.99	64.89	1.7	0.72	0.47
	Gender	0.37	0.37	0.3	0.12	0.90
	marital status	2.26	2.23	3.3	1.46	0.14

Table 4A.4 (continued)

Treatment	Variable	Mean			t-test	
		Treated	Control	%bias	t	p>| t |
15. Diagnosed cholesterol problem	net housing wealth	2.56	2.57	-1.0	-0.27	0.79
	net non-housing wealth	2.42	2.43	-1.0	-0.28	0.78
	Homeowner	2.56	2.58	-1.5	-0.43	0.67
	education level	1.19	1.19	0.4	0.11	0.92
	Age	65.06	64.88	2.7	0.81	0.42
	Gender	0.37	0.38	-0.2	-0.07	0.94
	marital status	2.27	2.23	5.4	1.65	0.10

Figure 4A.1: Treatment: Asthma (early retirement)

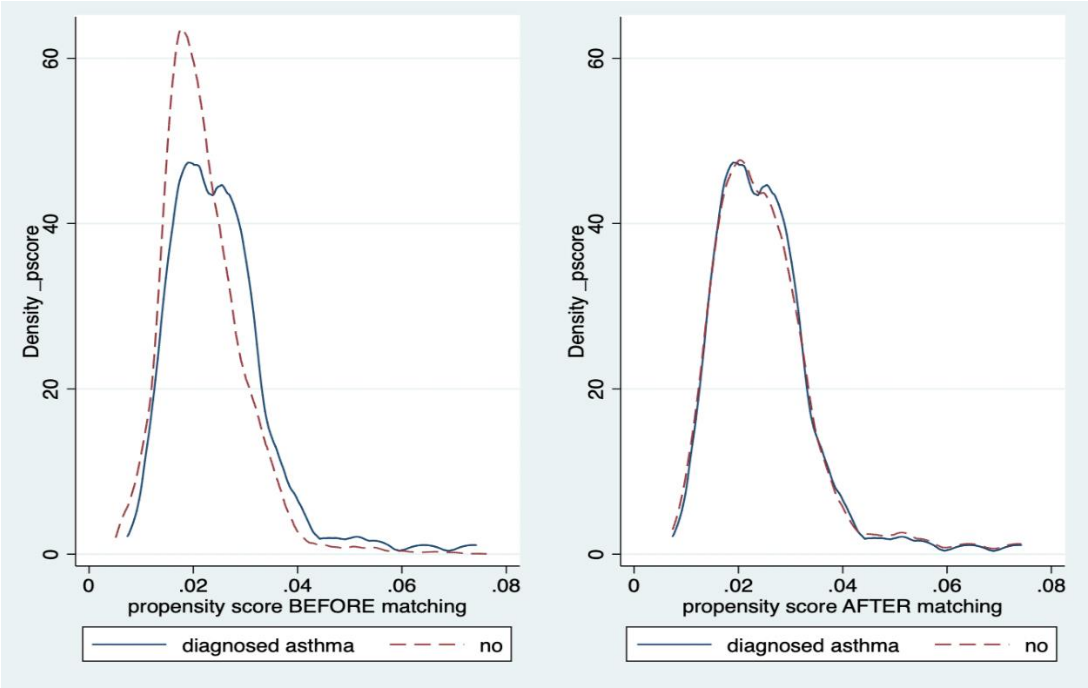


Figure 4A.2: Treatment: Asthma (delayed retirement)

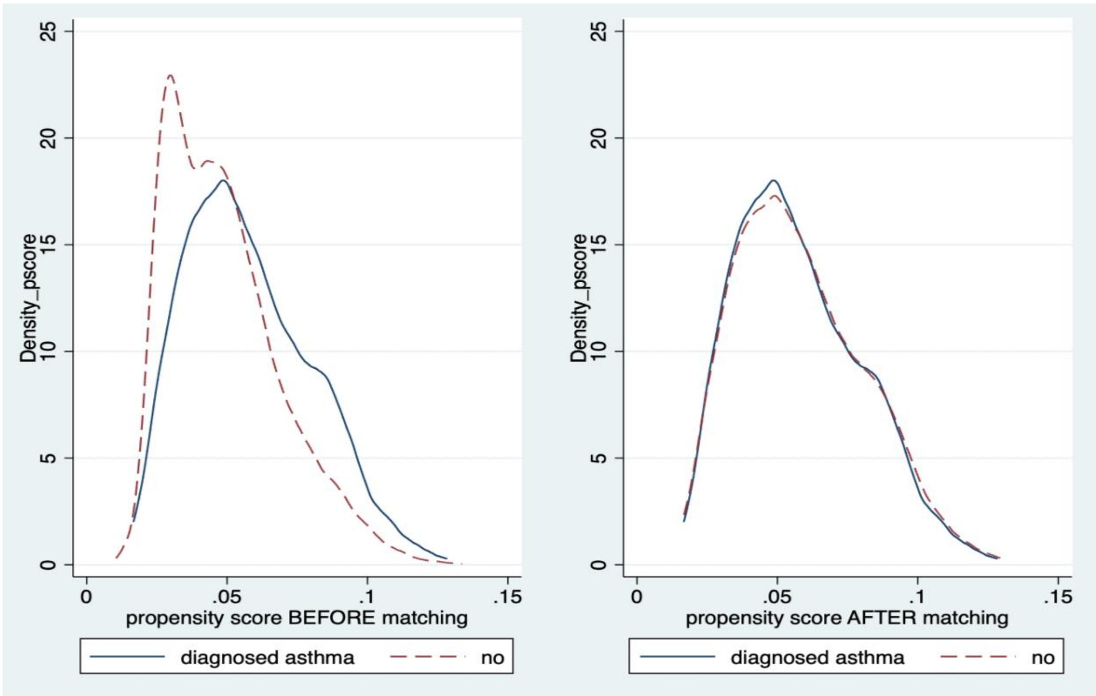


Figure 4A.3: Treatment: Cancer (early retirement)

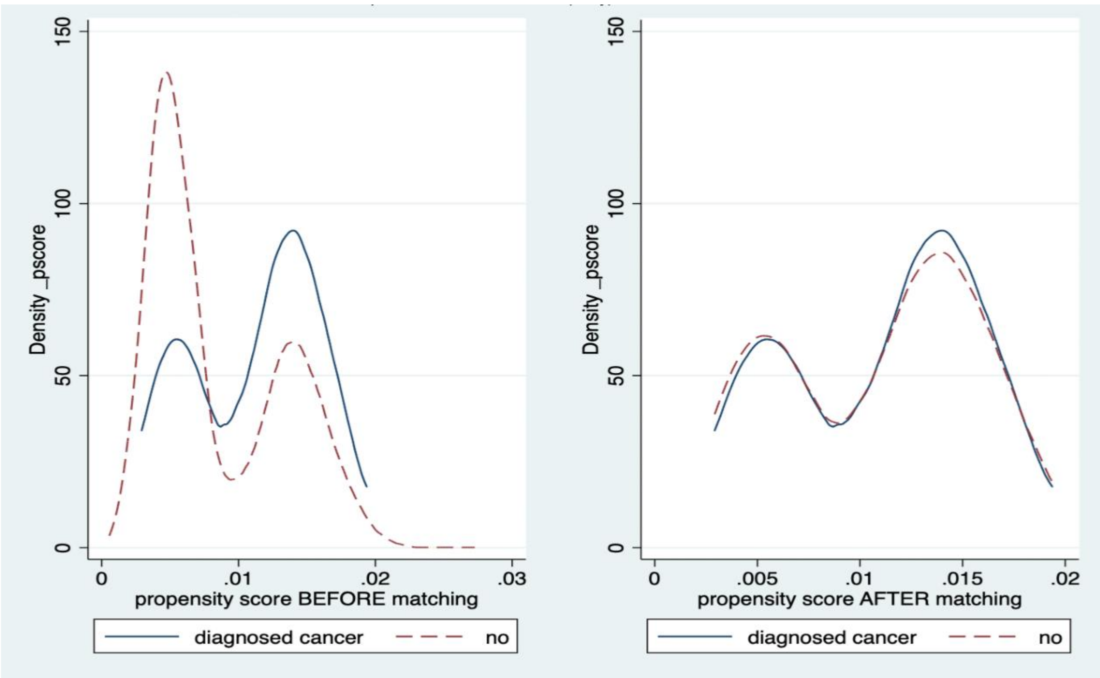


Figure 4A.4: Treatment: Cancer (delayed retirement)

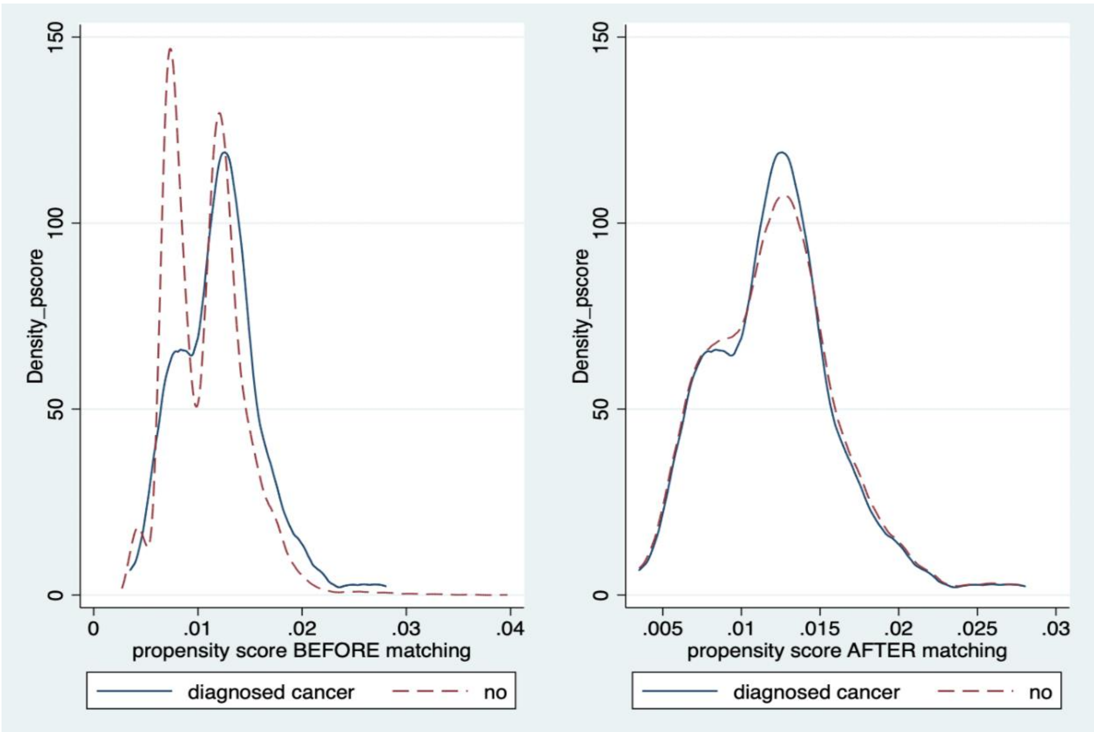


Figure 4A.5: Treatment: Cholesterol (early retirement)

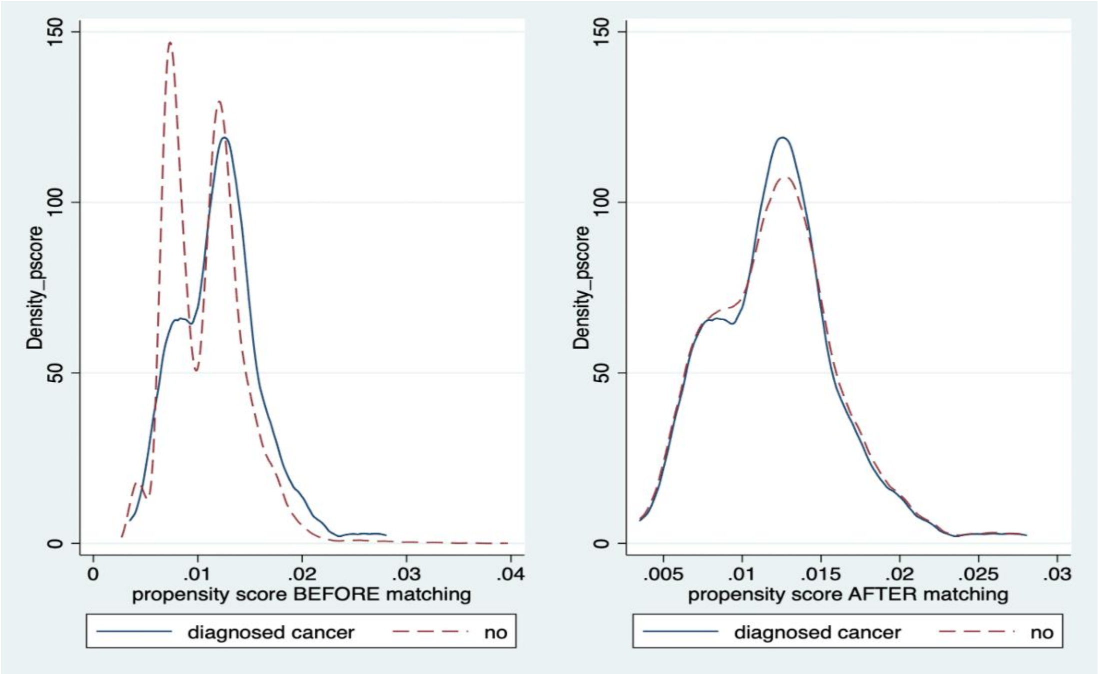


Figure 4A.6: Treatment: Cholesterol (delayed retirement)

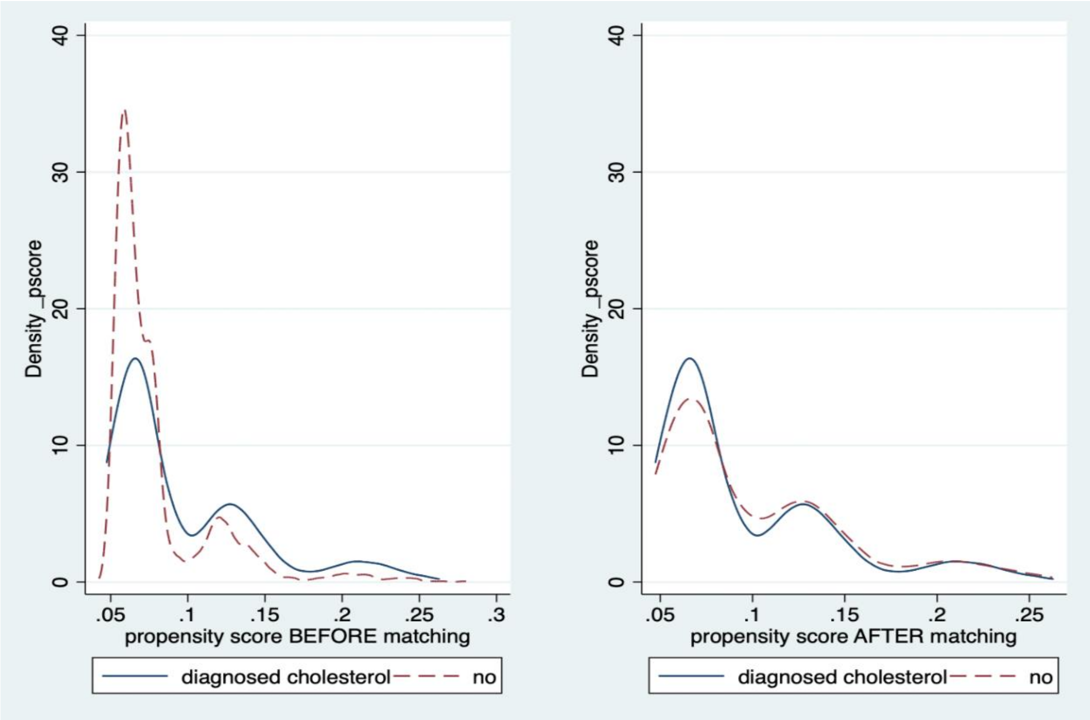


Figure 4A.7: Treatment: Diabetes (early retirement)

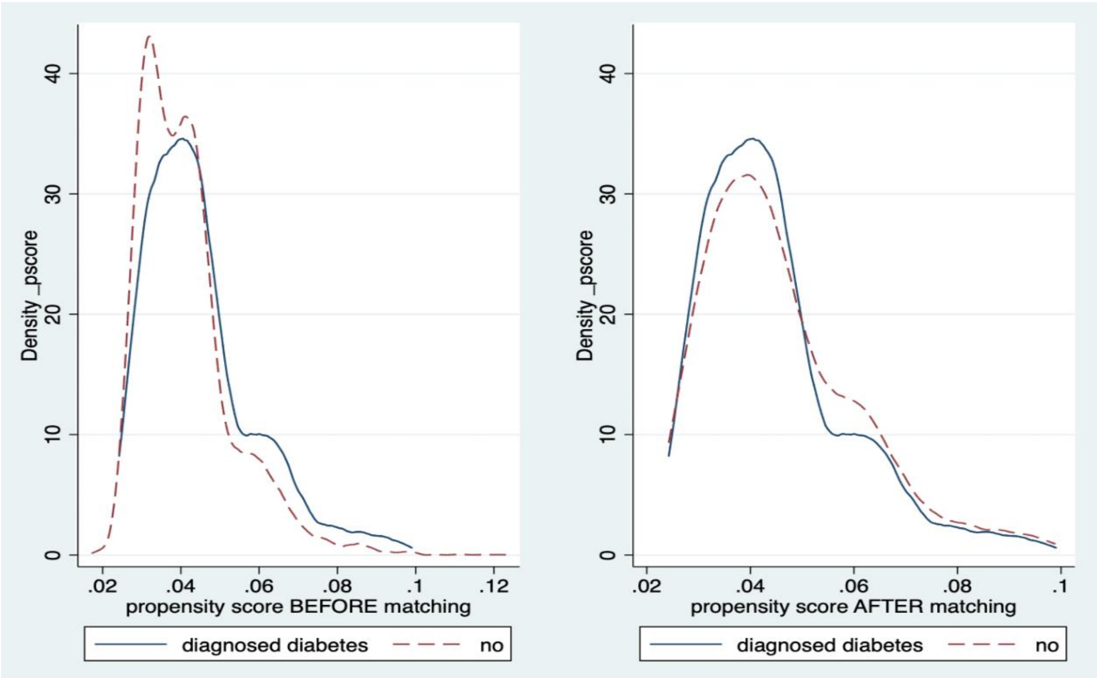


Figure 4A.8: Treatment: Diabetes (delayed retirement)

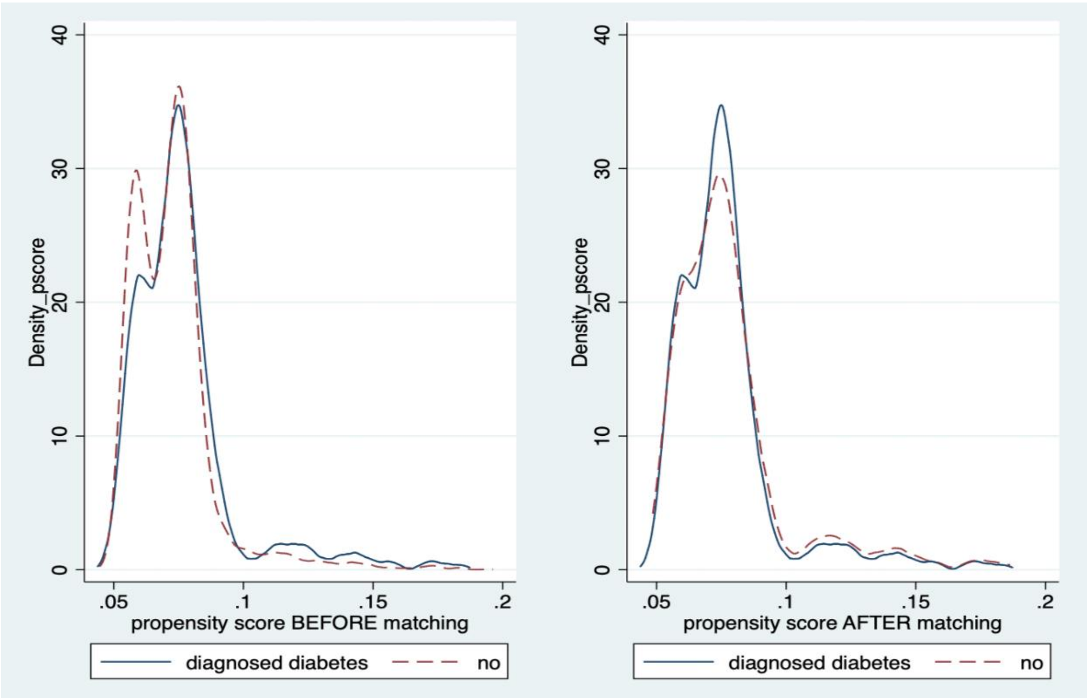


Figure 4A.9: Treatment: Heart problem (early retirement)

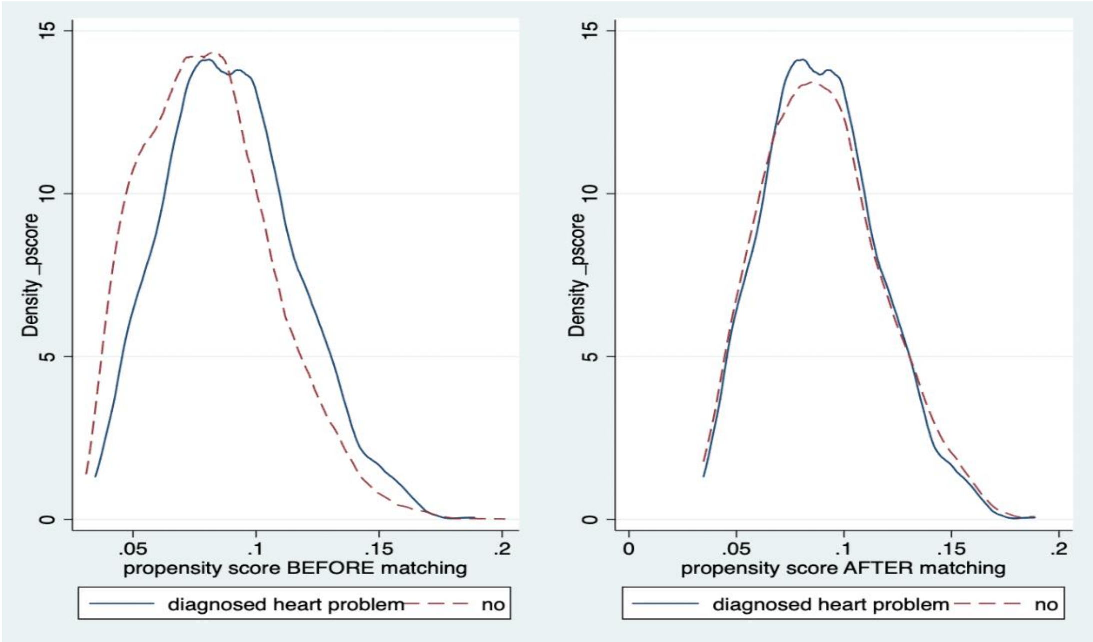


Figure 4A.10: Treatment: Heart problem (delayed retirement)

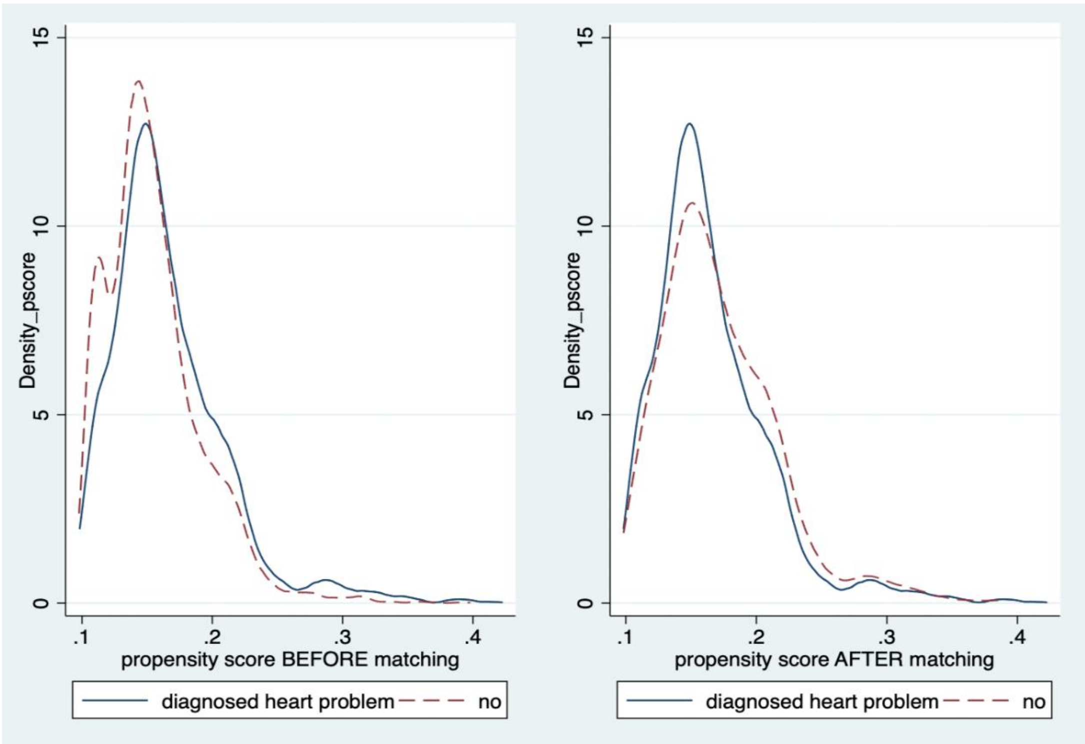


Figure 4A.11: Treatment: Hypertension (early retirement)

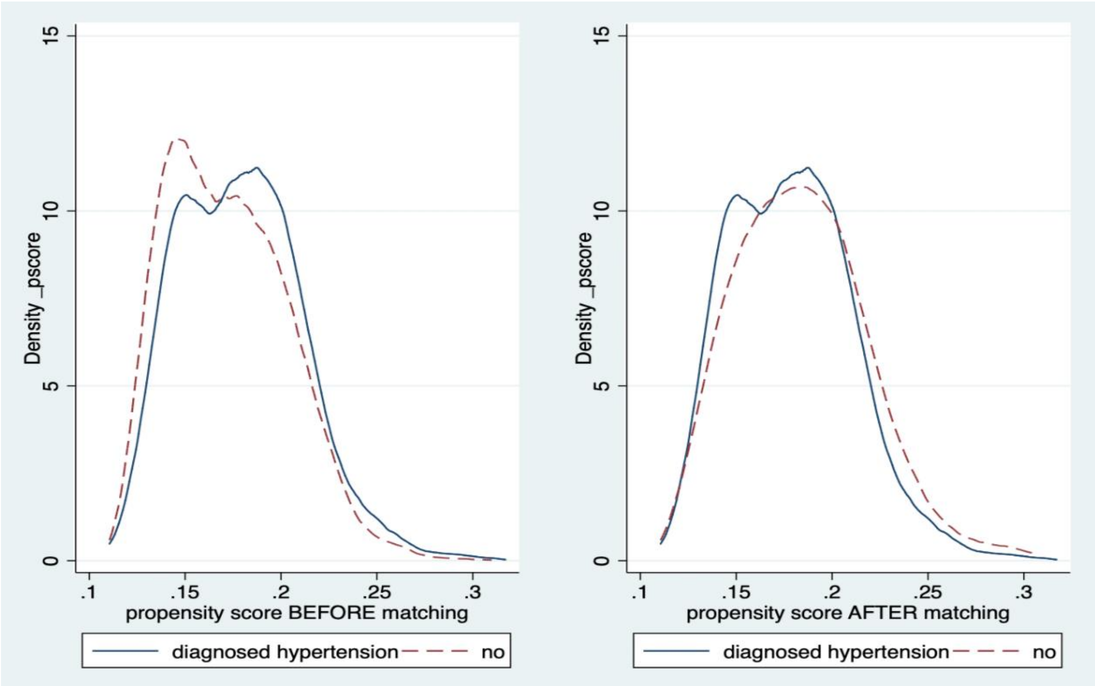


Figure 4A.12: Treatment: Hypertension (delayed retirement)

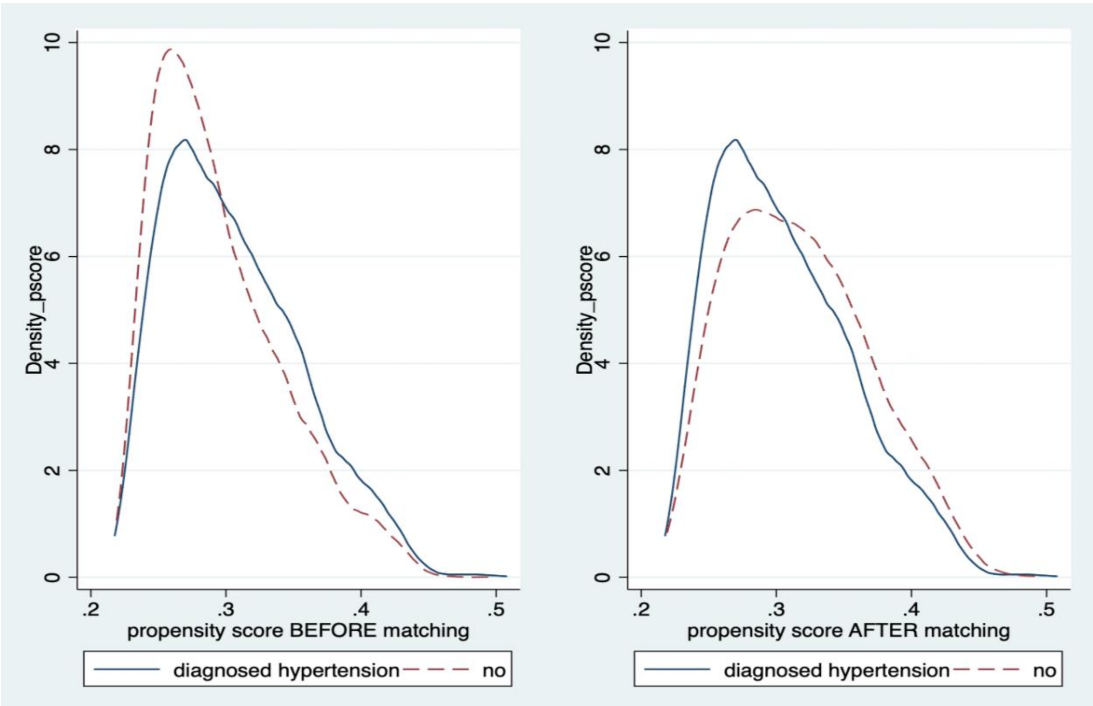


Figure 4A.13: Treatment: Kidney problem (early retirement)

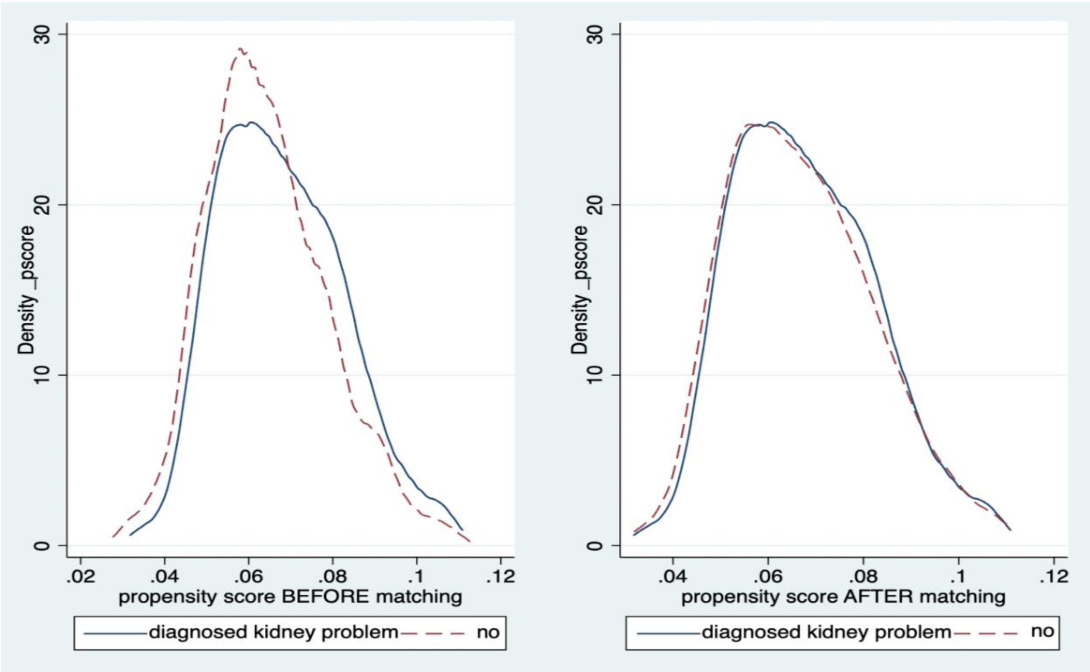


Figure 4A.14: Treatment: Kidney problem (delayed retirement)

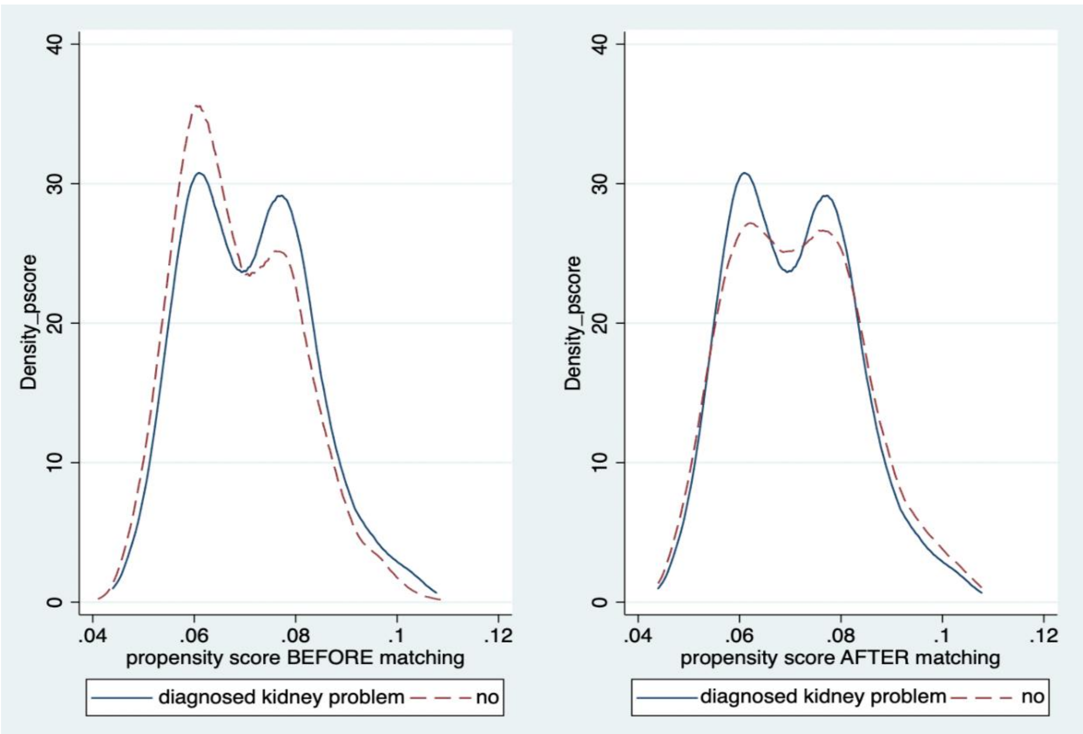


Figure 4A.15: Treatment: Liver problem (early retirement)

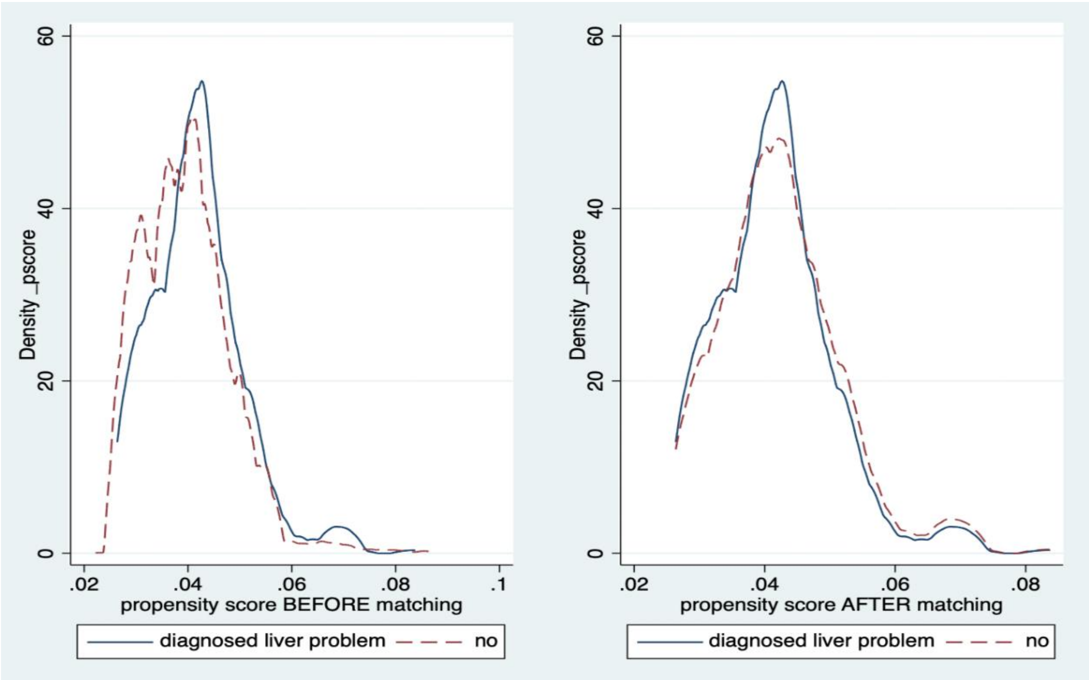


Figure 4A.16: Treatment: Liver problem (delayed retirement)

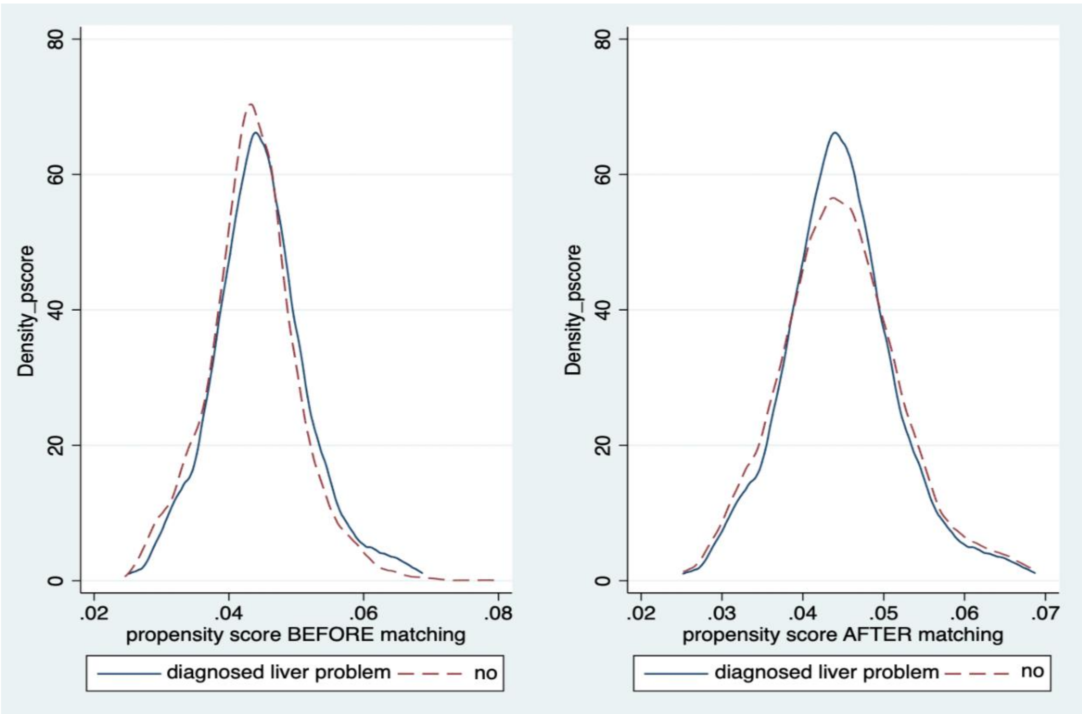


Figure 4A.17: Treatment: Lung problem (early retirement)

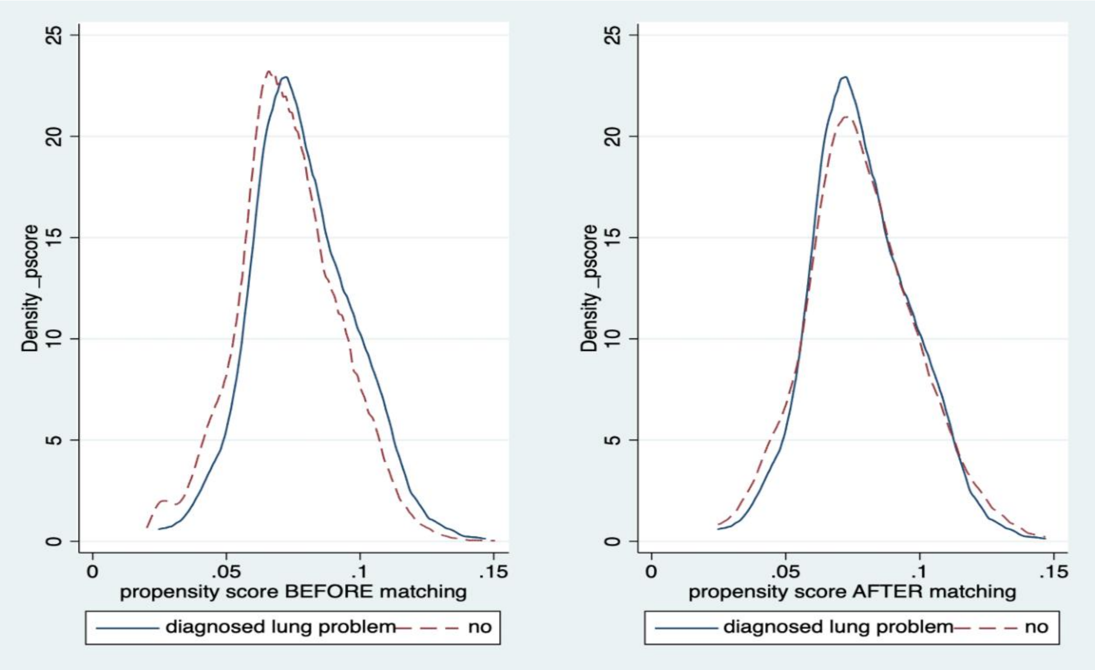


Figure 4A.18: Treatment: Lung problem (delayed retirement)

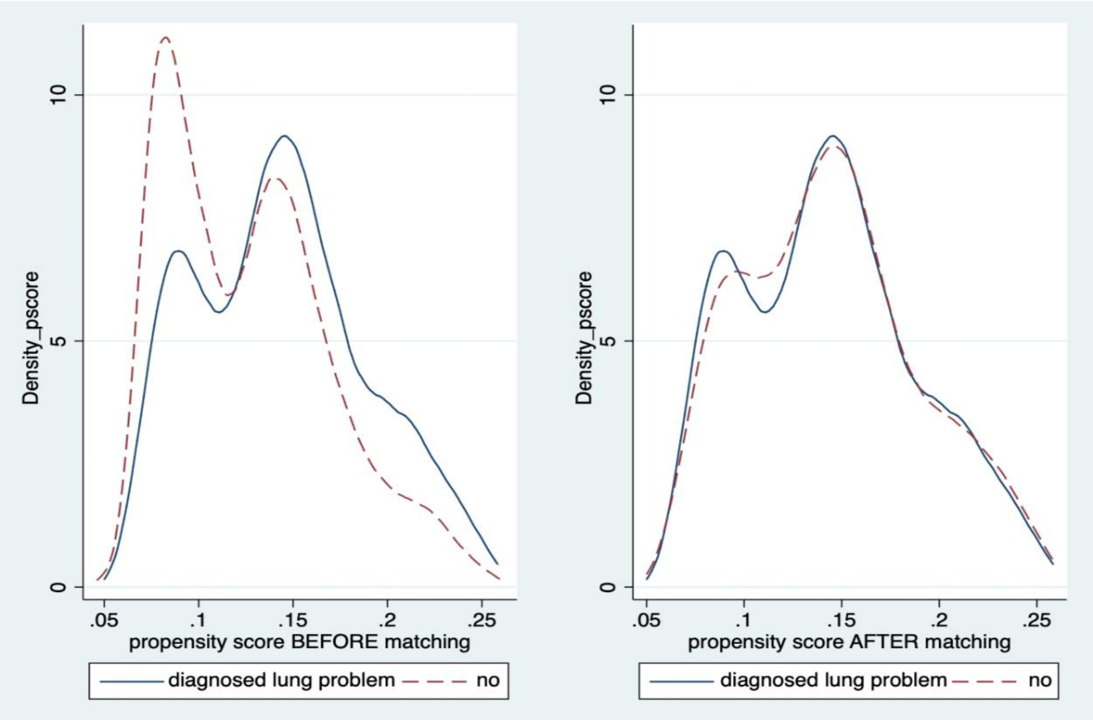


Figure 4A.19: Treatment: Memory problem (early retirement)

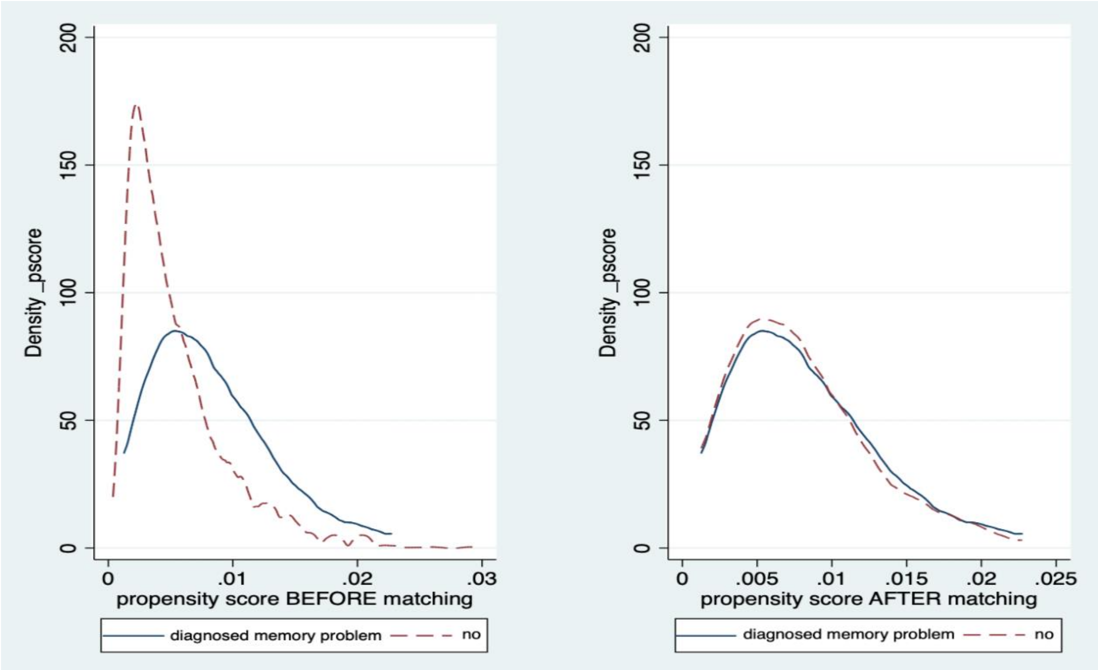


Figure 4A.20: Treatment: Memory problem (delayed retirement)

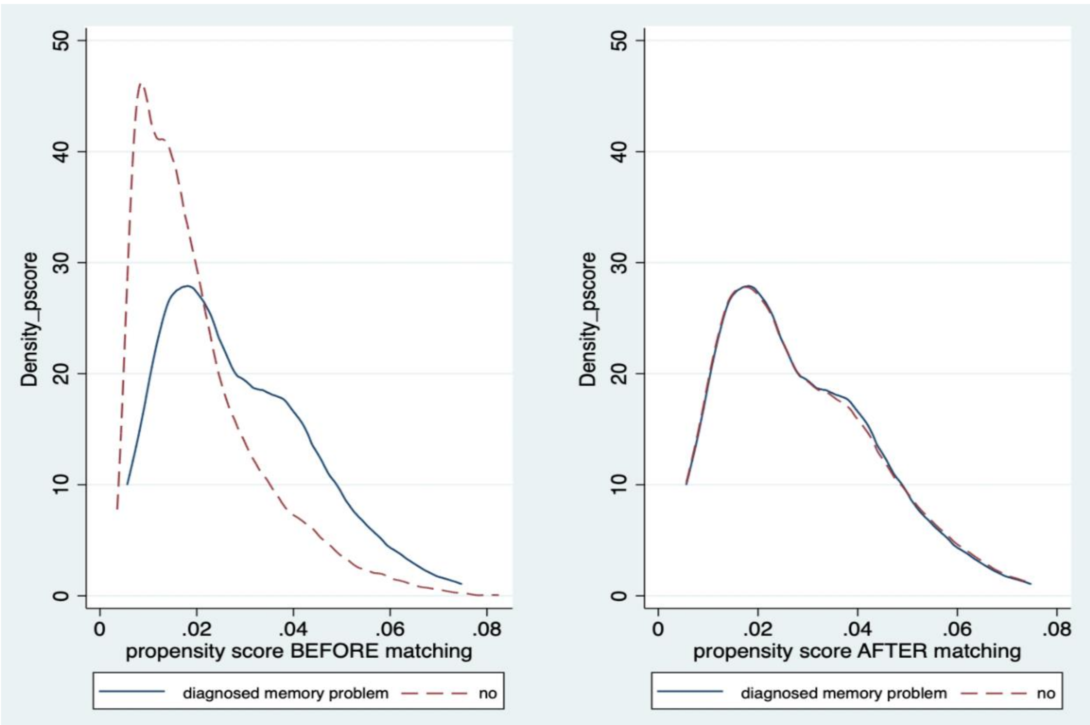


Figure 4A.21: Treatment: Mental health problem (early retirement)

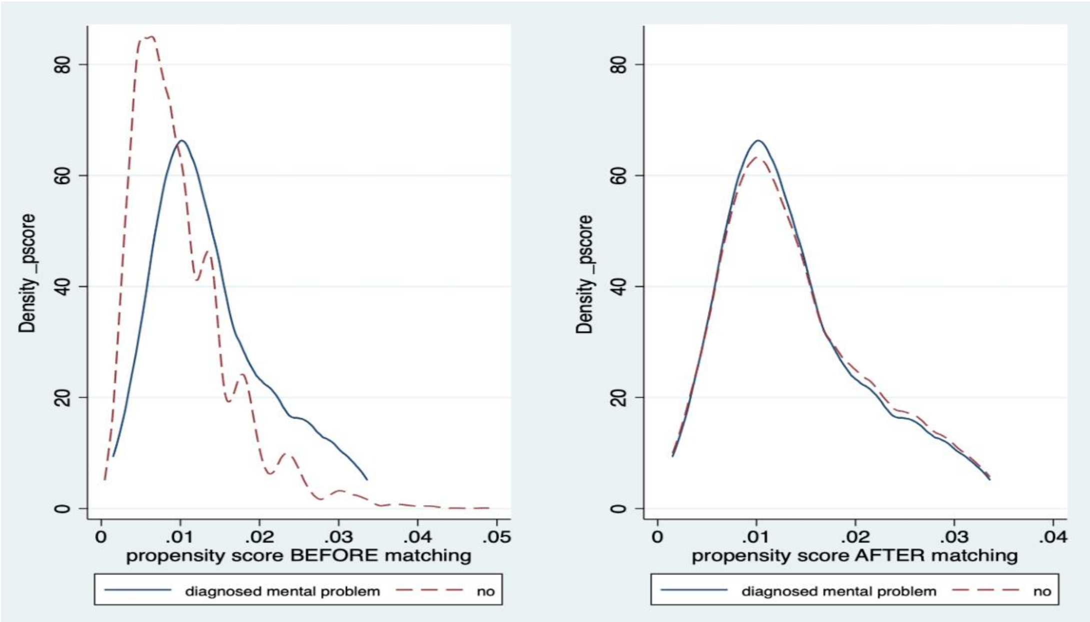


Figure 4A.22: Treatment: Mental health problem (delayed retirement)

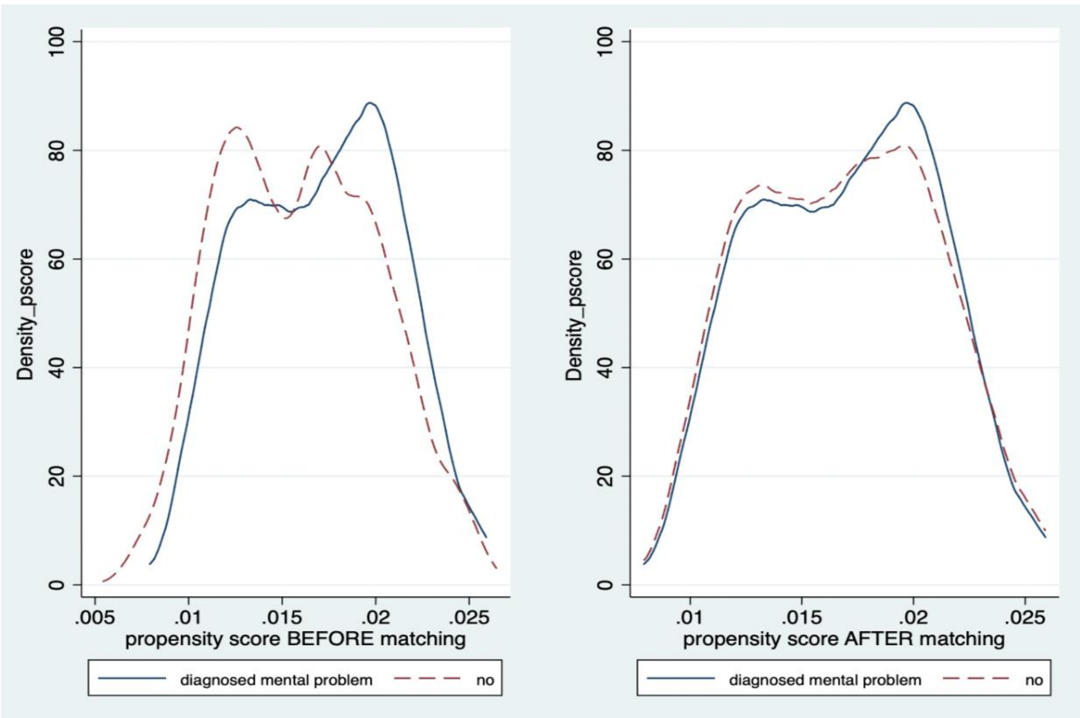


Figure 4A.23: Treatment: Stomach problem (early retirement)

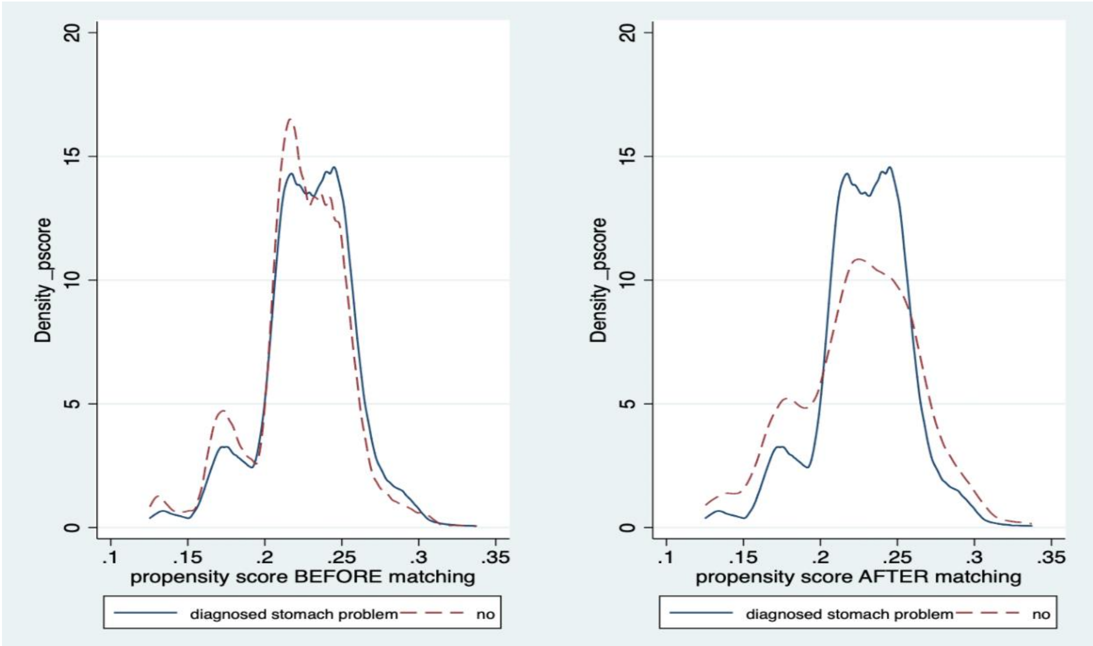


Figure 4A.24: Treatment: Stomach problem (delayed retirement)

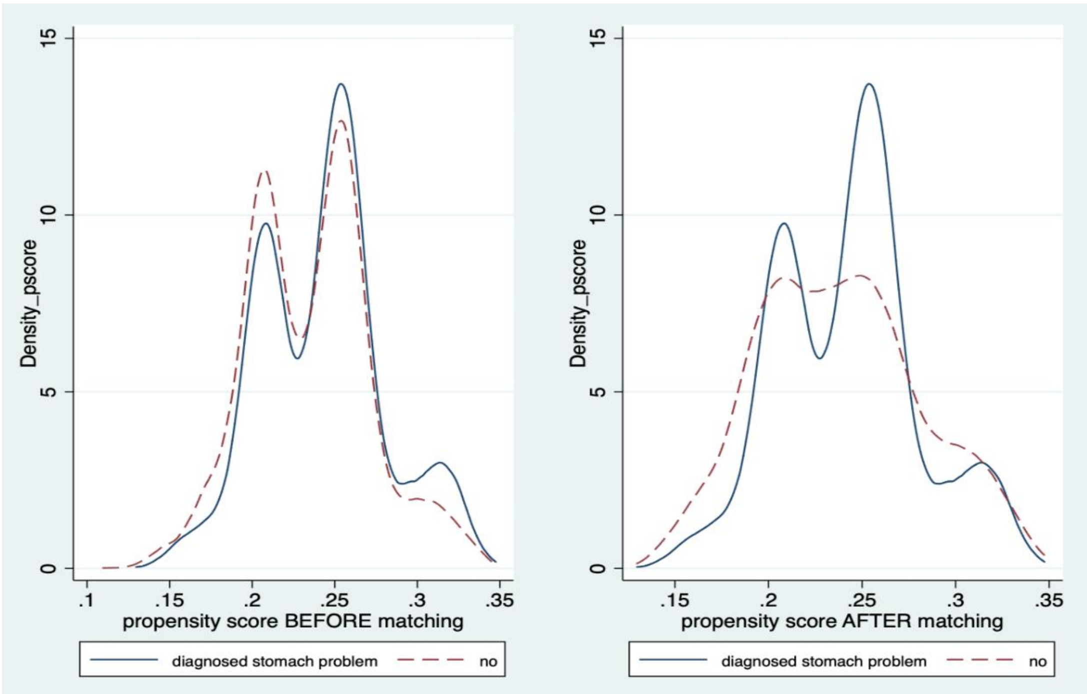


Figure 4A.25: Treatment: Stroke (early retirement)

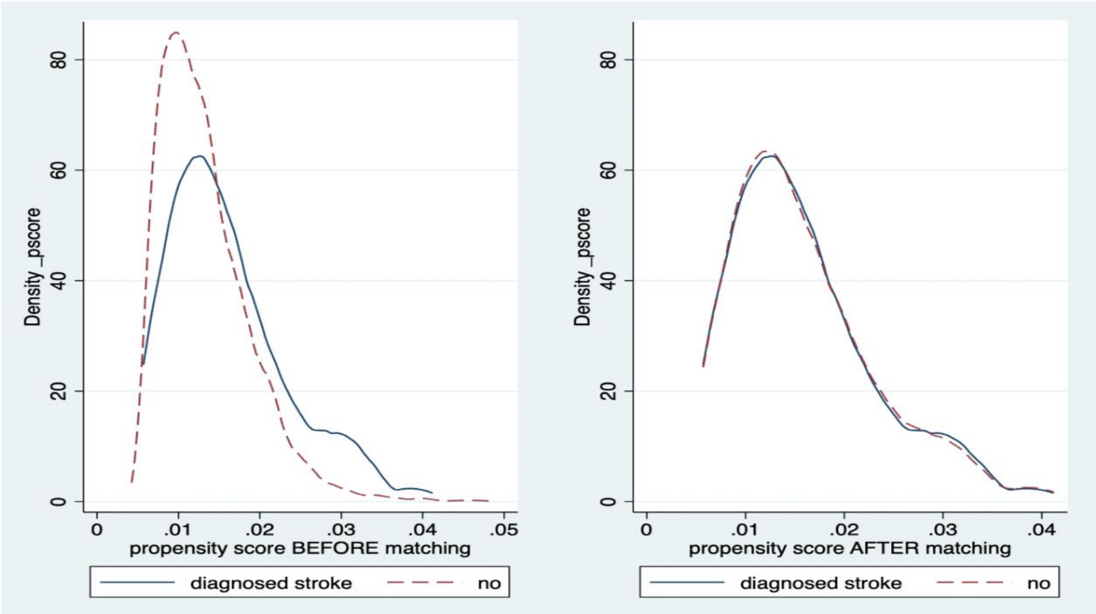


Figure 4A.26: Treatment: Stroke (delayed retirement)

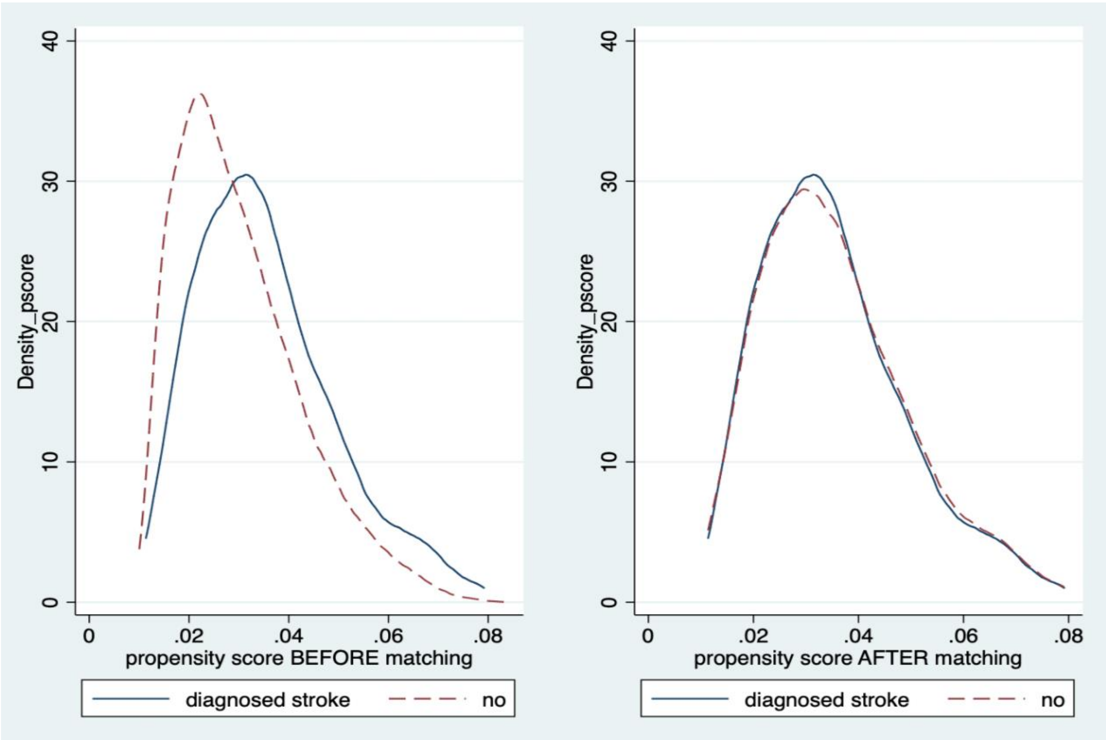


Figure 4A.27: Treatment: Pension participant/receiver (delayed retirement)

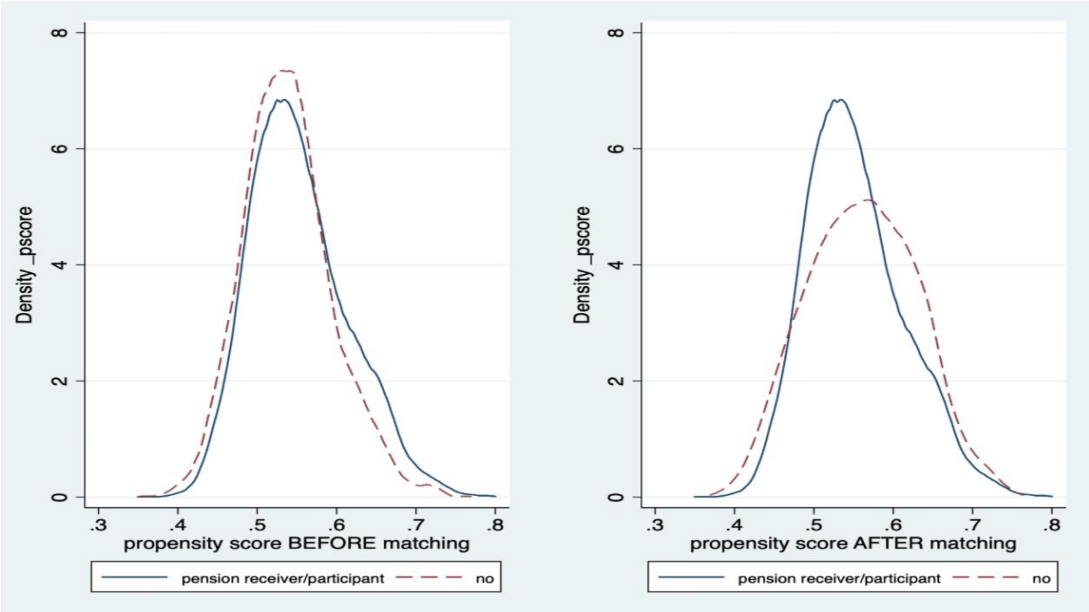


Figure 4A.28: Treatment: Pension participant/receiver (delayed retirement)

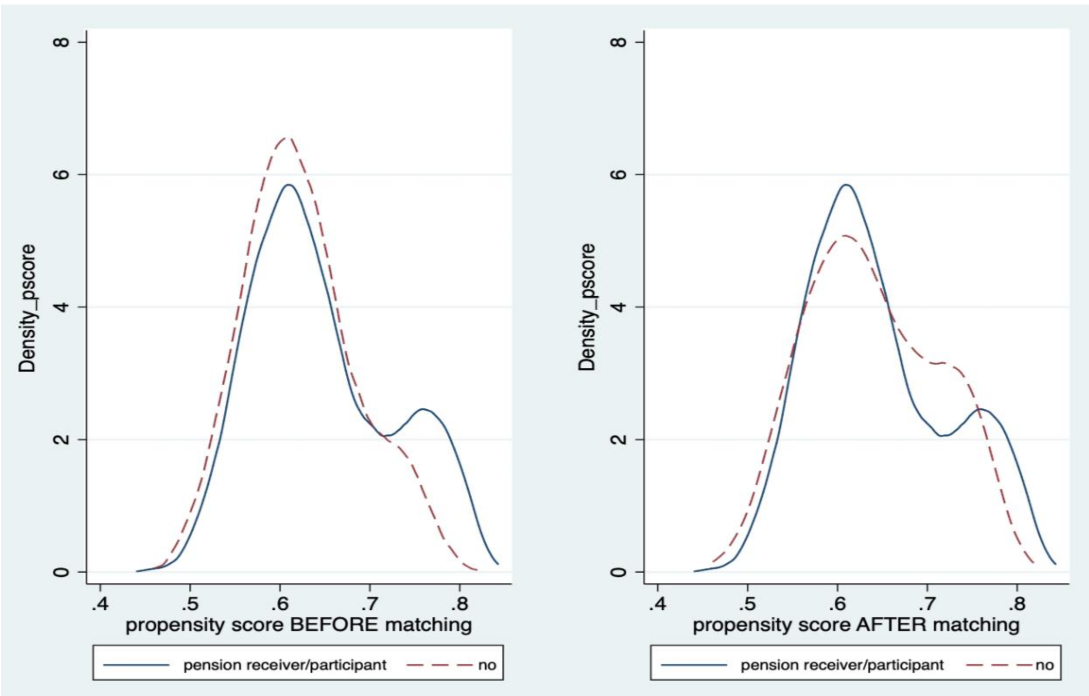


Figure 4A.29: Treatment: Urban residents (early retirement)

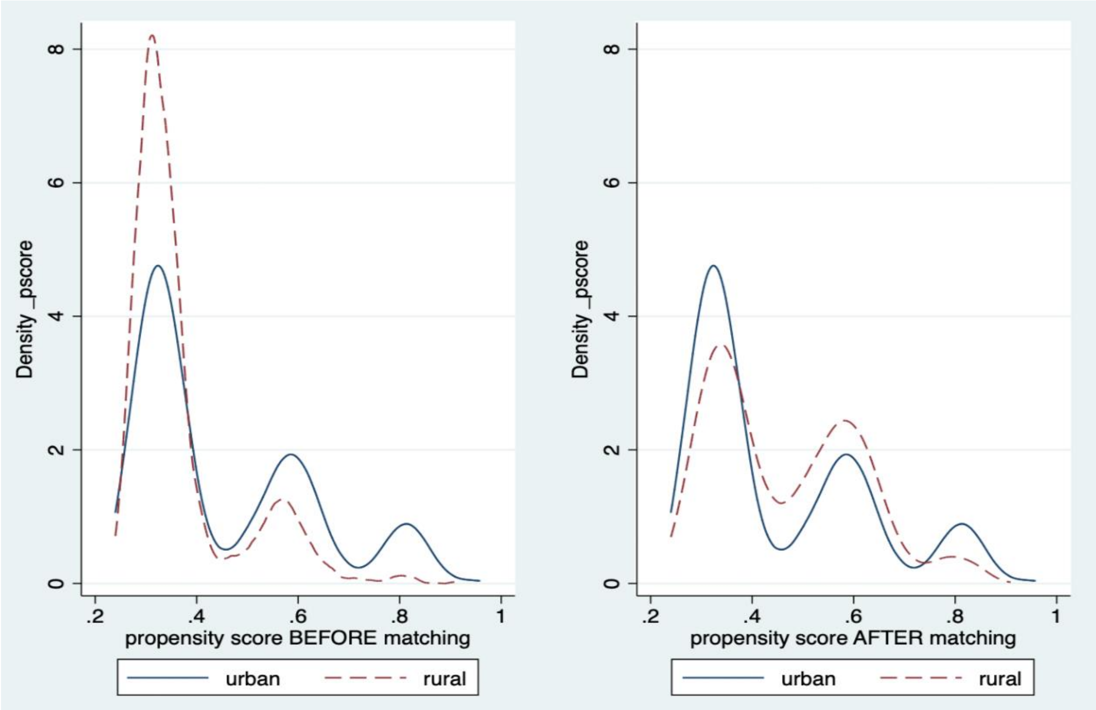
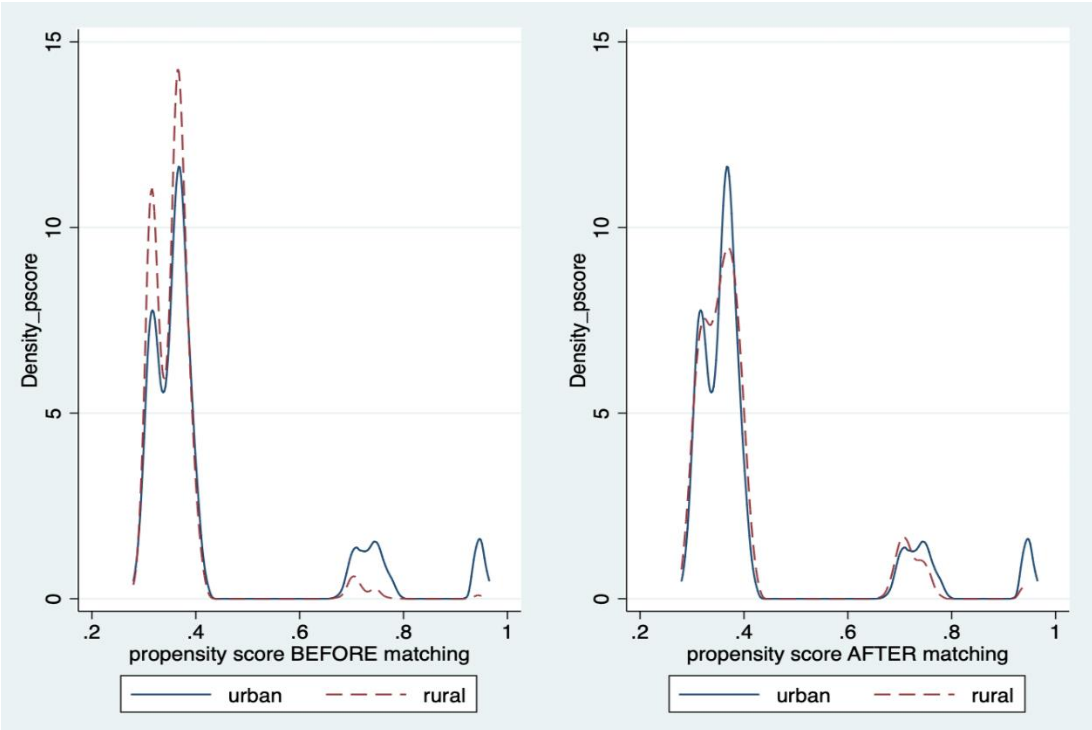


Figure 4A.30: Treatment: Urban residents (delayed retirement)



CHAPTER 5 CONCLUSIONS

This chapter concludes the thesis. A summary of the empirical results is presented in section 5.1. In section 5.2, we raise the implications of findings. Section 5.3 discusses the limitations of this research and provides recommendations for future study.

5.1 Summary of the Findings

This thesis comprises three empirical studies of retirement timing about health status, wealth and pension insurance. The key findings are as follows.

Chapter 2 is based on wave 1, wave 2, wave 4, wave 5, wave 6 and nine countries (Austria, Germany, Sweden, Spain, Italy, France, Denmark, Switzerland, and Belgium) in SHARE. The study uses a dynamic model to analyse longitudinal associations of early retirement with health status, job well-being and wealth. The analysis consists of two sections. One is based on a two-year dynamic model. The other one is for four-year dynamic model. The results show a strong positive relationship between poor health and early retirement. In particular, the effect of the limitations of doing daily activities is strong in all cases. We also find that the inequality in the working environment will incentivise people aged 50 to 64 to retire early. People who put high effort into the job but receive low rewards are more likely to retire early. Moreover, people with high housing mortgage are less likely to retire before 65.

In Chapter 3, the investigations focus on delayed retirement in association with health status, pension insurance and wealth. The data are the same as the one used in Chapter 2. The study applies panel data and does cross-country comparison. The findings show that people aged 65 to 80 with more depression symptoms or severe physical health problems are less likely to extend their working-age. Similar to findings in early retirement study, physical health problems generate a significant effect on retirement decisions. Moreover, generous pension benefits could reduce the incentives of delayed retirement. Pension effect can be observed in almost all sample countries. People with high housing mortgage tend to retire late.

In Chapter 4, we use 2011, 2013 and 2015 waves of CHARLS to evaluate the determinant of the retirement behaviour in Chinese residents aged 45 to 80. Given the compulsory retirement age, the study explores the effects of health status and pension insurance in both early retirement and delayed retirement. We examine both longitudinal analysis and treatment effects on retirement behaviour. Treatment effects are estimated in the Propensity Score Matching section. We observe a strong negative association between diseases, poor health and labour market participation. In particular, stroke, memory problems and mental health problems are the top three chronic diseases that could push respondents out of the labour market at an early age. By contrast, stroke, heart problems, diabetes are the top three diseases that reduce working life. People who are participating in the pension scheme are less likely to retire early. High pension income and delayed retirement have a significant negative relationship.

5.2 Implications of This Study

Chapter 2 shows that severe physical health problems in the past few years can lead to a decrease in the participation rate of the labour market in Europe. Early retirement is more common among people with unfavourable work environments. The empirical results show that the unfavourable working environment will induce impairment in health. Therefore, we recommend firm owners generate more favourable working environments and reducing inequalities of health functioning. Additionally, the study in 9 European countries provides the evidence that high non-housing values, high financial debt and high mortgage are associated with lower probability of an early exit from the labour market. European people with more debt will stay in the labour market could reflect the responsibility to realise the commitment of debt service. The negative relationship between non-housing value and early retirement is difficult to explain in one sentence. People with high non-housing assets could be those with more knowledge in investment, strong education background, or possible risk lover who are willing to dip into the financial market. This group of people typically has less physical demand in job, healthier lifestyle and stronger passion on working. Besides, some endogenous characteristics built into individuals can exert an impact on retirement decisions. These factors can be purely psychological preferences which are hard to measure in our model. Therefore, given a priority of a balanced financial market, possible entry points of policies to remain labour market participation among early old age people could be improving the financial environment, increasing financial literacy through education and encouraging individuals to become involve in the financial market.

Governments seek a solution to reduce pressure on pension schemes exerted by population ageing and the economic downturn. Chapter 3 provides empirical evidence that delayed retirement behaviour is more common among people in better health status, having a strong educational background or working as self-employment. Additionally, Social Security contributes to retirement behaviours. Generous pension benefits will induce the elderly to stop working. Moreover, in the post-crisis period, more wealth in housing and financial assets are correlated with people retiring late. Therefore, we recommend that governments need to reform pension programmes. Many developed countries have started to switch from a defined benefit programme to defined contribution plan. Pension benefits can also be adjusted with a tax on consumption and a progressive tax on labour income. Improve financial markets, encourage education, enhance policy environment, produce more opportunities for building privately owned business and reduce inequalities of health functioning are entry points of policies to maintain people staying in labour market into old age.

With the introduction of economic reforms directed toward the achievement of a market economy, China faces unique problems in supporting the elderly population. The authorities are in the process of trying to resolve all the unsettled issues for improving the welfare of the elderly, but the implications of social policies are uncertain. In Chapter 4, we examine the determinants of labour market participation in China. Estimates are done by using both pooled regression analysis and matching procedures, which allow us to have more insights on specific items that affect labour market participation.

We find that, on average, health problems have a detrimental effect on the labour market. Thus, the policy can promote national health insurance system to guarantee those residents, who paid national insurance contributions, are entitled to receive benefits when they are old. Also, medical systems should be improved. Those high-risk diseases, such as a stroke, heart problems, cancers and diabetes, which could mostly cause life impairment, require modern medical facilities to diagnose them. A preventive medical system could help patients get accurate treatment that postpones the onset of the disease.

Also, our results indicate that the propensity to work longer is higher among rural residents. Currently, the unbalanced Chinese social development attributes many barriers to the *hukou* location, such as education, employment and social security. The reform of the census register system is seen as essential and urgently needs to address that problem. While rising labour market participation, authorities could consider providing more flexible *hukou* policies to those migrants who moved their rural *hukou* to the city at an early stage.

Importantly, pension income received, and pension plan participation could have different implications for the labour market. A generous pension plan could attenuate labour market participation because pension benefits can provide a strong support in retirement. The beneficiaries of the pension plan are more likely to choose to retire right after they can claim pension benefits. However, a restricted pension plan would reduce the incentive of working. The policymaker should develop pension networks concerning pension coverage and the purchasing power in the pension account and reach full integration in the population by mid-old age.

Furthermore, our findings suggest that the effects of housing assets and non-housing assets are substantially heterogeneous between the younger group and older group. There is no clear evidence to prove that housing assets or non-housing assets is a significant difference among people aged below compulsory retirement age. However, both housing assets and the non-housing assets can play a significant role for the Chinese above retirement age. A higher value of housing assets will decrease the probability of the extending working life among Chinese elderly. On the contrary, people with a higher value in the net non-housing assets are more likely to stay in the labour market when they are old. Therefore, we can visualise that older households rely more on the wealth they own. In general, after adjusting for covariates, our findings suggest that among the early old age people in China, those who stay in the labour market appear to have better health conditions and are rural residents.

5.3 Limitations and Proposed Future Research

In Chapter 2, we use a dynamic model in all dimensions. The method applied in the study where the observed early retirement behaviour is based on the information in the past has dramatically reduced the available data points we can use. Therefore, we merge all sample countries into one panel to provide empirical analysis. Moreover, it is difficult to find data that address certain factors. Many previous studies have worked on pension policy and early retirement. We have considered the potential pension effect at a very early stage of this research. However, the data points in SHARE are insufficient to generate a result in a dynamic model. Additional and valid information on the exposure of data points in SHARE will enrich the analyses and allow us to do comparative analysis across different countries. Furthermore, the short version of measuring stress at work bases on available information in SHARE. A comprehensive version of Effort-Reward Imbalance (ERI) scale and low control indicator will enhance the explanatory power of job well-being in labour market participation.

In Chapter 3, we provide both pooled regression analysis and cross-country comparison. However, it is hard to rule out selection bias. Some groups are more likely to stay in the sample. For example, people who are healthier or wealthier tend to have a high response rate in the interview. They are more active to participate in the data collection process and stay with the SHARE group. Therefore, these people contribute more observations in the sample. It could generate sample selection bias. Weighted observations should be made to present the attribution of each stratification. The information about weights from SHARE dataset can help to solve the issue.

Additionally, the choices of the cutoff point in defining depression and disability are subjective. Also, the level of the categories can influence regression results. In the regression, we use two dummy variables to measure health status. Although we have widely worked on previous studies, there is not much uniformity of practice as to a clear definition in depression and disability. Our framework applies the scores in the studies which are closest to our topic, and however, due to differences in the dataset, sample years and age cohorts, the conclusions may still be different. Further research could consider more cutoff points and set categorical variables in health status to check whether the similar results could still be obtained.

In Chapter 4, our model contains pension benefits. The empirical results show the significant effects of pension income on retirement decisions. One problem in CHARLS is that pension receiver and pension participants are bonded together in wave 2013. Pension benefit can generate income effect among receivers while it is saving for participants - people who have received pension income before retirement age can see this amount as additional income. People who still contribute in pension account can see this amount as saving because the more they contribute today, the more they will receive in retirement. In the later research, we could look at pension effect from receivers and participants separately when more information in CHARLS become available. In this study, we cut off the whole sample into early retirement and delayed retirement. The rule bases on the standard state pension age. In later research, we may use survival models to analyse the proportion of population which will survive (i.e. staying in the labour market) among people aged 45 to 80. Of the people who survive, at what rate will they retire on time or work beyond the state pension age. Also, survival analysis can help to find out the reasons of retirement. We can answer the circumstances or characteristics which can increase or decrease the probability of working.

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