Microeconomic Analyses of the Health of the Elderly in China

by

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A thesis submitted to the School of Economics
for the degree of Doctor of Philosophy

University of Nottingham
University Park, Nottingham, UK
(March, 2016)

Dedicated to Creativity

There is an underlying, in-dwelling creative force infusing all of life
- including ourselves

Abstract

China is currently facing unprecedented health challenges; non-communicable diseases (NCD) now account for 80 percent of its 10.3 million deaths annually. China's growing health challenges arise, at least in part, due to its rapidly aging population and are compounded by its inadequate social security provision and rapid urbanization. This dissertation examines the extent to the health and well-being of the elderly in China are affected in the presence of these demographic and social changes. It uses data from a rich but relatively underutilized data source, the China Health and Retirement Longitudinal Study (CHARLS). CHARLS is the first Health and Retirement Study (HRS) of its kind in China, and as such represents a rich source of data on health and well-being for the country. A two-province sample was piloted in 2008 and followed up in 2012, while a national wave was surveyed in 2011. This dissertation is a collection of three self-contained empirical studies on the health and well-being of the elderly in China. The first study examines the effect that chronic diseases have on different dimensions of health in a structural equation framework. The second study examines the extent to which elderly households are able to continue to finance their consumption in the presence of ill-health and the extent to which health insurance and family support from children play a role. In the last study, we further investigate the effect that adult children's migration decisions have on the physical and subjective well-being of their elderly parents.

Acknowledgements

I am extremely grateful to my Ph.D supervisor Dr. Sarah Bridges for her meticulous guidance over my study. I benefited substantially from numerous discussions with her over the research and matters big and small. She never hesitated to share with me her precious personal experience in academia which I could not have learnt anywhere else. My other supervisor, Prof. Dave Whynes, offered me constant help to view my work from a bigger picture throughout my thesis research. I was greatly influenced by his way of writing, working and laughing. I am also greatly indebted to Prof. Sourafel Girma, without whom I would not grow such a great interest in applied micro-econometrics. I am also grateful to Prof. Richard Disney. He taught me how to grasp the essence and to ignore the many trivial details.

I give my special thanks to Prof. Jennifer Roberts and Prof. Simon Appleton, who served as my external and internal PhD examiners respectively, for their detailed and helpful comments on my thesis as well as their great inputs in examining my thesis. Their suggestions for corrections contributed to the further improvement of this thesis.

I owe my deepest gratitude to Zong-Gang Mou for his support and love for years. He enriched my life and is my eternal company. My parents have provided me with unconditional love over the four years journey and I love them more than anything in the world. I also wish to thank all my fellow Ph.D colleagues for their care and support in the past four years. Lastly, financial support from the University of Nottingham and China Scholarship Council are greatly acknowledged.

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CHAPTER 1

Introduction

This dissertation is a collection of three self-contained empirical studies on the health and well-being of the elderly in China. China is currently facing unprecedented health challenges; non-communicable diseases (NCDs), also known as chronic diseases, now account for 80 percent of its 10.3 million deaths annually. NCDs are by definition non-infectious and non-transmissible from person to person. They tend to be diseases of long duration and slow progression (WHO, 2011b). China's growing health challenges arise, at least in part, due to its rapidly aging population and are compounded by its inadequate social security provision and rapid urbanization. This dissertation uses data from a relatively underutilized data source, the China Health and Retirement Longitudinal Study (CHARLS). CHARLS is the first Health and Retirement Study (HRS) of its kind in China, and as such represents a rich source of data on health and well-being for the country. It is designed to be a survey of the elderly in China, based on a sample of households with members aged 45 or above. A two-province sample was piloted in 2008 and followed up in 2012, while a national wave was surveyed in 2011. The national baseline survey conducted in 2011-2012 collected data across 28 provinces consisting of 17,705 individuals living in 10,251 households. This dissertation is of relevance to policy makers in China where the challenge of an ageing population is beginning to take hold, specifically, the problem of how to maintain and finance the health of the elderly. Support for the elderly often remains the responsibility of their adult children, yet inadequate social security provision, rapid urbanization characterised by large scale internal migration and a sharp decline in fertility are beginning to change the traditional patterns of living arrangements and forms of support. This dissertation examines the extent to which the economic well-being and health of the aged population in China are affected in the presence of these demographic and social changes.

The first study (Chapter 3) in this dissertation is entitled "The Health Impacts of Non-communicable Diseases in China". Using data from the 2011 national wave of CHARLS, we examine the effect 5 key non-communicable diseases have on different dimensions of health. In order to represent the health of the elderly with fewer variables, we firstly use factor analysis and extract 3 correlated factors from 8 health measurements, which describe 'physical health', 'subjective health' and 'cognitive health', respectively. Then, using seemingly unrelated regression models, we find that all NCD types have negative and significant effects on 'physical health' and 'subjective health' but have nearly no impact on 'cognitive health'. Applying a system equation approach and conducting a series of cross-equation tests comparing the disease effects between subjective and physical health, we find that disease effects do not differ between the two health factors except for respiratory diseases. In addition, we show that depression impairs subjective and physical health to a greater degree than other chronic physical diseases. Investigating this further we find that comorbid depression with chronic physical illnesses significantly worsens the physical health of the elderly, and depression and cardiovascular diseases are found to have separated and additive effects. The findings from this study help to delineate the relative impacts of different NCDs on the health of the elderly with a common measurement strategy and the system equation approach used in this chapter fully explores the unobserved correlation among the commonly used health measurements which has been ignored in previous studies.

The second study (Chapter 4) is entitled "Catastrophic Health Spending, Noncommunicable Diseases and the Role of Children: A Microeconomic Analysis for China". This chapter examines the extent to which NCDs lead to episodes of catastrophic health spending, and how this varies with living arrangements, disease type and residential status (rural/urban). In doing so, we make three important findings. Firstly, we find that although China now has near-universal insurance coverage, it is still not sufficient to fully protect its members from the risk of catastrophic health spending, with those covered by the rural scheme being particularly vulnerable to the risk of catastrophic health spending, compared to those covered by the two urban schemes. Secondly, a household's proximity to its adult children is important in managing the financial burden of diseases, with physical support being more important than financial support. Finally, we show that large differences emerge between rural and urban China in terms of the impact that chronic diseases have on the household's finances. The negative effect that NCDs have on the probability of undergoing catastrophic spending is twice as big in rural areas as it is in urban areas, and cancer and diabetes are the two types of NCDs that pose the greatest impact in rural and urban areas, respectively.

The third study (Chapter 5) is entitled "Migration of Adult Children, Inter-generational Support and the Well-being of Elderly Parents". Extending the findings of the second study we look in detail at the effect the migration of adult children has on the health and subjective well-being of their parents. We examine the process of migration from two perspectives. Firstly, from the perspective of those who migrate we examine the main reasons behind their decision to migrate, as well as the reasons behind their decision to remit. Then secondly, from the perspective of parents who are left-behind, we examine the effect migration has on their physical health and subjective well-being.

We find that migration decisions in China are significantly related to household structure including sibling size, birth order and sibling composition (i.e. age and gender). We estimate the sibling size effect using an instrumental variable strategy, using twin births and gender of the firstborn child as instruments for sibling size. We find evidence of a negative relationship between sibling size and migration when this potential endogeneity is taken into account. In addition, we find that the probability of migration is not equally distributed across children within the family. Firstborn children appear less likely to migrate, especially firstborn sons. However, having more elder brothers systematically increases the younger sibling's probability of migration out of the village regardless of gender. Furthermore we find that migrant children are more likely to send transfers to their parents than children who live closer (i.e. the same village as their parents). When intergenerational support exchanges between children and parents are also controlled, this effect would persist but greatly diminish.

Controlling for endogenous selectivity, we find that the migration of children is associated with a better outcome for their parents' subjective well-being including mental health and life satisfaction but has no significant effect on physical health measured by activities of daily living (ADLs) scale. However, when a series of biomarkers are used to measure the parent's physical health, we find that migration is associated with a reduction in their risk of being underweight. To investigate the potential mechanism underlying these beneficial health effects, we use the same identification strategy and find evidence that child migration eases liquidity constraints that might prevent a parent from accessing health care.

The structure of the dissertation is organized as follows. In Chapter 2, we review the institutional backgrounds pertinent to the demographic and social changes giving rise to the ageing population and affecting their well-being in China and provide an overview to the data source we use throughout the dissertation. Chapters 3, 4 and 5 contain the aforementioned studies. Lastly in Chapter 6 we summarize the main findings and the limitations in each study and discuss potential directions for future research.

CHAPTER 2

Background and Data Overview

The elderly in China are currently facing considerable health challenges. The purpose of this chapter is to provide an overview of the social background where these challenges arise following China's transition from a planned to a market economy and to outline the main health problems the elderly currently face.

The first challenge is inadequate support from formal health insurance programmes and we review China's health care system and its reform since 1949. The second challenge is the declining support from adult children. Traditionally there is a strong notion of the extended family in China, where the elderly are cared for by their adult children in the family home. Now an increasing proportion of the elderly are living separately from their adult children as their adult children migrate in search of better opportunities elsewhere. To understand the migration process we review rural-to-urban migration in China and the role that the Hukou (household registration) system plays. Maintaining the health of the elderly is made even more challenging because the future elderly population will have fewer children to support them due to the country's strict family planning policy (the so called "One child policy"). We review how this policy was implemented in China and the unintended consequences it has had on the elderly.

We also provide an overview of the data source used in this dissertation including its representativeness, sampling methodology, questionnaire design, interviewing process, relationship with other similar surveys, etc. Drawing on rich health related questions collected in the 2011 national survey data, we are able to provide a detailed picture of the physical and mental health of the Chinese population aged 45+.

2.1 Background

2.1.1 China's Health Care System and Its Reforms

China's health care system has followed different paths since the Chinese Communist Party came to power in 1949. During the command and control era of the 1950s, China extended basic health care to its large peasant population, relying on prevention, primary care and a limited drug list delivered by low cost and modestly trained health care providers (Yip, 2010). During this period, enormous improvements in health and health care were achieved. For example, the death rate of new borns decreased from 200 to 34 per 1000 births from 1955 to 1982 and the the life expectancy increased from 35 to 68 years during the same period (Blumenthal and Hsiao, 2005). Despite this, embarking on economic reform in 1978, China gave its priority to economic growth without a coherent health policy in place, making its health care system vulnerable to repercussions from the economic transition process. Following the economic reform, the health system in China was transformed into arguably the world's most market-oriented health system in which individuals' access to health care became dependent on ability to pay and many families were driven into poverty due to large out-of-pocket health expenses (Wagstaff et al., 2009b). Rural areas, especially in western and central regions of China, where economic progress lagged behind experienced a harder hit resulting in a huge rural-urban gap in access to health care and health status. It was not until 2003, with the outbreak of SARS that the government acknowledged the limitations of such a market-driven system and focused more on universal social health care provision. In this section, we will firstly describe the health care policies in China between 1949 and 2002 then we turn to health care reforms from 2003 onwards.

China's Health Care System 1949-2002

Between 1949 and 1978, under the command and control system of Mao, health care in China was built around three pillars: universal insurance coverage through the Cooperative Medical System (CMS) in rural areas and Government/Labour Insurance Scheme (GIS/LIS) in urban areas; a public health care delivery system mainly subsidized by the governments; and a stringent price control policy for medical services.

Health insurance was mainly organized around the workplace: (1) the Cooperative Medical System (CMS) ensured health care for members of agricultural communes and was primarily financed by the commune's welfare fund; (2) the Labour Insurance

Scheme (LIS) covered health care for state-owned enterprise (SOE) workers, their dependents and retirees and was financed by the welfare fund of each enterprise; and (3) the Government Insurance Scheme (GIS) covered health care for civil servants, public services unit employees and retirees, disabled veterans and university teachers and students, and was financed by government budget funds (Wagstaff et al., 2009b; Yip, 2010).

The health care delivery system was organized in both rural and urban areas through a three-tier system. In rural areas, this consisted of village health posts, township health care centres and county hospitals, while in urban areas, employee clinics operated by enterprises, community health centres and city hospitals were coordinated accordingly (Wagstaff et al., 2009b). The practitioner training varied across the three-tier system. Village doctors with one year training after junior high school were usually assisted at the grass-root level by more minimally trained 'barefoot doctors' and county/city hospitals were staffed with more qualified health professionals. In larger cities, there were also specialty hospitals and medical centres affiliated with medical schools (Yip, 2010).

Finally, health facilities including hospitals in cities and small town clinics were public owned like nearly all other enterprises at that time. Physicians and health care workers were thus employees of the state and paid on a salaried basis. The financial support collected from communes, enterprises or local and central governments ensured the subsidies to the health insurance programmes and the salaries of health care providers at each level. The government also kept the input price artificially low, which helped hold down the prices that providers were allowed to charge patients. This, combined with near-universal health insurance coverage, meant that out-of-pocket health spending was minimal (Wagstaff et al., 2009a).

China began its economic reform around 1978, when the agricultural commune was replaced by household production, and state-owned enterprises were granted substantial financial autonomy (Cai et al., 2008; Hsiao, 1984; Liu, 2004). The breakup of the commune led to the almost total collapse of the CMS, and the financial autonomy for state-owned enterprises meant that many fell into financial difficulty, were thus unable to sustain their commitments to the LIS. As a result, rural residents were literally uninsured and workers in the urban areas lost the security to have their medical expenses fully reimbursed (Gao et al., 2001).

At the same time, tax revenues for all levels of governments declined rapidly following fiscal reform in the early 1990s (Wong and Bird, 2008). The immediate effect of this decline was a drastic reduction in government subsidies to health facilities. The government subsidies used to make up more than 50 percent of total hospital and health centre revenues in the pre-reform era, which decreased to less than 10 percent in the 1990s (Eggleston, 2012). This change seriously constrained the ability of public facilities to provide subsidized care. At the same time, the government maintained its strict price control policy on basic health care by setting the price below the cost, but set the price of new and high-tech services above the cost allowing a 15 percent profit margin on drugs so that hospitals could survive financially (Yip, 2010). These health policies created perverse incentives for health care providers who overprescribed drugs and profitable tests to generate 90 percent of their budgets (Yip et al., 2010). This period saw the delivery of unnecessary medical care, rapid cost escalation and an ever larger share of health spending financed out-of-pocket by patients.

China's Health Care System Since 2003

Since the SARS outbreak in 2003, which highlighted the weaknesses in China's health care system, health care in China has undergone a series of reforms aimed at providing the whole nation with basic medical and health care, while ensuring equal access to, and affordability of, health services. This has involved the establishment and expansion of health insurance for rural residents and urban residents that are unemployed or out of the labour market. Following these reforms the provision of health care in China is now centred around the following three main schemes: (1) the New Rural Cooperative Medical Scheme (NRCMS), which is a voluntary health insurance programme for rural residents with enrolment on a household basis; (2) the Urban Employee Basic Medical Insurance (UEBMI), which is a mandatory scheme for formal sector workers in urban areas and funds are largely pooled at the municipal level; (3) the Urban Resident Basic Medical Insurance (URBMI), which is a voluntary health insurance programme for those not covered by UEBMI (i.e. students, children, elderly people without previous employment, and other non-working urban residents) and is also pooled at the municipal level. Finally, the Medical Assistance (MA) programme provides supplementary financial support to those who cannot afford to pay their health insurance premiums in either the NRCMS or URBMI and in some circumstances covers the cost of out-of-pocket medical expenses. In reality, however, the MA programme is often ineffective in identifying its target population and the additional benefits provided are slim for most of those involved (Liang and Langenbrunner, 2013). A summary of China's three main health insurance schemes can be found in Table 2.1.[1]

By the end of 2011, around 95 percent of the Chinese population (1.3 billion people) were covered by one of these three health insurance schemes. However, the funds available in the three schemes, especially in the NRCMS and URBMI are not always sufficient to meet the needs of their members. The NRCMS covers only inpatient services, and the URBMI includes inpatient and critical outpatient expenses, while the UEBMI is the most generous of the three schemes covering both inpatient and outpatient expenses with a supplementary insurance package. The effective reimbursement rate for inpatient care is also less than 100 percent across the three schemes. In 2011, it was 88 percent for UEBMI, 42 percent for URBMI and estimated to be less than 50 percent for NRCMS (Liang and Langenbrunner, 2013). As a result, out-of-pocket health spending is still widespread across most of China (Li et al., 2012; Long et al., 2013; WHO, 2014; Yip et al., 2012).

Next we turn to the delivery system. The current health care delivery system in China is largely dominated by general hospitals and managed through the Ministry of Health and local governments, along with the providers of community health care centres, health care posts and village clinics at the lower end of the hierarchy (see Figure 2.1). Similar to the pre-reform system, hospitals in China are organized according to a three-tier system of Primary, Secondary and Tertiary, which is based on a hospital's ability to provide medical care and medical education, and to conduct medical research. Despite the three-tier system, patients were traditionally free to self-refer to any provider as access to care depends on ability to pay (Eggleston, 2012). Self-referral without gatekeeping requirements resulted in inefficiency characterized by overcrowding in large hospitals and underutilization of lower level facilities. To restore efficiency, the government aims to introduce the General Practitioner System (GP) throughout China by 2020.[2]

[1] Another insurance scheme remaining from pre-reform era is the Government Insurance Scheme (GIS) for civil servants and public services unit workers (including employees, retirees, and their dependents), which reimburse nearly 90 percent of their medical expenses. A small group of Old Red Army and disabled veterans also receive a subsidy for this insurance. To reduce the inequality across the different health insurance schemes, the government plans to incorporate the Government Insurance Scheme into UEBMI and ultimately integrate the urban and rural schemes (NDRC, 2013).

[2] See 'Directions on the Establishment of the General Practitioner System', which was published by the State Council in 2011, accessed via http://news.xinhuanet.com/english2010/health/2011-07/07/c_13971885.htm.

Table 2.1: Overview of the Three Basic Medical Insurance Programmes in China, 2011

Characteristics	**New Cooperative Medical Insurance**	**Urban Employees Basic Medical Insurance**	**Urban Residents Basic Medical Insurance**
Overseeing Ministry	Ministry of Health	Ministry of Human Resource and Social Security	Ministry of Human Resource and Social Security
Year of pilot/formal launch	2003/2006	1994/1998	2007/2009
Level of pooling	County	Municipality	Municipality
Target populations	Rural residents	Urban employees	Urban non-employed residents (children, students, elderly, disabled and other non-working residents)
Enrolment rate	97%	95%	Data not available
Participation	Voluntary at households	Mandatory for individuals	Voluntary for individuals
Number of enrolees	832 million	252 million	221 million
Percentage of total population	62%	18%	16%
Per capita fund (RMB)	246	1,962	269
Benefits package	Inpatient care	Inpatient and outpatient care	Inpatient and critical outpatient care
Average reimbursement per discharge (CNY)	1235.5 (2009)	6,112	2,891
Mandated reimbursement rate	75%	>80%	70%
Effective reimbursement rate	<50% (estimated)	88%	42%
Supplementary insurance package	N.A.	Civil servant medical aid, big disease medical aid and social medical aid	N.A.
Revenues (RMB)	204.76 billion	395.54 billion (2010)	43.30 billion
Expenditures (RMB)	171.02 billion	327.16 billion (2010)	28.78 billion

Source: Barber and Yao (2010) and Liang and Langenbrunner (2013); Audit Results of the National Social Security Funds (http://www.cnao.gov.cn/main/articleshow_ArtID_1270.htm).
Notes: If otherwise stated in parentheses, the figures are for year 2011.

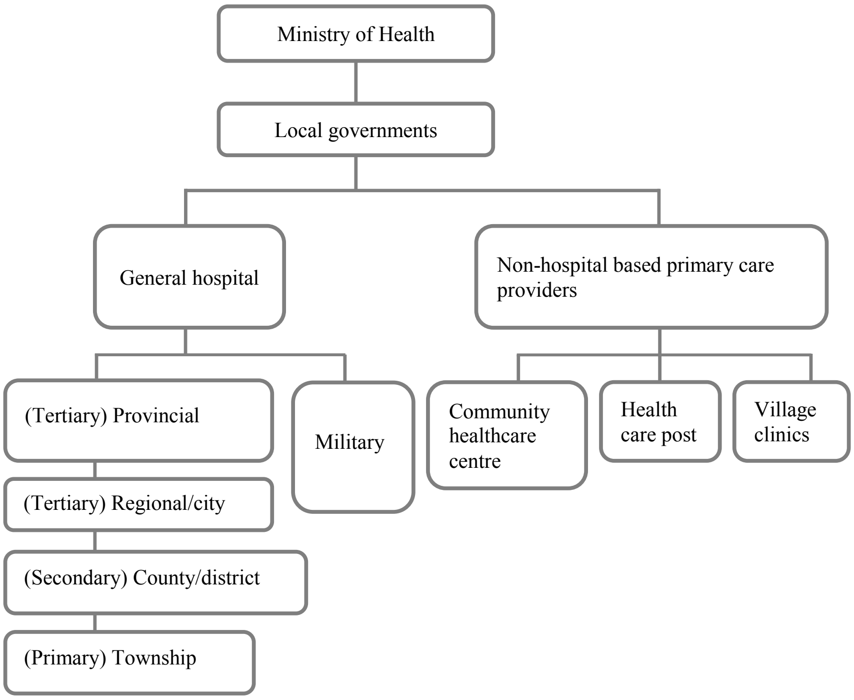


Figure 2.1: Health Care Delivery System In China

The most pivotal health care reform took place in 2009, with a goal of addressing a ubiquitous slogan of 'getting health care is difficult and expensive'. This reform is backed with funding from the government of 850 billion RMB with five priorities during 2009-2011: (1) extending basic health insurance coverage to 90 percent of the whole population; (2) expanding the public health service benefit package; (3) strengthening primary care; (4) implementing an essential drug list for all the service providers at grass-root level (including separation of prescribing and dispensing in primary care); (5) experimenting with reforms of government-owned hospitals. Generally, China has achieved wide but shallow coverage (the first priority) and is proceeding to deepen coverage assuring "value for money spent". The second phase of the health care reform, was announced in 2012, having the goals of: (1) enriching insurance benefits; (2) improving portability; (3) encouraging private sector delivery; (4) reforming county-level hospitals; (5) extending the essential medications system to private primary care providers; and (6) further strengthening population health initiatives.

At the same time China's primary burden of disease has shifted from infectious to non-communicable diseases, although some infectious diseases such as tuberculosis remain a concern (WHO, 2010). China now faces a growing burden of non-communicable diseases such as cancer, heart attacks, strokes, asthma, chronic obstructive pulmonary disease, and mental health problems. Non-communicable diseases now account for over 80 percent of China's 10.3 million annual deaths (OECD, 2012). For example, hypertension has become the most common and preventable risk factor for premature mortality among Chinese adults aged 40+ in 2005; total mortality was 48 percent higher among those who had hypertension than among those who did not (He et al., 2005). Diabetes among adults (18+) in China in 2010 was 12 percent, and pre-diabetes was estimated to be 50 percent with the majority of patients undiagnosed and untreated (Xu et al., 2013). China's health system faces the challenge of transitioning from the focus on acute care and control of communicable disease to a system supporting prevention and cost-effective management of chronic diseases (Eggleston, 2012).

The treatment of chronic diseases is often expensive and lengthy. In contrast, although health care in China has achieved near universal insurance coverage, reimbursement rates for inpatient care are still low, while the costs of outpatient care are still not covered by two of the country's three main health insurance schemes (Tang et al., 2013). This poses many challenges for the elderly people in China, who are particularly vulnerable to ill health, especially chronic diseases as they grow older.

2.1.2 Migration and the Hukou System

Next we briefly review the background of migration and its social consequences on the well-being of the elderly in China, especially the elderly living in the rural areas. Large scale migration in China did not begin until the economic reforms started in 1978. Prior to 1978 China had been a typical dual society characterised by economic and institutional segmentation between rural and urban areas (Cai et al., 2009). Rural labour forces were not allowed to engage in off-farm activities or migrate to urban areas and this is enforced by the strict regulation of the Hukou system. The Hukou system was established in 1951. A Hukou is a record of household registration, which officially identifies a person as a resident of an area (urban or rural) and includes information such as the name of the individual, their parents, spouse, and date of birth. Not having a Hukou results in some loss of public benefits and an urban Hukou is always associated with better public benefits (Chan and Zhang, 1999). Since China's reform and liberalization in 1978, rural-to-urban migration has gradually become a historical phenomenon in China.

Migration in China has been dominated by labour migration, which was caused by the rural reform that released surplus labour from agriculture. The "household responsibility system" initiated in 1981 replaced the egalitarian distribution method created in the commune system and made the rural households the residual claimants of their marginal efforts. Together with the reform in the pricing system of agricultural products, the rural economy is greatly stimulated and farmers are liberalized from agricultural work and attracted by the high returns to work in non-agricultural sectors (Cai et al., 2003).

The institutional obstacles for labour mobility have been gradually removed (at the centre of the Hukou system) since the 1980s , and rural inhabitants were encouraged to migrate to cities. Initially, farmers were just allowed to engage in long distance transport and sell their products beyond the local market in 1983. In 1984, regulations were further relaxed and farmers were encouraged by the state to work in nearby small towns where emerging township and village enterprises demanded labour. A major policy reform took place in 1988, when the central government began allowing farmers to relocate in small towns but taking food together with them (Cai et al., 2008).[3] As a result, a great flow of rural labour flooded into the cities and the urban population started increasing steadily.

Since 1995, rural migrants have become the main source of the urban population expansion. This was propelled by Deng Xiaoping's Southern Tour talk in 1992. His talk insisted on economic openness, which aided the inflow of foreign direct investment and witnessed phenomenal economic growth in the coastal areas (UNDP, 2013). At the same time, a large rural surplus labour force from western and central China were attracted to the developed regions in eastern and southern China. The majority of these groups engage in labour-intensive work which has greatly accelerated China's industrialization process. By 2010, these rural migrants comprised of 31.2 percent of urban residents (UNDP, 2013). Estimates from the National Census show that the migrant population grew from just over 100 million in 1990 to 213 million in 2000 (Giles and Mu, 2007). In 2011, the migrating population reached 260 million, and figures from the United Nations Development Programme (UNDP) suggest that during the next two decades an additional 310 million people are expected to migrate from rural-to-urban areas, a speed and scale unprecedented in history (UNDP, 2013).

[3] Supply of staple food such as meal and rice was based on the local hukou in the period when major daily necessities were rationed in the 1980s (Chan and Zhang, 1999).

One of the consequences of this large-scale internal migration is the distortion of the demographic structure of the rural population. Due to the Hukou regulation, rural migrants can hardly become permanent residents in urban areas and in most cases their spouses, parents, and children are left-behind in home villages. Furthermore, because of their non-urban Hukou, rural migrants do not enjoy the same rights as native urban citizens in terms of voting, employment opportunities, education, medical care, social security and other social services (Chan and Buckingham, 2008; Chan and Zhang, 1999). They are variously called peasant workers, the floating population and shifted population from agricultural sectors.[4]

In light of this rapid demographic change, there are increasing concerns surrounding the well-being of the rural elderly. Historically, large gaps exist between rural and urban China in terms of income levels, levels of coverage by safety nets and benefits received from social welfare systems. Due to the rigid Hukou system, young children of migrant workers often have limited access to education in urban areas and were left in the countryside to be raised by their grandparents. In addition, migration of children places greater pressure on the rural elderly to continue working to finance their consumption in old age (UNDP, 2013). As a result, the rural elderly are especially vulnerable to falling into poverty due to a lack of pension support, insufficient savings and the migration of adult children. On the other hand, the remittances from migrants might play an active role in poverty reduction in rural China and narrowing the income gap between rural and urban areas (Cai et al., 2012; Giles and Mu, 2007).

2.1.3 One Child Policy

The One child Policy was formally launched in 1979. Actual implementation began in certain regions as early as 1978, and enforcement gradually tightened across the country until it was firmly in place in 1980 (Banister, 1987; Croll et al., 1985). Second births became forbidden with limited exceptions. In 1979, the population in China was approximately 970 million and the government aimed to curtail the growth rate so that the population would be below 1.2 billion by the end of the 20th century to achieve its development goal of modernization.

The one child policy advocated delayed marriage and childbearing and fewer and healthier births through disproportionate punishment measures for those who broke

[4] Despite the debate on the exact definition, migrants are officially defined as persons who have left their townships for more than 6 months (Cai et al., 2009).

the policy and incentives for those who complied. People were encouraged to have only one child through a package of financial and other incentives, such as preferential access to housing, schools and health services. Discouragement included financial levies on each additional child and sanctions which ranged from social pressure to curtailed career prospects for those in government sectors. All these measures had more effect in urban than in rural areas as rural residents with limited savings and without pensions needed children to support them in old age (especially sons, as married daughters moved into their husbands' families). As a result, the enforcement of birth control was confronted with resistance when the policy went into force in rural areas (Kane and Choi, 1999). Although local authorities were given economic incentives to suppress fertility rates by imposing fines for higher order births, forced sterilization and abortion were common due to the stringent birth control campaigns in the policy's earlier years and reports of female infanticide became widespread.

To decrease infanticide of the firstborn child and to curb the coercive methods in birth control campaigns, local governments began issuing permits for a second child as early as 1982 but were not made widespread until the central government issued the 'Document 7' in April, 1984 (Qian, 2009). The purpose of this document was to curb female infanticide, forced abortion and forced sterilization and to devolve responsibility from the central government to the local and provincial government. Following Document No. 7, rural couples were allowed to have a second child if the first child is a girl. Relaxation of this policy also extended to households with 'practical' difficulties such as a parent or firstborn child was handicapped, or if a parent was engaged in a dangerous industry (e.g. mining) (Greenhalgh, 1986).

The immediate effect of the one child policy was the declining fertility rate, which results in a rapidly aging population in China at its early economic development stage, although it successfully reduced the country's population growth by some 250 million (Kane and Choi, 1999). Currently those aged 60 and above in China represents 14 percent of the whole country's population, and it is estimated that by 2050 this figure will be 33 percent, outstripping many developed nations (UN, 2014). At the same time, the elderly support ratio (i.e. the number of prime-age adults aged 25 to 64 divided by the number of adults aged 65 or above) is likely to more than double between 2013 and 2030, from 11 percent to 23 percent (UN, 2014).

The growth of internal migration also had many unintended consequences for the one child families. For example, as these parents get older, they are more likely to be left unattended or to live alone. Older parents living in multigenerational households (i.e. three-generation households or with grandchildren in skipped-generation households) are found to have better psychological well-being than those living in single-generation households (Silverstein et al., 2006). In addition, fertility restrictions might provide incentives for households to increase their offspring's education and to accumulate financial wealth in expectation of lower support from their children (Choukhmane et al., 2013). All of these may or may not counteract the negative effect migration of children has on the well-being of their parents.

2.2 Data Overview

This dissertation uses data from the 2011 national survey of the China Health and Retirement Longitudinal Study (CHARLS). CHARLS is based on the Health and Retirement Study (HRS) and other related aging surveys such as the English Longitudinal Study of Ageing (ELSA) and the Survey of Health, Ageing and Retirement in Europe (SHARE). It is designed to be a survey of the elderly in China, based on a sample of households with members aged 45 and above.

Before a national survey started, a pilot was carried out between July and September 2008 in two provinces: Zhejiang and Gansu, which are at different ends of the spectrum in terms of location and economic growth. Zhejiang is located on the east coast and is one of the richest provinces in China, while Gansu located in the less developed north western region is one of the poorest. The pilot survey collected data from 95 primary sampling units (villages or neighbourhoods) which are located in 32 counties/districts, covering 2,685 individuals living in 1,569 households using stratifying sampling methodology. The follow-up survey was conducted in 2012 and includes 2,378 respondents in 1,408 households. Out of the 2,378 respondents, 2,341 respondents were interviewed in both years.

The national baseline survey conducted between 2011 and 2012 maintains the same sample representativeness across 28 provinces covering 450 primary sampling units (villages/neighbourhoods) located in 150 counties/districts. Among the 450 primary sampling units, 53 percent were in rural areas and 47 percent were in urban areas.[5] The

[5] The urban-rural definition in CHARLS is based on the National Bureau of Statistics of China definition. A primary sampling unit (PSU) is defined as urban if it is located in a city, suburb of a city, a town,

2011 national survey consists of 17,705 individuals living in 10,251 households.

All age-eligible households in each primary sampling unit are interviewed. If more than one age-eligible household resides in the same dwelling, one household is chosen at random. Similarly, if there is more than one age-eligible member in each household, one is selected at random. The respondent's spouse, regardless of age, is also interviewed.[6] CHARLS is the first HRS of its kind in China, and as such represents a rich source of data on health and well-being for the country. Interviewees are asked standard questions concerning their demographic characteristics, education, work status, and income sources, together with more detailed questions on their health status. Information can be found in the eight modules comprising the CHARLS household survey: household roster; demographic background; family; health status and functioning; health care and insurance; work, retirement and pension; income, expenditure and assets; household characteristics and interviewer observation.

2.2.1 Sample Structure

Table 2.2 describes the age structure split by gender, Hukou and region of residence of the 2011 national wave of CHARLS sample. We apply individual sampling weights so as to be representative of the population of China aged 45+ (Tibet is excluded).[7]

We put our respondents into eight age groups. Around 23.4 percent are aged 45-49, 14.5 percent are aged 50-54 and 19.1 percent are aged 55-59. The rest 42.9 percent of the sample are elderly aged 60+.[8] In the sample, 47.6 percent are men, 28.6 percent have an urban Hukou, and 50.1 percent live in urban areas. The fact that females slightly out-

suburb of a town, or other special areas where non-farm employment constitutes at least 70 percent of the workforce (e.g. a special economic zone, state-owned farm enterprise, etc.).

[6] Although household is commonly defined as a unit comprising individuals living in the same residence, household members in CHARLS are defined as meeting one of the following criteria: (1) currently live permanently in the household and who lives in the household for more than 6 months during the past year; (2) currently attend school/work away from home but come back almost every week, and who lived in the household for more than 6 months during the past year; (3) currently do not live in the household permanently, but lived in the household for more than 6 months during the past year and will return to live in the household for long-term in the upcoming one year.

[7] The demographics of CHARLS 2011 national baseline wave mimics that of the 2010 population census after applying sampling weights (CHARLS, 2013).

[8] Although the definition of 'elderly' might vary from country to country, it is at many times associated with the age at which one begin to receive pension benefits. The retirement age in China is currently 60 for men and 55 for women.

Table 2.2: 2011 CHARLS Sample Description - Age Structure by Gender, Hukou and Residence (%)

Age Group	Total	Gender		Hukou		Residence	
		Female	Male	Rural	Urban	Rural	Urban
45-49	23.36	25.34	21.18	23.97	21.88	22.02	24.71
50-54	14.67	14.63	14.72	15.41	12.84	14.68	14.66
55-59	19.09	18.53	19.70	19.01	19.32	19.14	19.05
60-64	14.84	14.23	15.52	15.06	14.29	15.57	14.12
65-69	9.77	9.05	10.57	9.69	10.01	10.74	8.82
70-74	7.78	7.24	8.39	7.03	9.68	7.57	8.00
75-79	5.41	5.20	5.63	4.85	6.77	5.15	5.66
80+	5.07	5.78	4.29	4.97	5.21	5.14	4.99
Total	100	52.39	47.61	71.36	28.64	49.88	50.12

Note: Individual weights with household and individual non-response adjustment are applied.

number males might reflect the fact that females on average outlive males. Although respondents with a rural Hukou are much greater than respondents with an urban Hukou, those living in the rural areas and those living in the urban areas are almost equal. A rural migrant is usually defined as an individual who lives in an urban area but owns a rural Hukou. As such we expect that around half of those living in urban China are rural migrations and this is consistent with the figures reported by (UNDP, 2013).

Table 2.3 describes the highest education attainment levels of the population by age cohort, gender and Hukou status. Substantial differences arise across groups, showing that respondents who are younger, male and with an urban Hukou are more likely to obtain a better education.[9] Among the older elderly (aged 60+), only 44.7 percent completed primary school and 9.4 percent completed high school. The education level is much higher for the younger cohort (aged 45-59); 66.4 percent completed primary school and 19.7 percent finished high school. Education levels across gender are also striking. Over one third of women in our sample did not attend any school, compared to just 12 percent among men. Individuals with a rural Hukou are on average less educated. Half of those with a rural Hukou did not finish primary school, and just 6 percent finished high school. In contrast, 80 percent of those with an urban Hukou completed primary school, 33.6 percent completed high school and 21.5 percent completed college or above, a figure that dramatically outnumbers that among individuals

[9] Respondents were asked the highest level of education they had attained with responses: (1) No formal education (illiterate); (2) Did not finish primary school but capable of reading and/or writing; (3) Sishu/home school; (4) Elementary school; (5) Middle school; (6) High school; (7) Vocational school; (8) Two/Three-year college/associate degree; (9) Four-year college/Bachelor's degree; (10) Master's degree; (11) Doctor degree/Ph.D.

with a rural Hukou.

Table 2.3: Education Attainment of Population Aged 45+ in China (%)

Education	Total	Age		Gender		Hukou	
		45-59	60+	Female	Male	Rural	Urban
No schooling	25.61	17.72	36.14	38.21	11.77	32.25	8.99
Did not finish primary	16.18	14.88	17.9	16.21	16.14	19.04	9.04
Finished primary	21.78	19.86	24.34	17.96	25.96	23.43	17.67
Finished middle school	21.17	27.85	12.26	16.48	26.34	19.22	26.09
Finished high school	8.61	12.97	2.79	6.76	10.65	5.35	16.7
Finished college and above	6.65	6.71	6.58	4.38	9.15	0.71	21.51
Total	100	57.13	42.87	52.39	47.61	71.36	28.64

Note: Individual weights with household and individual non-response adjustment are applied.

2.2.2 Health Outcomes

The primary focus of this dissertation is the health of the elderly living in Chinese households. Similar to the HRS survey designs, CHARLS has a rich set of questions on the health status of the main respondents being interviewed and their spouses living in the same household.

Health is conceptualized as being multidimensional in CHARLS, with a general emphasis on physical and mental (including cognitive) domains. Based on the health related questions in CHARLS we group our health related measures into two categories - physical and mental health in Table 2.4.[10] Physical health is further classified into subjective and objective assessments (Cote, 1982).

Table 2.4: An Overview of the Health Measures in CHARLS

Classification 1	Classification 2	Measures
Physical	Subjective	Self-reported overall health status
		Survival probability
		Self-reported disease
	Objective	Biomarkers
		Activities of Daily Living (ADLs)
Mental	/	Cognition tests
		Depression indicator

Self-reported overall health status is widely used in the literature as a measure capturing the overall level health of an individual. It is based on questions asking people to

[10] Health outcomes at the aggregate level, such as life expectancy and mortality, are not the focus of the dissertation as CHARLS is a micro level data set.

evaluate their health on a five-point scale - 'very good', 'good', 'fair', 'poor' and 'very poor'. The appeal of this type of index is partly due to an attempt to summarize a very multidimensional concept such as health in an intuitively appealing and simple manner (Banks and Smith, 2012). It is worth noting CHARLS has a particular feature from HRS; two scales are used to measure self-reported health status. The respondent was randomly assigned to a scale and was asked to rate their health status twice - before and after a series of specific health status and functioning questions. Another scale (the one used in HRS) ranges from 'excellent', 'very good', 'good', 'fair' and 'poor'. The exact questions appearing in the survey can be found in the Appendix A. We choose the former likert-type scale ('very good' - 'very poor') because its distrubution is more symmetrical around the mean (see Figure A.1 in the Appendix).

Another overall health status measure is self-reported survival probability, whereby respondents are asked the likelihood that they are able to survive to a certain age 10-15 years from now and this response ranges from 'almost certain' to 'almost unlikely' on a five-point scale. CHARLS also asks questions on the presence of common chronic medical conditions and follow-up treatments, enabling us to compute the disease prevalence in the population. A potential problem with subjective measures is differential item functioning (DIF), namely, respondents with a different background or from a different region may interpret the questions differently and hence give different answers even though in some objective sense they have the same health problems (King et al., 2004). Anchoring vignettes are designed to overcome the measurement problems arising from DIF and elicit the thresholds that respondents use when evaluating their health. Health vignettes are collected on a random subsample (50 percent) in CHARLS and are beyond the discussion in this dissertation because using vignettes would render us insufficient observations in most cases when other key variables are considered in a regression framework.

In addition, although vignettes could be used to correct subjective differences in order to conform with objective differences in measured health, it does not mean these subjective differences do not matter for behaviour, nor that subjective assessments of health are not a legitimate outcome for analysis (Banks and Smith, 2012). In fact, subjective differences can be objects of interest in their own right, which might be intrinsic to the self-reported 'subjective' measure (Disney et al., 2006). We investigate this topic further using factor analysis approach in Chapter 3.

Objective measures of health outcomes are clinical-based in nature, including biomarkers and the activities of daily living (ADLs).[11] Biomarker in CHARLS are collected via biological samples, which can include blood pressure, height, weight and waist circumference, measures indicating diabetes, and measures related to the risk of cardiovascular disease, etc. The ADLs are questions used by health professionals as a measurement of a person's functional status, particularly in regard to people with disabilities and the elderly. Questions on mental health include cognition tests evaluating memory, numerical ability, verbal fluency, fluid intelligence, etc., and a depression index derived from the 10-item version of the Centre for Epidemiologic Studies Depression Scale (CES-D).[12] Next we look at the health of the CHARLS respondents based on these measures.

Self-reported health measures

In Table 2.5, we report the distribution of the 5-level self-reported overall health status by residence and gender.

Table 2.5: Self-Reported Overall Health Status by Residence and Gender (%)

Health Status	Rural area		Urban area		Total
	Female	Male	Female	Male	
Very poor	6.85	4.65	3.15	3.14	4.47
Poor	30.05	22.95	19.06	15.07	21.92
Fair	44.68	47.35	51.17	48.92	48.03
Good	13.95	18.01	19.28	22.14	18.26
Very good	4.47	7.04	7.33	10.73	7.31
Total	100	100	100	100	100

Note: Individual weights with household and individual non-response adjustment are applied.

Respondents in CHARLS were asked to assess their health as being: 'very good', 'good', 'fair' 'poor' or 'very poor'. The majority of respondents report an overall health status being in the middle scale 'fair' (48 percent). Males are more likely to report good health than females. Respondents living in rural areas are more likely to report 'poor' or worse health than those living in urban areas. For example, 36.9 percent of female respondents living in rural areas self-report having 'poor' or 'very poor' health. In contrast, 22.2 percent of female respondents in urban areas do so.

Next we turn to survival probability where respondents are asked to evaluate the

[11] Alternative physical measures also include physical performance tests cover administered tests for grip strength, walking speed, balance, lung function test, timed chair rises, etc.

[12] Questions on health behaviours such as smoking, drinking, and physical activities (including both physical exercise and physical activities in daily life) are also asked in CHARLS.

probability that they will survive to a certain age (over the coming 10-15 years) on a five-point scale being (1) 'almost impossible', (2) 'not very likely', (3) 'maybe', (4) 'very likely' or (5) 'almost certain'. We define a respondent as having a positive survival probability if his/her response falls into 'maybe', 'very likely' or 'almost certain'. In Figure 2.2, we compare the proportion of respondents reporting positive survival probability across eight age groups between rural and urban areas. On average, respondents living in urban areas are more likely to give a high evaluation on their probability of surviving to an older age than do respondents living in rural areas within each age group. We also find that this self-reported probability of surviving to an older age declines remarkably when the respondents are near the age of 60 in both rural and urban areas. For example, in rural areas (the solid line in Figure 2.2), around 71 percent of respondents aged 60-64 self-report having a positive probability of surviving to an older age but this figure drops to 53 percent among those who are aged 65-69.

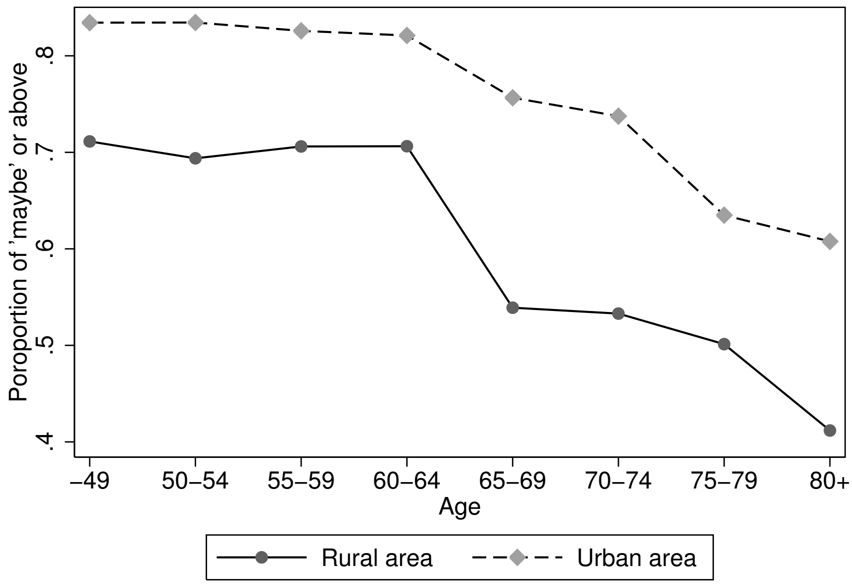


Figure 2.2: Age Specific Positive Survival Probability by Region

Lastly, we examine the presence of common medical conditions self-reported by respondents. A check list of 13 chronic medical conditions is used to ask the respondent 'Have you been diagnosed with the conditions by a doctor or nurse or paramedic or doctor of traditional Chinese medicine?'.[13] In Table 2.6, we present the number

[13] To account for undiagnosed disease, those responding 'no' to the following conditions: hypertension, chronic lung disease, stomach or other digestive diseases, emotional, nervous, or psychiatric problems, memory-related diseases, and arthritis or rheumatism are asked whether they knew they had the dis-

and proportion of respondents reporting having (either diagnosed with or known by oneself) a specific disease condition, together with the mean history with the disease (among those who had that disease).

Table 2.6: Summary of 13 NCD Prevalence and Average History (N=16,865)

NCDs	Count	Prevalence rate (%)	Average history (year)
1 Hypertension	4,103	24.33	8.02
2 Dyslipidaemia	1,549	9.18	6.23
3 Diabetes or high blood sugar	968	5.74	6.33
4 Cancer or malignant tumour	162	0.96	9.22
5 Chronic lung diseases	1,905	11.30	16.61
6 Liver disease	641	3.80	13.76
7 Heart problems	1,992	11.81	10.34
8 Stroke	395	2.34	10.39
9 Kidney disease	1,059	6.28	11.02
10 Stomach or other digestive disease	3,686	21.86	15.14
11 Emotional, nervous, or psychiatric problems	234	1.39	18.36
12 Memory-related disease	256	1.52	6.19
13 Arthritis or rheumatism	5,468	32.42	14.21

Note: Individual sampling weights are not applied.

Among the 13 chronic medical conditions 5 of them has a prevalence rate exceeding 10 percent in the sample.[14] Arthritis/rheumatism has the highest prevalent rate. Near one third of the sample self-reported having arthritis/rheumatism. Among those with arthritis, they self-report being diagnosed with it on average for about 14 years. The second and third most prevalent diseases are hypertension (24 percent) and stomach/other digestive disease (22 percent). Heart problems and chronic lung diseases have similar prevalence rates of about 11 percent.

In later chapters we focus on five of these medical conditions, namely, cardiovascular disease (including hypertension, dyslipidaemia, heart problems and stroke), cancer, diabetes, respiratory disease (including chronic lung diseases), and mental health problems (including emotional, nervous or psychiatric problems, and memory-related diseases). The first four conditions encompass the main NCDs in China, and are largely

ease. Respondents are further asked when the condition was first diagnosed or known by respondents themselves.

[14] We do not apply sampling weights because we intend to focus on comparing the prevalence rates among different diseases in which case we think comparing number of each disease incidence in the sample is more intuitive. Despite this, the size of the prevalence rate after applying sampling weights does not differ noticeably from the one we report.

caused by shared behavioural risk factors, i.e. tobacco, an unhealthy diet, insufficient physical activity, and alcohol (WHO, 2011b). We also include mental health problems as a disease category in our analysis, which is a major contributor to the burden of disease worldwide (Üstün et al., 2004). Although those reporting having emotional, nervous, or psychiatric problems take only 1.39 percent of the entire sample, this might be because there exists a stigma in reporting mental health related problems (Li et al., 2006; Ng, 1997).

As an illustration, we show the proportion of people suffering from hypertension by age, residence and gender (see Table 2.7). Self-reported hypertension is more prevalent among those who are older (aged 60+) and is higher in urban areas than in rural areas. In rural areas, males on average are less likely to report having hypertension than females but in urban areas the opposite is true. The fact that people in urban areas are more likely to be diagnosed with hypertension may reflect the positive association of selected disease conditions with increasing wealth in a society due to modern diet and sedentary lifestyle (Ezzati et al., 2005).

Table 2.7: Prevalence Rate of Self-Reported Hypertension by Age, Residence and Gender (%)

Age Group	**Rural area**		**Urban area**		**Total**
	Female	**Male**	**Female**	**Male**	
Under 50	13.21	12.18	14.90	19.50	14.96
50-59	20.76	17.30	23.89	22.05	21.04
60-69	31.44	24.94	34.42	37.61	31.76
70+	35.31	29.27	41.10	46.75	38.18
Total	24.17	20.59	27.00	29.80	25.38

Note: Individual weights with household and individual non-response adjustment are applied.

Objective health measures

Next we examine the summary statistics of several biomarkers from CHARLS (see Table 2.8). It is worth noting that the average response rate for biomarkers is 73 percent, a figure lower than other modules in the survey. On average, the lung capacity is 264.73 litres per minute, with the maximum value of 800 and the minimum of 60. The systolic blood pressure is 133.77 mmHg among our respondents with 29 percent of them having systolic blood pressure above the cut-off of 140. The diastolic blood pressure is on average 75.99 mmHg and 12 percent of our respondents have diastolic blood pressure above the cut-off of 90.[15] The two figures combined show that 10 percent of our sample

[15] Blood pressure is measured in millimetres of mercury (which is written as mmHg) and it is recorded as two figures: systolic pressure, i.e. the pressure of the blood when your heart beats to pump blood out

are defined as having high blood pressure based on 140/90 scale (i.e. the systolic blood pressure above the cut-off of 140 and the diastolic blood pressure above the cut-off of 90). The average weight and height of the respondents in the sample is 58.7 kg and 158 cm. Body mass index (BMI), defined as body weight divided by the square of body height, is 23.45 on average. BMI can measure whether or not an individual has healthy weight for his/her height (WHO, 2006). BMI above the healthy range is associated with a raised risk of the serious health problems linked to being overweight, such as type 2 diabetes, heart disease and certain cancers. BMI below the healthy range however is associated with having problems of insufficient nutrition. The proportion of respondents being underweight (i.e. BMI $<$ 18.5) is 7 percent. Around 31 percent are defined as being overweight (i.e. BMI $\geq$ 25) and 5 percent having obesity problems (i.e. BMI $\geq$ 30).

Table 2.8: Summary Statistics of Biomarkers in CHARLS 2011

Variables	Mean	S.D.	Min	Max	n
Average lung capacity	264.73	112.88	60.00	800.00	13,062
Systolic blood pressure	130.77	21.67	60.50	235.00	13,725
Diastolic blood pressure	75.99	12.23	30.00	142.67	13,727
High blood pressure (above 140)	0.29	0.45	0	1	13,725
High blood pressure (above 90)	0.12	0.33	0	1	13,727
High blood pressure (above140/90)	0.10	0.31	0	1	13,725
Weight (kg)	58.68	11.15	35.50	90.10	13,728
Height (cm)	158.00	8.56	138.00	177.50	13,695
BMI (kg/m^2)	23.45	3.69	11.76	47.31	13,631
Underweight	0.07	0.25	0	1	13,631
Overweight	0.31	0.46	0	1	13,631
Obesity	0.05	0.21	0	1	13,631

Note: Weight and height variables are winsorized at the lower and higher 1 percentile of the sample. The number of observations for each variable is different because of different non-response rates.

Next we examine activities of daily living (ADLs) measures among rural and urban old people. The ADLs is a composite index of the level of difficulty that the respondent has in performing a number of fairly normal and routine day-to-day activities or tasks. Basic activities of daily living (BADLs) concern difficulty in performing 15 activities, i.e. walking, running or jogging, getting up from a chair after sitting a long time, climbing stairs, stooping, kneeling, or crouching, reaching or extending arms above shoulder level, carrying weights over 5 kg, picking up a small coin from a table, dressing, bathing and showering, eating, getting in and out of bed, using the toilet and controlling urination and defecation. Instrumental activities of daily living (IADLs) include

and diastolic pressure, i.e. the pressure of the blood when your heart rests in between beats.

difficulties with 5 activities, i.e. household chores, preparing hot meals, shopping for groceries, managing money, and taking medications.

There are 4 unique values corresponding to each question as being (1) 'No, I do not have any difficulty'; (2) 'I have difficulty but can still do it'; (3) 'Yes, I have difficulty and need help'; (4) 'I cannot do it'. Our measure of BADLs/IADLs is generated by summing up the responses to corresponding 15 questions/5 questions, which ranges from 15-60/5-20.[16] Smaller values indicate better functioning.[17]

In Table 2.9 we present the mean value of the two ADLs by age, residence and gender. BADLs score averages 17.9 and IADLs score averages 6.0. There are no benchmarks to determine the magnitude of these figures relative to diagnostic criteria. However, the average BADLs score is just above the possible minimum score by 3 units, and the average of IADLs score is above its minimum by 2 units, suggesting that, these scales do not vary much within the possible range. In other words, the majority of respondents do not report having much difficulty with these daily activities being asked. For example, in rural areas, the average score of BADLs is 22 among females aged 70+. Although it is the highest among all the age-gender groups, it implies that these respondents have difficulties in doing at most 7 out of the 15 BADLs, but still can do them. Similarly, the average IADLs score is 8.7 among them, indicating that they have difficulties in doing at most 3 out of 5 IADLs difficult, but still can do them. Despite this, these ordinal scores show us older respondents are more likely to have difficulties in performing both BADLs and IADLs and physical functioning is better among respondents in urban areas than those in rural areas. In addition, males on average perform better than females.

Mental health

We use three measures to measure the mental health of the Chinese elderly. Two measure cognitive skills and one measures depression. Following Hu et al. (2012), we define episodic memory as the average of immediate and delayed word recalls of a list

[16] There are mainly two ways of constructing ADLs measure, the first one is a composite index by aggregating the ordinal response score (1-4) for each ADL and the second is a variable counting the number of ADLs that respondents 'had difficulty' or 'could not do it'. We adopted the former method because the count measure not necessarily take full use of the response information in the questionnaire. A criticism towards count measure of ADLs can be found in Sims et al. (2008).

[17] We also use Cronbach's alpha test to assess the reliability of the summative rating scale composed of the 20 items. The internal reliability coefficient is found to be high, above 0.93.

Table 2.9: The Average Score of ADLs by Age, Residence and Gender

Age Group	Rural area		Urban area		Total
	Female	Male	Female	Male	
Basic ADLs					
Under 50	17.37	16.31	16.58	16.08	16.61
50-59	18.65	17.15	17.22	16.29	17.33
60-69	20.00	18.31	18.60	17.14	18.52
70+	22.00	20.29	20.50	18.91	20.36
Total	19.09	17.79	17.83	16.86	17.90
Instrumental ADLs					
Under 50	5.42	5.25	5.21	5.15	5.26
50-59	5.83	5.56	5.44	5.31	5.54
60-69	6.35	5.85	5.77	5.67	5.92
70+	8.72	7.30	7.72	7.28	7.77
Total	6.37	5.88	5.86	5.72	5.97

Note: Smaller values indicate better functioning status.

of 10 words. Respondents are read a list of 10 simple nouns and are then asked to immediately repeat as many of these words as they can in any order. After a five-minute measurement of depression and mental status, they are then asked to recall as many of the original words as possible (McArdle et al., 2009). Our second cognitive measure is the mental status questions designed to capture intactness or mental status of individuals. These questions consist of the following items: naming today's date (year, month and day), the day of the week, current season, serial 7 subtraction from 100 (up to five times) and whether the respondent needed any aid such as paper and pencil to complete the number subtraction, and ability to redraw a picture shown to respondents.[18] Answers to these questions are aggregated into a single mental status score that ranges from 0 to 11. For both measures the higher values indicate a better cognition performance.

We show in Table 2.10 the mean value of episodic memory score and mental status score by age, residence and gender. Episodic memory score averages 3.7, meaning a respondent recalls less than 4 out of 10 words. On average, the episodic memory of our respondents deteriorates with age. As shown by the mean value across the 4 age groups in the last column, the number of word recalls averages 4.3 for respondents under 50, 3.6 for those aged 50-59 and drops to 2.8 for those aged 70+. Respondents living in urban areas show a relatively better performance in episodic memory. The average recall score is 3.9 for females, while the counterparts in rural areas recall 3.5 words on average. A similar pattern can be found for mental status scores with a larger gender

[18] These questions are based on some components of the mental status questions of the Telephone Interview of Cognitive Status (TICS) battery established to capture intactness or mental status of individuals (Lei et al., 2012a)

difference. Mental status scores averages 7.3, indicating that respondents are able to get 7 out of 11 mental status questions correct. Older females living in rural areas appear particularly vulnerable to cognitive impairment. Their mental status score is 3.5 for females aged 70+ in rural areas, which is more than 2 points lower than that among their counterparts living in urban areas.

Table 2.10: The Average Score of Episodic Memory and Mental Health by Age, Residence and Gender

Health Status	**Rural area**		**Urban area**		**Total**
	Female	**Male**	**Female**	**Male**	
Episodic memory					
Under 50	3.98	4.20	4.51	4.43	4.27
50-59	3.43	3.73	4.07	3.93	3.79
60-69	3.15	3.39	3.74	4.03	3.56
70+	2.35	2.59	2.83	3.35	2.80
Total	3.35	3.53	3.92	3.95	3.69
Mental status					
Under 50	6.89	8.29	8.66	9.15	8.16
50-59	5.87	7.76	8.09	8.73	7.57
60-69	5.18	7.63	7.63	8.84	7.26
70+	3.47	5.83	5.51	7.66	5.60
Total	5.55	7.47	7.69	8.63	7.27

Notes: Individual weights with household and individual non-response adjustment are applied. Higher values indicate better health.

Our measure of depression is derived from the 10-item version of the Centre for Epidemiologic Studies Depression Scale (CES-D). The test includes questions on negative feelings (i.e. being bothered by small things, feeling hard to concentrate, feeling depressed, feeling an effort in doing everything, feeling lonely or sad and feeling fearful), on positive thoughts (i.e. being hopeful about the future and feeling happy) and on somatic activity (i.e. suffering from a restless sleep). Each of the 10 items is measured on a four point scale summing up to a total score of 30, where 0 = 'rarely or none of the time', 1 = 'some of the time', 2 = 'a moderate amount of time' and 3 = 'most or all of the time'. Higher scores indicate higher depressive symptoms. A cut-off score of 10 is used to determine clinically significant depressive symptoms (Andresen et al., 1994).

In Table 2.11, we present the proportion of respondent having significant depressive symptoms for each age group and compare between females and males in rural and urban areas. On average, 34 percent of our sample are defined as having depressive symptoms. We find that on average the older respondents have a higher risk of experiencing depressive symptoms. The proportion of respondents having depressive symptoms is low among those below 60 (29 percent among those under 50 and 32 percent among those aged 50-59) but increases to 40 percent among those aged 60+. Within each age cohort, females have a greater risk of being depressed compared to males in both rural and urban areas. For example, in rural areas, 48 percent of females are identified with depressive symptoms, compared to 34 percent among males. Although the proportion of respondents having depression is lower in urban than rural areas, the gender difference is similar to that in rural areas (32.6 percent vs 21.6 percent).

Table 2.11: The Proportion of Having Depressive Symptoms by Age, Residence and Gender (%)

Age group	Rural area		Urban area		Total
	Female	Male	Female	Male	
Under 50	40.60	26.82	26.14	16.56	28.70
50-59	47.39	31.35	27.89	20.75	32.22
60-69	52.73	38.00	42.50	24.15	39.74
70+	58.53	40.38	39.21	24.93	40.59
Total	48.70	34.05	32.63	21.58	34.77

Note: Individual weights with household and individual non-response adjustment are applied.

2.3 Summary

In this chapter, we review the transition of the health care system in China before and during the economic reform and provide an overview of China's contemporary health care system since the outbreak of SARS in 2003. The economic reform has propelled China's economic boom in the past three decades but the social security network is still far lagging behind. In light of the limited financial resources for support at old age, the elderly people in China have traditionally relied on their adult children for old age support. Despite this, rapid urbanization characterised by large-scale internal migration is beginning to change traditional patterns of living arrangements and forms of support. Maintaining the well-being of the elderly in China has become even more challenging due to sharp declines in fertility which means that many parents have fewer children to support them in old age. As a result, elderly people are especially vulnerable to falling into financial difficulty due to chronic diseases.

Beyond the rural-urban gap in health insurance coverage, the evidence based on the CHARLS 2011 survey data also highlights significant disparities in health status across regions. For example, the rural elderly are more likely to self-report having a poor health than their urban counterparts. They are also less certain about their survival probability over the next 10 to 15 years. Large differences also arise in terms of the prevalence of chronic diseases across gender and region. The rural elderly are also more likely to experience episodes of depression and their cognitive health is also inferior to their urban counterparts. In addition, the health deterioration with age is also striking. In the next chapter, we start to look at the rising epidemic of chronic diseases and to what extent these diseases affect different dimensions of the health of the elderly in China.

CHAPTER 3

The Health Impacts of Non-communicable Diseases in China

3.1 Introduction

Non-communicable diseases (NCDs) are the leading global cause of death. In 2008, 63 percent of all deaths were due to NCDs - chiefly cardiovascular diseases, cancer, chronic respiratory diseases and diabetes (WHO, 2011a). This is particularly true in China where NCDs represent the country's main health threat (Wang et al., 2011). NCDs affect not only physical health also subjective well-being. In 2010, 54 percent of total disability adjusted life years (DALYs) world wide were from non-communicable diseases, surpassing that of communicable, maternal, neonatal and nutritional disorders (35 percent) and injuries (10 percent) (Murray et al., 2013). This is particularly pertinent to China. China has been experiencing a critical stage of insurance coverage for diseases that might cause substantial burden on patients since 2011. Given the fragmented health insurance schemes and provincial discretion in funding priority, it is informational for the clinicians and policy makers to prioritize their limited funding allocation towards diseases that could be most cost-effective (Wells et al., 1989). This effectiveness could not be justified without the knowledge of the impacts of NCDs on the multi-dimensions of the health of the targeted group.

Over the years a large literature has developed investigating the effect NCDs have on health related quality of life.[19] Health-related quality of life is often viewed as a

[19] In health care, health-related quality of life is an assessment of how the individual's well-being may

multidimensional concept that includes physical, psychological, and social functioning (WHO, 1948).

Ekman et al. (2002), for example, using a group of elderly patients in the US (on average 81 years old) with moderate to severe chronic health failure find that these patients had lower levels of health-related Quality of Life scores compared with a group of healthy sex- and age-matched controls. Husted et al. (2001) compare health-related quality of life between two groups of patients experiencing two different arthritis and find higher levels of vitality among patients with psoriatic arthritis (PsA) than patients with rheumatoid arthritis (RA). However, patients with PsA also reported more role limitations due to emotional problems and more bodily pain than patients with RA. Stewart et al. (1989) using data for the US find that for eight out of nine common chronic medical conditions, individuals with the condition experience worse physical, role (the extent to which health interferes with usual daily activities), and social functioning; mental health; health perceptions; and/or bodily pain compared to those with no chronic conditions. Using a list of 25 health problems (e.g. asthma, severe heart disease, chronic back pain, arthrosis of knees, hips or hands and etc), Wensing et al. (2001) investigates the relationship between functional status and health problems in primary care patients. He finds patients with hypertension, diabetes mellitus or cancer did not differ from patients without these conditions on more than one dimension of functional status while General health and physical dimensions of functional status were better predicted by health problems than mental dimensions of functional status.

A common finding of many of these studies is that NCDs have a negative effect on most aspects of physical functioning. In contrast, subjective well-being, another important aspect of health-related quality of life, tends to be affected by only a few chronic medical conditions (Cassileth et al., 1984; Kempen et al., 1997). This may arise because patients have a surprising ability to adapt to discomfort and illness (Cutler et al., 1997; Groot, 2000).[20]

be affected over time by a disease, disability, or disorder. A more detailed discussions about general health status and quality of life can be found in (Bowling, 2001, Chapter 10). 'Quality of life' has a wide range of contexts, including the fields of international development, healthcare, politics and employment, as such we avoid using 'quality of life' alone in this thesis.

[20] In other words, when individuals are unable to change their circumstances (here the symptoms of a serious disease), the subjective meaning of those circumstances is adapted (Heyink, 1993). An alternative explanation might be that the outcome measures themselves suffer from reference bias (Cutler et al., 1997). In a sense, adaptation may be a specific form of changes in the scale of reference, so empirically it may not be possible to distinguish between adaptation and changes in the scale (Bowling, 2001).

In addition, in most of these studies the health outcome measures used are rarely generic, and instead multiple measures are often chosen that tend to be disease or domain-specific. This might be due to the fact that health or health-related quality of life is a multi-dimensional concept so that the condition of a specific disease might be more sensitive to a specific domain of measurement and a health status measure alone may fail to detect the effects of the disease-type in question. However, when the aim of many studies are to make comparisons as to the effect of different diseases and conditions formulating a generic measure should be considered a priority (Bowling, 2001).

So there seems to be a conflict. On the one hand, researchers have to select multiple health measures to fully capture an individual's health status, which is a multidimensional concept. On the other hand, the effect NCDs have on health often varies with different health outcome measures, making it difficult to draw meaningful conclusions from these measures, especially when used to inform the policy makers to target specific diseases in health care funding.

Another weakness of existing studies arises from the empirical comparison of a specific disease between different health measures. Researchers often report the relative effects of a specific NCD across a range of health outcome measures (Ekman et al., 2002; Husted et al., 2001; Stewart et al., 1989; Wensing et al., 2001). However, conclusions tend to be solely based on the magnitude of coefficients across a series of regressions that are estimated independently without any consideration of any intrinsic correlations. If these correlations are not taken into account when calculating the variance and covariance matrix of the errors, any cross-equation hypotheses will be invalid.

We address these issues using the CHARLS 2011 national wave. CHARLS asks detailed questions on disease prevalence together with detailed questions about the respondent's health status and functioning. Based on the correlation matrix of eight health outcome variables, we use factor analysis to formulate three underlying measures of health - 'subjective health', 'physical health' and 'cognitive health'. This technique allows us to obtain a smaller number of generic measures to examine the disease effects.[21] It also addresses the measurement error problem that is present in almost all

[21] Although this is not the first study to apply structural equation methods to derive health-related quality of life measures, this study differs with previous studies with regard to the data applied and the

self-reported variables measuring health since the common factors are supposed to only account for the communal component of the correlations and by assumption not correlated with a unique factor which might capture the inherent (random) measurement error(Kim and Mueller, 1978; Brown, 2009). Here systematic errors (i.e. errors that are correlated with some observed individual characteristics) in self-reported variables is not an issue. Respondents are asked for subjective judgements in self-reported questions, and these judgements may not be entirely comparable across respondents. Although this subjectivity might be viewed as errors when the goal is to construct health stock of an individual in objective sense our goal is to model this subjectivity rather than to eliminate it.[22] This subjective assessment of health could also matter for individual behaviour and is a subject of interest in its own right (Banks and Smith, 2012). Factor analysis allows us to explicitly model the underlying subjective health factor as well as objective health factor and to extract them from these self-reported variables. It is not surprising that subjective assessment on health (e.g. expectation of one's own health) captures individual differences (including diseases) or even differences in group-specific norms, which we are interested in exploring in our second stage - regression analysis.

We then use these three factor scales as outcome variables to measure the effect different NCDs have on health, accounting for any correlation between the three factors by estimating a seemingly unrelated regression model. In doing so, we find that our explanatory variables have different impacts on our three aspects of health. NCDs alone are able to explain more than 9 percent of the variance in 'subjective health', 12 percent in 'physical health' compared to just 2 percent of the variance in 'cognitive health'. In contrast, the variations in the socioeconomic characteristics especially education appear to have greater explanatory ability in explaining 'cognitive health' variation. Applying a system equation approach and conducting a series of cross-equation tests comparing the disease effects between subjective and physical health, we find that disease effects do not differ between the two health factors except for respiratory diseases. In addition, we find that depression impairs subjective and physical health to a

assumptions imposed (Andrews and Crandall, 1976; McDowell and Newell, 2006). The data we apply is not of a multimethod-multitrait (MTMM) design, an approach to assessing the construct validity of a set of measures in a study (Andrews and Crandall, 1976), as such, we are not able to replicate exact their methodology. Nonetheless, our paper is able to derive valid estimates in a similar manner.

[22] Bound (1991), for example, chooses a strategy that constructs a latent health stock or index of health for each individual as a function of personal characteristics and health indicators. This constructed variable is then used to instrument self-reported health in order to explore the relationship between time variations in health and changes in the outcome variable of interest.

greater degree than any other chronic physical diseases. Investigating this further we find that comorbid depression with chronic physical illnesses significantly worsens the physical health of the elderly, and depression and chronic physical illnesses are often found to have separated and additive effects.

The remainder of this chapter is organised as follows. In section 2 we describe the sample used in this chapter, and provide some descriptive statistics. Section 3 provides our main empirical results while section 4 concludes.

3.2 Data and Descriptive Analysis

3.2.1 China Health and Retirement Longitudinal Study (CHARLS)

This chapter uses data from the 2011 baseline national wave of CHARLS, which we described in detail in Chapter 2. As the first national survey, the 2011 survey enables us to collect sufficient observations on the specific chronic conditions we are interested in. Two sample exclusion criteria are executed sequentially in order to construct the samples for factor analysis and regression analysis. In constructing the sample for factor analysis, we exclude observations with missing information in at least one of the eight outcome variables we discussed below. This leaves us with 11,477 observations. The non-response rate of our 8 outcome variables ranges from 1 percent to 20 percent. Although it might pose potential non-response selection, we do not find systematic difference in our analysis sample from the larger full survey sample (17,705).

In order to construct the sample for regression analysis, we further exclude the observations with missing information in at least one of the independent variables. The two exclusion criteria leave us with a final sample comprising of 10,307 individuals. Using the larger sample to conduct factor analysis allows us to conduct the tests in factor analysis the favour large sample. In addition, using a larger sample might reduce the potential non-response bias if otherwise excluding more observations based on their demographic and socioeconomic characteristics.[23]

In addition to the health measures we introduced in Chapter 2, we measure the following three aspects of health and well-being of our respondents:

[23] We also estimate the results based on factor scores extracted from the sample for regression analysis and find the main results are similar.

In chapter 3, however, alternative health measures are tentatively used in an analytical framework in order to explore the extent to which the older Chinese people respond to the diseases in different dimensions of their health and subjective well-being. These alternative outcomes are chosen to represent the different dimension of health of these individuals. Summary of these health and life satisfaction measures is reported for that specific sample under analysis.

1. Physical functioning, which we measure using two activities of daily living (ADLs) indexes. As introduced in Chapter 2, the ADLs variable is a composite index of the level of difficulty that the respondent has in performing a number of fairly normal and routine day-to-day activities or tasks. For the convenience of comparing with other measures, 4 unique values corresponding to each question are re-assigned where 0 = 'I cannot do it', 1 = 'Yes, I have difficulty and need help', 2 = 'I have difficulty and need help', 3 = 'No, I do not have any difficulty'. As a result the basic ADL scale ranges from 0 to 45 for basic ADLs, and the instrumental ADL scale ranges from 0 to 15. Basic ADLs consist of self-care tasks while instrumental ADLs are not necessary for fundamental functioning, but they let an individual live independently.

2. Subjective health and general well-being, which we measure in four ways. Firstly, we use self-reported health status where respondents are asked to rate their general health as being: (1) 'very poor', (2) 'poor', (3) 'fair', (4) 'good' (4), or (5) 'very good'. Secondly, we use self-reported survival probabilities where respondents are asked to evaluate their probability of surviving to a certain age on a five-point scale ranging from (1) 'almost impossible' to (5) 'almost certain'. Thirdly, we use life satisfaction where respondents are asked to evaluate their overall life satisfaction as being: (1) 'not at all', (2) 'not very', (3) 'somewhat', (4) 'very', or (5) 'completely'.[24] Life satisfaction is not a health status measure, however we include it because of its subjectivity, which is often correlated with the subjective domains of health-related quality of life (Yildirim et al., 2013). Lastly, we use self-reported intensity of body pain where respondents are asked to rate the intensity of pain in four levels as being (1) 'no pain', (2) 'mild', (3) 'moderate' or (4) 'severe'.

3. Cognitive health, which we measure in two ways - episodic memory and mental status. Following Hu et al. (2012), episodic memory is constructed as the average of immediate and delayed recall scores from a list of 10 words while mental status

[24] The actual question asked in CHARLS is "Please think about your life-as-a-whole. How satisfied are you with it? Are you completely satisfied, very satisfied, somewhat satisfied, not very satisfied, or not at all satisfied?"

is the aggregate score to 11 mental status questions which are based on a standard test of cognitive functioning.

For ease of interpretation all our health outcome measures are constructed such that a higher score indicates better health. A more detailed explanation of the health outcome measures used in this analysis is given in Table B.1 in the Appendix.

CHARLS also asks detailed questions on disease history including the nature and duration of 13 medical conditions. Specifically, the interviewee is asked whether s/he has been diagnosed with any one of 13 medical conditions. The survey also accounts for the fact that respondents may know that they have certain diseases without being formally diagnosed. To this end, respondents are asked whether they think they have: hypertension; chronic lung diseases; stomach/other digestive disease; emotional; nervous or psychiatric problems; memory-related diseases; and arthritis or rheumatism.

In what follows we focus on five medical conditions, namely, cardiovascular problems (including hypertension, dyslipidaemia, heart problems and stroke), diabetes, respiratory disease (including chronic lung diseases), arthritis and depression. The first four conditions are chronic physical diseases. Cardiovascular disease, diabetes, respiratory disease encompass the main types of NCDs in China, and are largely caused by four shared behavioural risk factors (WHO, 2011b).[25] We look at arthritis as it is the most common cause of severe long-term pain and physical disability and it is predominantly a disease of the elderly worldwide (Wooldridge, 2010). We use the C-ESD 10-item index to classify our individuals with depression.[26] We include depression as a single disease category in addition to the above four chronic physical diseases in our analysis.

We look at not only the four major NCDs mentioned above, but also depression, which is a major contributor to the burden of disease worldwide (Üstün et al., 2004). Depression is an important global public-health issue, because of its relatively high lifetime

[25] The four main NCDs in China are namely cardiovascular diseases, diabetes, chronic obstructive pulmonary diseases, and lung cancer (Wang et al., 2011). We do not consider cancer in this study because we do not have enough sample size with respondents self-reporting having cancer.

[26] Although emotional related illness are also included in the 13 disease check list, the prevalence rate for this self-reported measure is too low (less than 2 percent). According to Phillips et al. (2009), whose sample included 12 percent of the adult population in China during 2001-2005, the prevalence of any mental disorders in China was 17.5 percent. The prevalence of mood and anxiety disorders was 6.1 and 5.6 percent, respectively. Thus we think it might be underreported and use this CES-D 10-item version index.

prevalence ranging from 2 percent to 15 percent and its association with substantial disability (Jamison et al., 2006). Despite this, depression, like other mental disorders, is often considered not as important as other chronic physical health conditions in terms of its effect on overall health (Wang, 2001; Herrman et al., 2002). This could be one of the underlying reasons behind the lack of parity between mental and physical disorders in terms of access to health care (Moussavi et al., 2007). Figures from the WHO suggests that depression will represent 25 percent of the total disease burden in China by 2020, much higher than the world average of 11 percent (Wong et al., 2013). Moreover, although the treatment of depression is often not covered by health insurance schemes it can nevertheless result in serious health and economic consequences. For example, it could recur if left untreated and hence over time be associated with increasing disability (Andrews, 2001).[27] In addition, comorbidity of depression with physical health conditions have become common but is less examined (Moussavi et al., 2007).

3.2.2 Descriptive Statistics

Table 3.1 outlines some simple descriptive statistics of the main variables used in this chapter, disaggregated by gender (female/male). We report mean responses and then depending on the nature of the question either the standard deviations, or for the categorical variables the number reporting the highlighted response.

Overall the sample is evenly split between females and males. Our average respondent is nearly 58, married, with a rural hukou and lives with at least one other household member (the average household size is 3.6 and over half of respondents live with at least one child). The majority of respondents live in the rural areas (60 percent), have at least an elementary school education (around 78 percent) and are doing agricultural work (47 percent). Their annual household expenditure per capita is 8,046 RMB on average.

Turning to our measures of health outcome we find that on average, respondents have a BADLs composite score of 42.75, which is very close to the maximum value of 45, implying that most of our respondents do not have any difficulty in performing the listed daily activities or tasks.[28] The average self-reported health status (3.08) and life

[27] It is one of the insufficiencies in previous researches that only non-psychiatric disorders were selected as the representative NCDs, and it has previously been shown that psychiatric diseases not only lead to depression but also have major effects on physical functioning health (Wells et al., 1989).

[28] Lee et al. (2011) using Korean Longitudinal Study of Aging (KLoSA, the HRS counterpart in Korean)

Table 3.1: Summary Statistics of Variables

Sample (Number of observations)	All (10,307)		Females (5,065)		Males (5,242)	
Variables	**Mean**	**S.D. / n=x**	**Mean**	**S.D. / n=x**	**Mean**	**S.D. / n=x**
Health outcomes						
BADLs (0-45)	42.749	2.861	42.361	2.970	43.124	2.699
IADLs (0-15)	14.636	1.053	14.584	1.089	14.686	1.014
Self-reported health (1-5)	3.078	0.890	3.022	0.877	3.133	0.898
Survival probability (1-5)	3.257	1.170	3.210	1.149	3.302	1.190
Life satisfaction (1-5)	3.088	0.698	3.084	0.720	3.092	0.676
Intensity of pain (1-4)	3.388	1.035	3.284	1.082	3.487	0.977
Episodic memory (0-10)	3.743	1.688	3.735	1.744	3.750	1.631
Mental status (0-11)	7.668	2.933	7.005	3.084	8.310	2.624
Chronic disease conditions						
Cardiovascular disease	0.331	0.471	0.350	0.477	0.313	0.464
Diabetes	0.055	0.229	0.060	0.238	0.050	0.219
Respiratory disease	0.106	0.308	0.085	0.279	0.126	0.332
Arthritis	0.311	0.463	0.344	0.475	0.280	0.449
Other chronic physical disease	0.288	0.453	0.291	0.454	0.285	0.451
Has any chronic physical disease	0.654	0.476	0.661	0.473	0.646	0.478
Depression	0.333	0.471	0.388	0.487	0.280	0.449
Demographic characteristics						
Age	57.918	9.299	56.852	9.341	58.947	9.142
Lives with spouse/partner	0.897	0.304	0.872	0.334	0.922	0.269
Urban area	0.409	0.492	0.421	0.494	0.398	0.489
Urban Hukou	0.242	0.428	0.231	0.422	0.253	0.435
Disability	0.143	0.350	0.125	0.331	0.160	0.367
Household size	3.606	1.805	3.615	1.788	3.597	1.821
Living arrangements						
At least one child lives at home	0.582	n=6,003	0.601	n=3,044	0.564	n=2,959
Closest child lives in the same province	0.354	n=3,650	0.342	n=1,734	0.366	n=1,916
Closest child lives in another province/country	0.044	n=451	0.042	n=213	0.045	n=238
No children	0.020	n=203	0.015	n=74	0.025	n=129
Socioeconomic status						
Education						
Illiterate	0.222	n=2,291	0.343	n=1,737	0.106	n=554
Elementary	0.397	n=4,091	0.362	n=1,833	0.431	n=2,258
High school	0.321	n=3,305	0.255	n=1,293	0.384	n=2,012
Vocational or above	0.060	n=620	0.040	n=202	0.080	n=418
Employment status						
Employed or self-employed	0.255	n=2,625	0.180	n=914	0.326	n=1,711
Subsistence farmer	0.470	n=4,844	0.493	n=2,497	0.448	n=2,347
Currently not working	0.168	n=1,733	0.219	n=1,108	0.119	n=625
Retired	0.107	n=1,105	0.108	n=546	0.107	n=559
Has insurance	0.940	0.237	0.936	0.245	0.944	0.229
Household expenditure per capita last year (RMB)	8046	12581	7971	12085	8118	13042

Note: Number in parentheses for the eight health outcome variables is the range for each variable.

satisfaction (3.07) is around the middle of the scale, while the average survival probability lies above the middle of the scale by 0.26 points. The average of intensity of pain is 3.40, meaning that the extent of feeling pain is between 'no pain' and 'light pain' for the entire sample. The average number of words recalled by our respondents is 3.74 out of 10 words (this is the average of an immediate word recall and a delayed recall) and the average mental status score is 7.67. Comparing the last two cognitive measures with a similar sample from the United States we find that our respondents have a slightly inferior performance than their US counterparts.[29]

In line with figures from the World Bank (Wang et al., 2011), we find that the most prevalent chronic physical disease amongst our sample is cardiovascular disease (33.1 percent), followed by arthritis (31.1 percent), respiratory disease (10.6 percent) and diabetes (5.5 percent). Overall, the prevalence of chronic physical diseases is high amongst our sample, with around 65.4 percent reporting that they have at least one NCD. Around one-third of the sample are diagnosed with episodes of depressive symptoms using the C-ESD 10-item index.[30]

Disaggregating our variables by gender we find that clear differences emerge between females and males in terms of our demographic and socioeconomic variables. We find that female respondents are on average younger and less likely to have a disability.[31] Although female respondents on average live in a larger household, they are less likely to live with their spouse/partner but are more likely to live with their children, which may arise because women are more likely to outlive men (Austad, 2006). In contrast, males are on average better educated, are more likely to be employed or self-employed while those whose main job is that of subsistence farmer is greater among females. In addition, the yearly household expenditure per capita is much higher for male respondents than for female respondents.

also shows that limitations to ADLs are very rare, affecting just a small proportion (2 percent) of the study sample.

[29] In McArdle et al. (2009), the variable of 'word recall' was 4.7 for males and 5.3 for females and the 'mental status' variable is 8.9 for both males and females. These substantive cross-country difference might be hard to define. Nonetheless, these summary statistics are consistent with the ones we find in the 2008 pilot survey, at least implying the differences are not due to sampling errors across survey years.

[30] We also classify the few observations self-reporting having emotional, nervous or psychiatric problems as having depression if their CES-D 10 item score is below the cut-off and it gives us similar results.

[31] Disabilities are defined as having a physical disability, brain damage/mental retardation, vision problems, hearing problems or speech impediment.

Again turning to our main health variables we find that male respondents appear to be in better health than females across our eight measures of health. For NCD prevalence, female respondents are more likely to be diagnosed with cardiovascular diseases, diabetes, arthritis and depression but are less likely than males to be diagnosed with respiratory diseases. So overall, we find evidence that there exists a substantial disparity in health between females and males and different prevalences across our chronic diseases.

3.2.3 Prevalence of NCDs and Comorbid Depression

In order to calculate the prevalence rate of depression comorbid with other chronic physical diseases, we construct a variable indicating seven types of chronic physical disease status for the respondent by taking into account the number and type of the four chronic physical diseases: (1) No chronic physical diseases; (2) cardiovascular disease alone; (3) diabetes alone; (4) respiratory disease alone; (5) arthritis alone; (6) other chronic physical disease alone; (7) two or more chronic physical conditions. This construction exclusively distinguish the seven disease statuses, allowing us to compare the health effects between specific disease types as well as comorbidities.[32] The prevalence of depression for each chronic physical disease status is shown in Table 3.2. We also present the percent of respondents with each chronic disease status.

Table 3.2: Prevalence of Seven Physical Chronic Disease States and Comorbid Depression

Chronic Disease Status	**Frequency**	**Percent (%)**	**Comorbid Depression (%)**
No chronic physical diseases	3,593	34.86	22.04
Cardiovascular disease alone	1,276	12.38	25.39
Diabetes alone	91	0.88	25.27
Respiratory disease alone	256	2.48	35.16
Arthritis alone	990	9.61	37.88
Other chronic physical disease alone	886	8.60	32.39
Two or more chronic physical diseases	3,215	31.19	47.93
Total	10,307	100.00	33.30

More than one-third of our respondents have no chronic physical diseases. The prevalence for any one condition alone does not exceed 10 percent except for cardiovascular disease (12.4 percent) followed by arthritis (9.6 percent) and respiratory diseases (2.5 percent). Less than 1 percent of our respondents have only diabetes without other

[32] We only include the comorbidity of two because in our sample less than 7 percent have more than 2 chronic physical diseases based on the 5 NCD types classification.

chronic physical conditions. The number of respondents with more than one chronic physical condition is also high, taking up around one-third of the entire sample.

Next we look at the prevalence of depression in respondents for each disease status we discussed above. We find a significant percentage of respondents with any one of the chronic physical disease status also have depression. For respondents with arthritis, 37.9 percent also have depression. Similarly, 35.2 percent also have depression for those with arthritis. For our respondents who have two or more chronic physical diseases, nearly half (47.9 percent) also have depression in addition to their existing comorbid conditions. We also conduct a series of t-tests to compare the prevalence of depression comorbid with any one chronic physical disease, with the prevalence of depression without any chronic physical diseases and find that the null hypothesis of equal proportion are all rejected at the 1 percent level except for diabetes.

3.3 Model Specifications and Results

3.3.1 Factor Analysis

Given the existing literature and its limitations in choosing the appropriate health outcome measures, our first task is to derive a smaller number of health measures in a more generic sense without losing the representativeness of the multiple health measures, which have been widely used in the literature. Overall our eight health outcome measures are designed to comprehensively measure an individual's health status and are similar to those used in previous studies where Medical Outcomes Study (MOS) is used (Kempen et al., 1997; Stewart et al., 1989; Wells et al., 1989). If we are merely interested in measuring the health status of an individual, the more diverse the variables, the more accurately we are able to compare the health status of individuals in a specific domain as long as their validities are satisfied (E. Ware Jr, 1987). In our study, the validities of the measures are satisfied as these measures have been accepted widely within each health dimension and collected via a standard questionnaire design. However, a generic measure is often more useful and straightforward to compare the health effects of different diseases (Bowling, 2001). Factor analysis is an approach to transform a multiple concept into a more parsimonious generic sense. It is natural to assume that underlying these health variables, there must be some more inherent factor(s) that are able to explain the correlations among these observed health variables. We use a factor analysis approach to extract the underlying health status that is able to explain the correlations of these observed health outcome variables and use the constructed factor scales in our later analysis to identify the health effects of NCDs.

Factor analysis, in the sense of exploratory factor analysis, is a means of exploring underlying dimensions so that a smaller number of hypothetical factors can account for the correlations among a set of observed variables.[33] In a factor model, each of these variables is expressed as a linear combination of the hypothetical common factors and one unique factor. It is the introduction of a unique factor (i.e. an error component) that distinguishes factor analysis from principal components analysis (PCA). Both techniques can be used for data reduction purposes, but factor analysis has the extra application of admitting meaningful interpretations by rotating the relevant factor loadings.[34] More than exploring underlying dimensions, factor analysis can also be used to construct the factor scales for each observation in the sample. Further details on the factor models, factor scales and its construction are given in the Appendix B.

We begin by examining the degree of correlation between our eight health measures (Table 3.3). Self-reported health and survival probability health measures are categorical variables with only 5 values, where the Pearson's moment correlation is inappropriate, as such we used polychoric correlation method in calculating the relevant correlation coefficients. For the other variables, which have more than 10 values, ordinary Pearson's moment correlation method applies. In doing so we find two sets of clusters; the correlations among the first six variables and among the last two variables are in general higher than the correlations between them. For the first set of clusters, however, the correlation between the first two ADLs variables is higher than their correlation with other subjective health measures. Intensity of pain also has a high correlation with BADLs which might arise because it could reflect the degree of difficulty that an individual has in performing some of the activities or tasks included in the ADLs despite being a self-reported measure in the first place. It is, thus, possible to extract three factors.

To fit a factor model as illustrated in Appendix B, we apply maximum likelihood method and obtain our initial solution of three factors. We use the information criteria

[33] As opposed to exploratory factor analysis, confirmatory factor analysis is used as a means of confirming a certain hypothesis as far as the underlying dimension is concerned. In most applications, exploratory factor analysis is used before moving to confirmatory factor analysis. Sometimes, the distinction between the two methods is blurred with the prior examination of the researchers.

[34] Rotation is a process of adjusting the initial factor loadings so that a simpler factor structure can be obtained without changing the degree of fit between the data (correlation matrix) and the factor structure.

Table 3.3: Polychoric Correlation Matrix for Eight Health Outcome Measurements

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) BADLs	1.000							
(2) IADLs	0.515	1.000						
(3) Self-reported health	0.471	0.343	1.000					
(4) Survival probability	0.329	0.254	0.397	1.000				
(5) Life satisfaction	0.161	0.134	0.291	0.198	1.000			
(6) Intensity of pain	0.464	0.311	0.509	0.316	0.211	1.000		
(7) Episodic memory	0.206	0.166	0.146	0.168	0.059	0.142	1.000	
(8) Mental status	0.281	0.261	0.197	0.222	0.045	0.234	0.383	1.000

Note: Sample size: n = 11,477.

AIC and BIC (chi-square test) associated with the maximum likelihood method to determine the number of initial factors retained.[35] As an initial solution, the three factors are orthogonal to each other and the associated factor loadings are not easy to interpret except that the first factor captures the greatest variance in the eight variables.[36] We later transform this initial solution using an oblique rotation with promax power equal to 2 and a simple structure is obtained (Table 3.4).[37]

Consistent with the clustering we observe in the correlation matrix in Table 3.3, self-reported health, survival probability, life satisfaction and intensity of pain have very high loadings in the first factor, ranging from 0.40-0.71, but low loadings in the other two factors. The first two ADLs variables have high loadings in the second factor and low loadings in the other two factors. In contrast, mental status and episodic memory have low loadings in the first and second factors but very high loadings in the third factor. As such, we are able to interpret the first and second factors as describing an individual's subjective and physical health status, and the third factor as describing an individual's cognitive health. Due to the correlation between the three rotated factors, the proportion of variance explained by the three factors do not sum to one.[38]

[35] Also see Appendix B for the reason we use maximum likelihood method and how the number of factors is determined.

[36] The two characteristics about initial solution are the two typical restrictions imposed on factor model in order to make the initial solution definite (see the details in the Appendix B).

[37] Promax oblique rotation is a way of obtaining an oblique solution by using some functions of the orthogonal solution as the target matrix. It is especially applicable when fitting a specific hypothesized factor structure. Larger promax powers (no greater than 4) simplify the loadings but at the cost of additional correlation between factors. The power of 2 is a common choice even though the solution with a promax power equal to 3 does not differ much from the one with power 2.

[38] Also notice that factor 3 has an eigenvalue small than one, which should not be retained under Kaiser's criterion. However, it is well noted that the methods of determining number of factors may not agree.

Table 3.4: Factor Analysis of Health Measurements: Three-Factor Extraction after Oblique Rotation

Variables	Initial factors			Rotated factors		
	Factor 1	**Factor 2**	**Factor 3**	**Factor 1**	**Factor 2**	**Factor 3**
BADLs	1.00	0.00	0.00	0.03	**0.99**	-0.02
IADLs	**0.51**	0.19	0.07	0.17	**0.38**	0.12
Self-reported health	**0.47**	0.33	**0.56**	**0.77**	0.08	-0.03
Survival probability	0.33	0.30	0.26	**0.42**	0.07	0.11
Life satisfaction	0.16	0.14	0.31	**0.40**	-0.03	-0.06
Intensity of pain	**0.46**	0.28	0.34	**0.51**	0.18	0.05
Episodic memory	0.21	**0.39**	-0.14	0.03	0.04	**0.43**
Mental status	0.28	**0.73**	-0.32	-0.02	-0.01	**0.85**
Eigenvalues	1.96	1.02	0.72	1.96	1.02	0.72
Sum of variance	1.96	1.02	0.72	1.93	1.93	1.37
Proportion of variance	0.53	0.28	0.19	0.52	0.52	0.37

Note: (1) Sample size: n=11,477; (2) Loadings >0.38 are bolded. (3) Sum of variance is the sum of the variance of the squared loadings in the columns.

Finally, we construct the factor scales. Even though there are several scaling methods to achieve the best fit between the underlying common factor and the factor scale, in general, each factor scale is constructed as a weighted linear combination of the initial set of the original variables. The weighting method we choose is the Bartlett approach which minimizes the sum of squares between each original variable and the weighted sum of common factors after weighting each variable with the reciprocals of the corresponding variance of the unique factor (Thomson, 1939). This method produces unbiased estimates of the underlying factor by taking into account the sampling variability. The resultant factor scales are standardized with a mean of zero and a variance of one for ease of interpretation.[39]

3.3.2 Estimating Health Effects Using Factor Scales

Next we examine the health effect of the different NCDs using the three factor scales as the outcome variables. Irrespective of the method used, the size of the health effect of a specific NCD always depends on the health outcome variable being studied, so if we want to answer which aspect of health is more responsive to a specific NCD, we need to test a cross-equation hypothesis. In previous studies, researchers standardize and reverse the scorings for any health outcome variable that enters negatively and then

[39] The correlation between subjective and physical health factor is 0.069, the correlation between subjective and cognitive health factor is 0.066, and the correlation between physical and cognitive health is 0.297.

estimate each regression independently in order to make the cross-equation comparisons plausible (see, for example, Kempen et al., 1997; Stewart et al., 1989), however, the conclusions based on analyses of this type lack validity if they fail to take into account correlations across these outcome variables. We address this limitation by estimating a linear equation system of the form:

$$y_{1i} = \theta_1 \cdot NCD\_status_i + \gamma_1 \cdot dprs_i + \beta_1' \cdot X_i + \varepsilon_{1i} \tag{3.1}$$

$$y_{2i} = \theta_2 \cdot NCD\_status_i + \gamma_2 \cdot dprs_i + \beta_2' \cdot X_i + \varepsilon_{2i} \tag{3.2}$$

$$y_{3i} = \theta_3 \cdot NCD\_status_i + \gamma_3 \cdot dprs_i + \beta_3' \cdot X_i + \varepsilon_{3i} \tag{3.3}$$

where y_{1i}, y_{2i} and y_{3i} are the health factor scales for each observation. NCD_status_i is a vector of six dummy variables indicating the six exclusive physical chronic diseases (i.e. cardiovascular diseases alone, diabetes alone, respiratory diseases alone, arthritis alone, other chronic physical disease alone, and two or more chronic physical diseases) outlined in the previous subsection (Subsection 3.2.3), where the respondents without any chronic physical diseases are used as the reference group. $dprs_i$ is a dummy variable indicating the incidence of depression. X_i is a vector of exogenous covariates including demographic and socioeconomic variables influencing health, and γ_j, θ_j and β_j $(j = 1, 2, 3)$ are coefficient or coefficient vectors to be estimated; ε_{ji} $(j = 1, 2, 3)$ is the corresponding disturbance terms.

Since y_{1i}, y_{2i} and y_{3i} are the constructed health scales which are correlated by design, the error terms in the three equations (i.e. ε_{ji} $(j = 1, 2, 3)$) are also assumed to be correlated even though we have controlled for a set of common regressors. We therefore use the seemingly unrelated regressions (SUR) method to estimate equations (3.1) and (3.2). First proposed by Zellner (1962), the SUR model is used to estimate a system of linear equations with errors that are correlated across equations for a given individual but are uncorrelated across individuals. The SUR equations are usually estimated using feasible generalized least squares (FGLS) with a specific form of the variance-covariance matrix to gain efficiency and traditionally the disturbances are not allowed to be correlated across individuals. However, in the health literature spousal correlation in health status is common (Meyler et al., 2007), and for this reason the disturbances are likely to be correlated within the household. In order to address this issue, we use maximum likelihood estimation to fit the SUR equations, which allows the disturbance to be correlated at the household level but be independent across households, and as such robust clustered standard errors can be obtained. All analyses are coded and done using Stata version 13 and we use a user written code -mysureg- to estimate this maximum likelihood estimator.[40]

Testing and imposing cross-equation constraints are not possible using equation-by-equation OLS but is possible using SUR estimation.[41] Since the factor scales are standardized with the same mean and variance, testing the equality of the corresponding cross-equation coefficients enables us to address whether the same variable has the same effect on any two of the three factors.[42] Specifically, we are interested in testing whether the effects of a specific disease status are the same for any two of the three health dimensions (Equations (3.4) and (3.5)). For completeness we also test whether the effects of the other covariates are the same for the chosen two health dimensions (Equation (3.6)).

$$H_0 : \theta_j = \theta_k \quad (j, k \in (1, 2, 3), j \neq k) \tag{3.4}$$

$$H_0 : \gamma_j = \gamma_k \quad (j, k \in (1, 2, 3), j \neq k) \tag{3.5}$$

$$H_0 : \beta_j = \beta_k \quad (j, k \in (1, 2, 3), j \neq k) \tag{3.6}$$

Results are presented in Table 3.5. For each equation we report coefficients and levels of significance. The p-values of the cross-equation restriction test for any two of the three equations are reported in columns 4 to 6. The Breusch-Pagan test for independent equations shows a p-value of 0.000 in the three estimations, rejecting the null hypothesis that the residuals from the three equations are independent, justifying the need for a system equation approach.[43]

[40] For more technical details, refer to Gould et al. (2006).

[41] Since our three equations have the same set of explanatory variables, we could estimate them using OLS. If each equation in an equation system contains exactly the same set of regressors, the FGLS systems estimator as used in SUR reduces to equation-by-equation OLS. Another case when SUR is in fact equivalent to OLS is when the disturbance terms are uncorrelated across equations (Cameron and Trivedi, 2009).

[42] Our dependent variables are constructed factor scores that is difficult to interpret in its own right, as a result each single estimated coefficient could not be interpreted with natural cardinal meaning. Statistically, each coefficient represent the change in unit of standard deviation of the factor score in response to one unit change in the explanatory variable.

[43] The Breusch and Pagan (1980) χ^2 statistic can be used to test for independent equations, i.e. the disturbance covariance matrix is diagonal.

Table 3.5: The Seemingly Unrelated Regression Models in Predicting Three Health Factors (Maximum Likelihood Estimation)

Variables	(1) Subjective Health		(1) Physical Health		(1) Cognitive Health		(4) (1) vs (2)	(5) (1) vs (3)	(6) (2) vs (3)
Chronic physical disease status (Base: No chronic physical diseases)									
Cardiovascular disease alone	-0.279***	(0.030)	-0.216***	(0.025)	-0.015	(0.026)	0.133	0.000	0.000
Diabetes alone	-0.266***	(0.096)	-0.364***	(0.080)	0.025	(0.069)	0.483	0.009	0.000
Respiratory disease alone	-0.405***	(0.057)	-0.221***	(0.048)	-0.038	(0.051)	0.012	0.000	0.007
Arthritis alone	-0.248***	(0.033)	-0.297***	(0.030)	-0.081***	(0.029)	0.302	0.000	0.000
Other chronic physical disease alone	-0.406***	(0.034)	-0.157***	(0.027)	-0.017	(0.029)	0.000	0.000	0.000
Two or more chronic physical diseases	-0.603***	(0.024)	-0.558***	(0.021)	-0.040**	(0.020)	0.177	0.000	0.000
Depression	-0.524***	(0.021)	-0.523***	(0.021)	-0.238***	(0.018)	0.965	0.000	0.000
Demographic characteristics									
Age/10	0.106***	(0.013)	-0.159***	(0.013)	-0.073***	(0.012)	0.000	0.000	0.000
Male	-0.076***	(0.019)	0.165***	(0.018)	0.142***	(0.017)	0.000	0.000	0.322
Lives with spouse/partner	-0.082**	(0.033)	0.021	(0.035)	0.093***	(0.030)	0.051	0.000	0.087
Urban area	0.114***	(0.025)	0.104***	(0.022)	0.112***	(0.021)	0.781	0.958	0.776
Urban Hukou	-0.025	(0.031)	0.033	(0.026)	0.076***	(0.026)	0.169	0.012	0.218
With disability	-0.040	(0.029)	-0.381***	(0.032)	-0.180***	(0.025)	0.000	0.000	0.000
Household size	-0.022***	(0.007)	0.005	(0.006)	-0.007	(0.006)	0.008	0.138	0.135
Living arrangements (Base: No children)									
At least one child lives at home	0.094	(0.068)	-0.069	(0.061)	-0.015	(0.068)	0.103	0.269	0.537
Closest child lives in the same province	0.112*	(0.068)	-0.104*	(0.061)	0.005	(0.067)	0.029	0.271	0.208
Closest child lives in another province/country	0.025	(0.080)	-0.103	(0.069)	-0.070	(0.075)	0.259	0.399	0.732
Education (Base: Illiterate)									
Elementary	-0.099***	(0.026)	0.137***	(0.026)	0.819***	(0.024)	0.000	0.000	0.000
High school	-0.062**	(0.030)	0.208***	(0.028)	1.131***	(0.027)	0.000	0.000	0.000
Vocational or above	-0.045	(0.046)	0.313***	(0.039)	1.192***	(0.037)	0.000	0.000	0.000

Table 3.5 Continued:

Variables	(1) Subjective Health		(1) Physical Health		(1) Cognitive Health		(4) (1) vs (2)	(5) (1) vs (3)	(6) (2) vs (3)
Main job status (Base: Employed or self-employed)									
Subsistence farmer	-0.191***	(0.025)	-0.041**	(0.020)	-0.140***	(0.021)	0.000	0.127	0.000
Currently not working	-0.197***	(0.032)	-0.330***	(0.031)	-0.081***	(0.027)	0.005	0.007	0.000
Retired	-0.105***	(0.038)	-0.081**	(0.032)	0.042	(0.032)	0.651	0.003	0.005
Has insurance	-0.002	(0.041)	-0.049	(0.034)	0.134***	(0.034)	0.402	0.012	0.000
ln (Household expenditure pc)	-0.127***	(0.042)	0.022	(0.046)	-0.011	(0.051)	0.010	0.063	0.579
ln (Household expenditure pc) (square)	0.009***	(0.003)	-0.001	(0.003)	0.004	(0.003)	0.007	0.163	0.201
Constant	0.551***	(0.212)	1.190***	(0.227)	-0.619**	(0.257)			
Number of observations	10,307		10,307		10,307				
Adjusted R^2	0.183		0.313		0.375				
Correlation for residual							-0.127	-0.025	0.103
P-value for BP test							0.000	0.000	0.000

Notes: (1) the dependent variables are factor 1 (subjective health), factor 2 (physical health) and factor (cognitive health), which are standardized with a mean of zero and variance of 1. (3) Clustered robust errors in parentheses. * p<0.1. ** p<0.05. *** p<0.01.

We first look at our chronic disease dummy variables. The negative sign on these coefficients accord with our expectations i.e. the occurrence of a specific chronic physical disease is associated with a reduction in the factor scale. The negative coefficients on all the disease dummy variables are of substantial size and are significant at the 1 percent level on our first two factors. In contrast, 'cognitive health' is not significantly affected by any of the single chronic physical disease dummies except for arthritis. In terms of magnitude, depression has the largest effect among all the chronic diseases for subjective and physical health. Among all chronic physical diseases, however, respiratory disease has the greatest impact on 'subjective health' and diabetes has the greatest impact on 'physical health' followed by arthritis. We also find that respondents with multiple chronic physical diseases have the greatest effect on subjective and physical health factors, indicating that comorbidity results in an aggravation in their health status. Reading from the p-values for the cross-equation tests in column 4 we find that the effect diseases have on subjective and physical health factors are not statistically different from each other except for respiratory diseases.

We turn now to look at the effect the demographic and socioeconomic status variables have on the three factors. Differences arise across equations and we firstly look at the effects of demographic characteristics variables. We find that age has a positive effect on 'subjective health' but has a negative effect on 'physical health' and 'cognitive health', indicating that the cognitive and physical health of the elderly in China deteriorates as they grow older but their subjective health gets better. There is increasing evidence that there is a u-shape of well-being over the life course (Blanchflower and Oswald, 2008). The well-being of adults tends to be high in young adulthood and old age and at the lowest around the age of 40, which might explain this positive relationship in our sample of respondent aged 45+. Also notice that including a quadratic term we do not find significant result, indicating that there is no u-shape relationship of subjective well-being over age in our sample. We also find considerable gender differences in the three health factors. 'Subjective health' is higher among females but the opposite is true for 'physical' and 'cognitive health'. Although the evidences on gender difference in positive subjective well-being tend to be mixed in the literature (Gardner and Oswald, 2002, see, for example), males are generally acknowledged as having better health in physical and cognitive domains compared to females of similar age (Bird and Rieker, 2008; Read and Gorman, 2006). Paradoxically, marriage seems to have a significant and negative effect on 'subjective health' but positively affects the cognitive health of our respondents. In addition, respondents living in the urban areas have better health than those living in the rural areas. We also find that disability has a very strong negative effect on physical and cognitive health, which exceeds that of any chronic physical disease alone. In contrast, the effect disability has on subjective health is insignificant. This might arise because those who have disability could subjectively adapt to their physical limitations (Oswald and Powdthavee, 2008).

Next we turn to examine the effects of living arrangements. Here respondents with no children are used as the reference group and we find that among those where the closest child lives in the same province, the three proximity dummy variables are positive on the first factor, indicating that respondents with children have better subjective health than those without children. In contrast, the negative estimates of the three dummy variables on physical health indicate that the physical health of respondents with children is worse than those with no children.

Education also has an important role to play in this setting. We find that those with an education level of 'elementary' or 'high school' have a worse 'subjective health' than their illiterate counterparts. This runs counter to our intuition but might arise because better educated people have high unsustainable expectations (Gardner and Oswald, 2002). Indeed, in the robustness section where the eight original health measures are used as outcome variables, we find that this result is driven by one subjective measure, namely the life satisfaction measure. In contrast, compared to those who are illiterate, respondents with a higher education have better physical health and cognitive health, and the size of this education-health gradient is substantial and greater for cognitive health than for physical health. Those with an education of 'high school' or above have a higher cognitive health score by 1.1 points, i.e. more than 1 standard deviation in cognitive health. Compared to those being employed or self-employed, respondents who are subsistence farmer or currently not working have a lower score in the three health factors. However, respondents who are retired have similar levels of cognitive health as those who are employed or self-employed.

Finally, we do not find evidence that having insurance has any effect on the subjective and physical health of our respondents, indicating that insurance does not offer any security on their subjective or physical health. In contrast, having insurance is positively associated with 'cognitive health', which might arise because non-participation in health insurance might be conditional upon the presence of a cognitive bias, which might be due to illiteracy (Platteau and Ontiveros, 2013). Lastly, we find that economic status is only significantly related to 'subjective health'. There is a u-shape relationship between the household's expenditure and subjective health. The subjective health of an individual decreases and is the lowest when the logarithm of household expenditure per capita reaches 7, which if converted into a monetary amount is around 1,096 RMB. Given that the average of household expenditure per capita is 8,046 RMB in our sample, for the majority of the respondents in our sample, their subjective health gets better as their economic status improves.

It follows from this that NCDs have a greater effect on 'subjective health' and 'physical health', with a limited effect on 'cognitive health'. In contrast, 'cognitive health' tends to be affected by demographic and socioeconomic background, especially education status. We find further support for this conclusion when we examine the model fit of our three estimations. When the covariates are not added, the chronic physical diseases and depression are able to explain 9 percent of the variation in the subjective health factor, 12 percent of the variation in the physical health factor, but less than 2 percent of the variation in the cognitive health factor (results not reported here). However when we control for demographic and socioeconomic variables, the R-squared for the cognitive health factor increases to 0.375, which is much higher than that for subjective health factor (0.183) or physical health factor (0.313).

Finally we examine whether the explanatory variables have similar effects on subjective and physical health factors using a series of F-tests in column 4. In doing so we find that only for the following dummy variables: urban areas, retired (versus employed or self-employed) and having insurance can we not reject the hypothesis of equality of coefficients at conventional levels of significance, implying that the effects of the three variables (if significant) are statistically not different on the subjective and physical health of our respondents. The same F-tests are conducted between estimations for subjective health and cognitive health (column 5) and for physical health and cognitive health (column 6).

We draw four conclusions from the above analysis. Firstly, chronic physical diseases and depression are more likely to affect 'subjective health' and 'physical health' which represents subjective health status and physical functioning and have less impact on 'cognitive health' which represents cognitive abnormalities among the elderly. In contrast, 'cognitive health' is more affected by the socioeconomic characteristics especially education attainment. Secondly, depression has the greatest effect on both subjective and physical health domains of our respondents compared to any one chronic physical disease alone. Thirdly, the effects different diseases have on subjective and physical health are not significantly different across equations except for respiratory diseases. Fourthly, among the chronic physical diseases, respiratory diseases and diabetes are the two types of chronic physical diseases that have the greatest effect on subjective and physical health respectively.

3.3.3 Comorbid Depression

Next we look in more detail at the effect comorbid depression has on the three factors, and include a series of interaction terms of depression with various chronic physical diseases. The prevalence for each of these disease conditions can be found in Table B.3 in the Appendix. The results are reported in Table 3.6. We begin by looking at subjective health (column 1). Compared to those with no chronic diseases, those with depression alone have worse subjective health and this effect is greater in magnitude than having any one chronic physical disease. For those with comorbidity, having depression and another chronic physical disease is associated with a worse subjective health than having multiple chronic physical diseases, and the magnitude of the effect is greater still for those with two more chronic conditions.

Table 3.6: The Seemingly Unrelated Regression Models in Predicting Three Health Factors (Maximum Likelihood Estimation): Comorbid Depression

Variables	**(1) Subjective Health**		**(1) Physical Health**		**(1) Cognitive Health**		**(4) (1) vs (2)**	**(5) (1) vs (3)**	**(6) (2) vs (3)**
Chronic physical disease status (Base: No chronic physical diseases)									
Cardiovascular disease alone	-0.306***	(0.033)	-0.178***	(0.026)	-0.020	(0.029)	0.004	0.000	0.000
Diabetes alone	-0.302***	(0.104)	-0.287***	(0.079)	-0.027	(0.080)	0.913	0.030	0.013
Respiratory disease alone	-0.381***	(0.069)	-0.263***	(0.057)	-0.053	(0.062)	0.177	0.001	0.008
Arthritis alone	-0.278***	(0.038)	-0.283***	(0.033)	-0.083**	(0.035)	0.932	0.000	0.000
Other chronic physical disease alone	-0.432***	(0.039)	-0.134***	(0.027)	0.008	(0.035)	0.000	0.000	0.001
Depression alone	-0.581***	(0.040)	-0.371***	(0.031)	-0.219***	(0.033)	0.000	0.000	0.000
Comorbid depression with cardiovascular disease	-0.774***	(0.055)	-0.717***	(0.062)	-0.223***	(0.049)	0.520	0.000	0.000
Comorbid depression with diabetes	-0.735***	(0.222)	-0.976***	(0.211)	-0.040	(0.128)	0.505	0.002	0.000
Comorbid depression with respiratory disease	-1.009***	(0.097)	-0.573***	(0.080)	-0.238***	(0.086)	0.000	0.000	0.006
Comorbid depression with arthritis	-0.756***	(0.053)	-0.756***	(0.055)	-0.306***	(0.046)	0.997	0.000	0.000
Comorbid depression with other chronic physical disease	-0.917***	(0.061)	-0.625***	(0.057)	-0.296***	(0.049)	0.001	0.000	0.000
Two or more chronic physical diseases	-0.621***	(0.028)	-0.453***	(0.023)	-0.025	(0.024)	0.000	0.000	0.000
Comorbid depression with two or more chronic physical diseases	-1.134***	(0.031)	-1.127***	(0.033)	-0.286***	(0.027)	0.877	0.000	0.000
Observations	10,307		10,307		10,307				
Adjusted R^2	0.182		0.315		0.372				
Correlation for residual							-0.127	-0.026	0.103
P-value for BP test							0.000	0.000	0.000

Notes: (1) the dependent variables are factor 1 (subjective health), factor 2 (physical health) and factor (cognitive health), which are standardized with a mean of zero and variance of 1. (2) Additional controls include those included in Table 3.5. (3) Clustered robust errors in parentheses. * p<0.1. ** p<0.05. *** p<0.01.

Similar results hold for subjective health and cognitive health (columns 2 and 3); having depression together with cardiovascular disease has an additional negative effect on physical health beyond having the two conditions separately.

Lastly, we show the results for the cross-equation tests for each disease status reported in columns 4-6. It appears that most disease states have a greater effect on subjective health than on physical health, although this difference is only significant for the following disease status: cardiovascular disease, other chronic physical disease, depression alone; depression comorbid with respiratory disease, depression comorbid with other chronic physical disease and two or more chronic physical diseases (column 4). It should be noted, that since cognitive health is affected by only a few comorbid conditions, when comparing the disease effects between cognitive health and subjective/physical health, they are all significant at the 5 percent level.

3.3.4 Robustness Tests

We conduct a series of sensitivity tests on our main results. First, the summary statistics presented in Table 3.1 suggest that there is substantial gender variation in the health outcome variables and NCD prevalence. We re-estimate our SUR models separately by gender in Tables 3.7 and find our main results are unchanged. Subjective and physical health factors are more affected by chronic diseases than cognitive health, and depression has a bigger effect on all health factors than any other chronic physical condition. We also find depression comorbid with chronic physical diseases has an additional effect on the physical health (see Table B.5 and Table B.6 in the Appendix).

Table 3.7: Robustness Test: SUR Estimation by Gender

Variables	**(1)**		**(1)**		**(1)**		**(4)**	**(5)**	**(6)**
	Subjective Health		**Physical Health**		**Cognitive Health**		**(1) vs (2)**	**(1) vs (3)**	**(2) vs (3)**
Panel A: Females									
Chronic physical disease status (Base: No chronic physical diseases)									
Cardiovascular disease alone	-0.267***	(0.042)	-0.217***	(0.036)	-0.038	(0.038)	0.390	0.000	0.000
Diabetes alone	-0.021	(0.151)	-0.463***	(0.150)	0.115	(0.114)	0.071	0.458	0.000
Respiratory disease alone	-0.356***	(0.098)	-0.203**	(0.081)	-0.125	(0.095)	0.214	0.106	0.516
Arthritis alone	-0.220***	(0.046)	-0.364***	(0.043)	-0.042	(0.042)	0.032	0.004	0.000
Other chronic physical disease alone	-0.318***	(0.049)	-0.208***	(0.042)	-0.023	(0.044)	0.092	0.000	0.002
Two or more chronic physical diseases	-0.552***	(0.034)	-0.622***	(0.031)	-0.040	(0.029)	0.149	0.000	0.000
Depression	-0.507***	(0.028)	-0.520***	(0.028)	-0.239***	(0.025)	0.756	0.000	0.000
Observations	5,065		5,065		5,065				
Adjusted R^2	0.118		0.260		0.390				
Correlation for residual							-0.139	-0.032	0.0966
P-value for BP test								0.000	
Panel B: Males									
Chronic physical disease status (Base: No chronic physical diseases)									
Cardiovascular disease alone	-0.294***	(0.042)	-0.216***	(0.036)	0.015	(0.033)	0.173	0.000	0.000
Diabetes alone	-0.485***	(0.115)	-0.266***	(0.079)	-0.024	(0.083)	0.141	0.000	0.056
Respiratory disease alone	-0.435***	(0.070)	-0.219***	(0.059)	-0.009	(0.059)	0.016	0.000	0.010
Arthritis alone	-0.278***	(0.046)	-0.230***	(0.040)	-0.125***	(0.039)	0.448	0.009	0.044
Other chronic physical disease alone	-0.487***	(0.048)	-0.107***	(0.034)	-0.012	(0.039)	0.000	0.000	0.046
Two or more chronic physical diseases	-0.661***	(0.032)	-0.496***	(0.029)	-0.034	(0.027)	0.000	0.000	0.000
Depression	-0.551***	(0.031)	-0.514***	(0.030)	-0.232***	(0.025)	0.418	0.000	0.000
Observations	5,242		5,242		5,242				
Adjusted R^2	0.138		0.230		0.258				
Correlation for residual							-0.114	-0.018	0.111
P-value for BP test								0.000	

Notes: (1) the dependent variables are factor 1 (subjective health), factor 2 (physical health) and factor (cognitive health), which are standardized with a mean of zero and variance of 1. (2) Additional controls include those included in Table 3.5. (3) Clustered robust errors in parentheses. * p<0.1. ** p<0.05. *** p<0.01.

Secondly, we also use the original eight health variables (standardized with a mean of zero and a variance of one) as outcome variables and re-estimated our SUR model with eight equations. Although the advantage of using factor analysis is to extract and deliver meaningful interpretation when comparing the effect of different diseases and conditions, this exercise helps us check the robustness of our framework to this end. We report the results of base-line estimations in Table 3.8. Chronic diseases have more significant effects on the first six outcome variables, whilst diabetes and arthritis are the two types of chronic physical diseases that have the greatest effect on cognition (here on episodic memory and mental health status, respectively). In addition, depression has a bigger effect than any other single physical diseases across the eight outcome measures. Similar results are found when comorbid depression are taken into account (see Table B.7).

Table 3.8: Robustness Test: Using Eight Health Outcome Measurements

Variables	(1) NADL	(2) IADL	(3) Self-reported health	(4) Self-reported Survival Probability	(5) Life Satis-faction	(6) Intensity of pain	(7) Episodic Memory	(8) Mental Status
Chronic physical disease status (Base: No chronic physical diseases)								
Cardiovascular disease alone	-0.203***	-0.040**	-0.379***	-0.178***	0.028	-0.081***	-0.065**	-0.012
	(0.023)	(0.018)	(0.028)	(0.030)	(0.032)	(0.024)	(0.030)	(0.024)
Diabetes alone	-0.340***	-0.062	-0.429***	-0.294***	0.042	-0.039	-0.259***	0.044
	(0.074)	(0.047)	(0.098)	(0.092)	(0.097)	(0.067)	(0.082)	(0.066)
Respiratory disease alone	-0.208***	0.008	-0.477***	-0.331***	0.048	-0.129**	-0.070	-0.033
	(0.044)	(0.035)	(0.056)	(0.059)	(0.056)	(0.051)	(0.054)	(0.048)
Arthritis alone	-0.276***	-0.023	-0.275***	-0.176***	-0.099***	-0.323***	-0.074**	-0.075***
	(0.028)	(0.018)	(0.030)	(0.032)	(0.035)	(0.033)	(0.033)	(0.027)
Other chronic physical disease alone	-0.149***	-0.027	-0.395***	-0.208***	-0.103***	-0.235***	-0.060*	-0.012
	(0.025)	(0.017)	(0.031)	(0.035)	(0.033)	(0.031)	(0.033)	(0.027)
Two or more chronic physical diseases	-0.522***	-0.133***	-0.692***	-0.376***	-0.099***	-0.527***	-0.016	-0.043**
	(0.020)	(0.014)	(0.022)	(0.023)	(0.024)	(0.022)	(0.023)	(0.019)
Depression	-0.484***	-0.199***	-0.480***	-0.398***	-0.528***	-0.561***	-0.235***	-0.208***
	(0.019)	(0.015)	(0.019)	(0.021)	(0.023)	(0.022)	(0.020)	(0.017)
Observations	10,307	10,307	10,307	10,307	10,307	10,307	10,307	10,307
Adjusted R^2	0.309	0.133	0.231	0.147	0.081	0.219	0.198	0.357

Notes: (1) the dependent variables are factor 1 (subjective health), factor 2 (physical health) and factor (cognitive health), which are standardized with a mean of zero and variance of 1. (2) Additional controls include those included in Table 3.5. (3) Clustered robust errors in parentheses. * p<0.1. ** p<0.05. *** p<0.01.

3.4 Conclusion

This chapter examines the health effects of NCDs using data from the 2011 national survey of CHARLS. In order to account for the potential correlation among multiple health measurements which have been ignored in previous studies, we use factor analysis to determine the factor structure of eight key health measurements. An oblique rotation delivers three factors, which describe 'subjective health', 'physical health' and 'cognitive health', respectively.

We find that NCDs have strong significant effects on 'subjective health' and 'physical health' but have very little impact on 'cognitive health'. Applying a system approach we show that depression has the largest effect on worsening subjective and physical health compared with other chronic conditions. Conducting a series of cross-equation tests, we find that the effects different NCDs have on subjective and physical health do not differ except for respiratory disease. Furthermore, we show that when depression is comorbid with other chronic physical diseases it produces a significantly greater deterioration in health than any chronic physical disease alone, and that this additive effect is substantially amplified in the case of depression comorbid with cardiovascular diseases and comorbidity with diabetes for physical health. These findings are robust to a series of sensitivity tests, including splitting the regression sample by gender and replacing the two factors with the eight original health measures.

The findings from this study help to delineate the relative impacts of different NCDs on the health of the elderly in a quite global sense and the equation system approach used in this paper fully explores the unobserved correlation among the commonly used health measurements which is ignored in previous studies.

Another implication of these findings is associated with the alarming fact we found that depression have the greatest effect on elderly's 'subjective health' and 'physical health'. In another study by Zhang et al. (2009), mental health problems is also found to be the NCD type with greatest impact on labour participation for those aged 50-65 compared with other NCD types such as cardiovascular diseases and diabetes. Given the coverage for mental health problems is overlooked in the health insurance system for most developing countries, our study might provide a supplementary evidence for the proactive prioritized coverage of 'depression' in primary care. In addition, using factor analysis to obtain fewer scales that describe the health of the targeted group, policy makers are more informed in resource allocation to fulfil this goal.

CHAPTER 4

Catastrophic Health Spending, Non-communicable Diseases and the Role of Children

4.1 Introduction

Non-communicable diseases (NCDs) represent a growing world-wide health threat. NCDs are the leading global cause of death. In 2008, 63 percent of all deaths were due to NCDs - chiefly cardiovascular disease, cancer, chronic respiratory disease and diabetes (WHO, 2011b). Although in the past chronic diseases tended to be confined to high income countries this is no longer the case, and current estimates from WHO suggest that 80 percent of all deaths due to NCDs occur in low and middle-income countries (WHO, 2011b). China, in particular, appears to be facing a rising NCD epidemic; NCDs account for over 80 percent of its 10.3 million deaths annually, and estimates suggest that the number of cases of NCDs among those over the age of 40 is likely to double or even triple over the next two decades (Wang et al., 2011).[44]

China's growing health challenges arise, at least in part, due to its rapidly ageing population. Although those aged 60+ currently represent just 14 percent of the country's population, current projections suggest that by 2050 this figure will be 33 percent (UN, 2013), and it is estimated that this alone could increase the NCD burden by at least 40 percent by 2030 (Wang et al., 2011). China is also experiencing rapid urbanisation, which is likely to further increase the exposure of the population to the risk factors

[44] According to these estimates there will be a five-fold increase in the incidence of lung cancer, while diabetes will become the most prevalent disease.

associated with chronic diseases (Tang et al., 2013). Figures from the United Nations Development Programmes (UNDP) suggest that by 2030 more than 900 million people - 60 percent of China's total population - will live in a city (Klugman, 2009). In addition, the risk factors associated with chronic diseases, namely tobacco use, unhealthy nutrition, and physical inactivity leading to obesity and hypertension are already common, and physical inactivity is increasing (Wang et al., 2011).

Another by-product of urbanisation and shifting lifestyles is that it is changing the nature of living arrangements in China. Traditionally, China has a strong notion of the extended family and of patrilineal and patrilocal living arrangements, whereby parents are cared for by their children in the family home.[45] Now the elderly are increasingly living separately from their adult children, as their children move away in search of better economic opportunities elsewhere (Meng and Luo, 2008; Ren and Treiman, 2014; Silverstein et al., 2006; UN, 2005). This coupled with a lack of adequate social security provision is likely to have implications as to how elderly households manage chronic diseases.

Over the years a large literature has developed that examines the impact health insurance and chronic disease have on the probability that large out-of-pocket health payments lead to catastrophic health spending.[46] Health spending is said to be catastrophic if it exceeds a certain fraction of household income or expenditure, leading to a disruption in living standards. Spending a large fraction of the household budget on health care must be at the expense of the consumption of other goods and services. This opportunity cost may be incurred in the short term if health care is financed by cutting back on current consumption or in the long term if it is financed through savings, the sale of assets, or credit. In this chapter, we examine the effect living arrangements and changing disease patterns have on the probability that elderly households in China experience catastrophic health spending. Following Xu (2005) we define health spending

[45] In a patrilocal society, when a man and woman marry, the wife joins her husband in his father's home.

[46] See for example, Ataguba and Goudge (2012) for South Africa, Ekman (2007) for Zambia, Nguyen (2012) for Vietnam, and Yardim et al. (2014) for Turkey who find that health insurance does not provide financial protection against the risk of undergoing catastrophic health spending, but instead can increase the risk. In contrast, Knaul et al. (2011) using cross-country data for Latin America and the Caribbean find that health insurance reduces the risk that a household experiences catastrophic health spending. There is also an established literature which finds that NCDs lead to catastrophic health spending and subsequent impoverishment (see, for example, Engelgau et al. (2012) for India, Li et al. (2012) for China, and Su et al. (2006) for Burkina Faso).

as catastrophic if it exceeds 40 percent of the household's capacity to pay each year, where capacity to pay is defined an effective income remaining after basic subsistence needs have been met.

We find that although health care in China has undergone significant reform over the past decade, its health insurance schemes are still not sufficient to fully protect households from the risk of catastrophic health spending, with those covered by the New Rural Cooperative Medical Scheme being particularly vulnerable to the risk of catastrophic health spending, compared to those covered by the two urban schemes. In both rural and urban areas, utilization of both inpatient and outpatient care significantly increases the household's incidence of catastrophic health spending.

We also show that a household's proximity to its adult children is important in managing the financial burden of disease. Households where the adult children still live in the family home are less likely to experience catastrophic health spending, compared to those households where the children have moved away. Receiving financial support also has a role to play, although its effect is not clear-cut, and varies with the level of physical support that the household receives. We find that receiving financial support reduces the risk of catastrophic health spending when the household has accessible physical support (i.e., when at least one other child lives at home) or for those households where the children have moved far away (i.e. to another province/country) when the level of net transfers are sufficiently large.

Finally, we show that large differences still exist between rural and urban China in terms of the impact chronic diseases have on the incidence of catastrophic health spending; NCDs raise the probability of catastrophic health spending by 7 percentage points in urban areas compared to 14 percentage points in rural areas. In terms of specific diseases, we find that cancer poses the biggest threat to rural households, while in urban areas this disease is diabetes. Such findings persist after controlling for differences in the types of health insurance between the two areas, and arise, at least in part, due to differences in disease patterns between the rural and urban areas.

The structure of the remainder of the chapter is as follows. In Section 2, we provide a literature review. In Section 3 we describe the data used in this chapter, and provide some descriptive statistics. Section 4 provides our main empirical results and section 5 discusses some robustness tests conducted in this chapter. Section 6 concludes the chapter.

4.2 Literature Review

Over the years a large literature has developed that examines the effect NCDs have on a household's economic well-being with a large number of studies focussing on the extent to which chronic diseases lead to out-of-pocket health payments. Abegunde and Stanciole (2008), for example, using data for Russia find that chronic diseases are often significantly associated with higher levels of healthcare expenditure for the household. On a related issue, Wagstaff (2007) for Vietnam finds that health shocks lead to large increases in medical spending even among those who are insured, while Van Minh and Xuan Tran (2012) again for Vietnam find a similar result.

However, since the treatment of chronic disease is often expensive and lengthy there is also evidence that the cost of treating NCDs represents more than just a one-off cost to the household, and in some instances can lead to catastrophic health spending, even among those who are insured. Health spending is said to be catastrophic if it forces a household to reduce its basic expenditure over a period of time to cope with its health costs (Wyszewianski, 1986). Engelgau et al. (2012), for example, using data for India find that NCDs lead to catastrophic health spending and subsequent impoverishment. Similarly, Su et al. (2006) for Burkina Faso find that the presence of a household member with chronic illness is the key determinant of catastrophic health spending, while Knaul et al. (2011) using cross-country data for Latin America and the Caribbean find that the presence of older adults and a lack of health insurance in the household has a positive effect on the likelihood that a household experiences catastrophic health spending. Finally, Li et al. (2012) using data for China find that the key determinants of catastrophic health spending and impoverishment are whether there are household members who have been hospitalized, are elderly or have chronic diseases.

At the same time there is growing evidence that NCDs and their risk factors affect other aspects of household well-being. In particular, they often prevent individuals from working or seeking employment, and globally around a quarter of those who die from a NCD are of working age, thus permanently denying families a source of income (WHO, 2011b). Abegunde and Stanciole (2008) for Russia find that chronic diseases, in addition to their impact on healthcare expenditure, cause labour income to fall while increasing non-health consumption. Similarly, Zhang and Wilson (2012) using data for

Australia find that the growing prevalence of chronic diseases such as diabetes, cardiovascular diseases and mental health problems is likely to have a negative impact on labour force participation and performance in the labour market. These effects are likely to be compounded in low and middle income countries where NCDs exacerbate inequality in both health status and access to health care and this is especially true in China (WHO, 2011b).

Since the SARS outbreak in 2003, which highlighted weaknesses in China's health care system, health care in China has undergone a series of reforms aimed at providing the whole country with basic health care, while ensuring equal access to, and affordability of, health services. Following these reforms, by the end of 2011, around 95 percent of the Chinese population (1.3 billion people) were covered by one of the three government-provided health insurance schemes - New Rural Cooperative Medical Scheme (NRCMS) in rural areas and Urban Employee/Resident Basic Medical Insurance (UEBMI/URBMI) in urban areas.[47]

However, despite this the funds available in the three schemes, especially in the NRCMS and URBMI are not always sufficient to meet the needs of its members. The NRCMS covers only inpatient services, URBMI only includes inpatient and critical outpatient expenses, while the UEBMI is the most generous of the three schemes covering both inpatient and outpatient expenses. As a result, out-of-pocket health spending is still widespread across most of China. There is also growing evidence that having health insurance may encourage people to seek excessive and more expensive health care, leading to catastrophic health spending (Ataguba and Goudge, 2012; Ekman, 2007; Nguyen, 2012; Yardim et al., 2014). This is also true in China, especially for those insured under the NRCMS, where the benefit package does not protect against the accrued treatment costs given its limited scope and level of reimbursement (Wagstaff and Lindelow, 2008; Wagstaff et al., 2009b).

A potential problem with insurance is it might be endogenous. Wagstaff and Lindelow (2008) pays particular attention to the problem of endogeneity of health insurance using three household survey datasets in China. A key feature differing our paper from Wagstaff and Lindelow (2008) is our data set. Although we use a cross-sectional data set, it was collected in 2011, when the majority of the nation was covered by at least

[47] A more detailed overview of the three health insurance schemes can be found in Section 2.1 in Chapter 2.

one type of government provided health insurance schemes; whereas in Wagstaff and Lindelow (2008), the most recent survey year was in 2000 when the insurance coverage was relatively low and adverse selection could be serious.[48] Endogeneity is not an issue in our analysis since over 90 percent of households in our sample are covered by one of the three main social schemes, and the participation is largely determined by their residence and Hukou status. Some might be concerned that a household with greater risks of undergoing catastrophic health spending could choose to participate in a more generous programme, however, the possibility is rare because the generous programme is UEBMI, which is compulsory.

The impact NCDs have on economic well-being is likely to be particularly pertinent in China. Bloom et al. (2013) predict the economic impact of NCDs in China for the period of 2012-2030 using a macro model. Focusing on the negative effects of NCDs on labour supply and capital accumulation, they find that the five main NCDs (cardiovascular disease, cancer, chronic respiratory disease, diabetes and mental health) will cost China USD 27.8 trillion in total (in 2010 USD). They predict that the most costly NCDs are cardiovascular disease and mental health problems followed by respiratory disease.

Despite this, empirical evidence that looks in detail at the effect living arrangements and changing disease patterns in China has on the likelihood that a household will experience catastrophic spending is still scarce. In addition, a limitation of some of this work in this area, and one that we aim to address in this paper is that due to a lack of suitable data few studies have looked in detail at the effects specific NCDs have on the probability that a household will undergo catastrophic health spending. In what follows we address this issue using data from CHARLS, a rich source of data on the disease history, and treatment costs of healthcare in China.

4.3 Data and Descriptive Analysis

4.3.1 Data and Define Catastrophic Health Spending

This chapter uses data from the 2011 baseline national wave of CHARLS. As mentioned in the data overview section in Chapter 2, interviewees in CHARLS are asked standard

[48] Due to the survey year, the definition of health insurance in Wagstaff and Lindelow (2008) differs from ours. They define health insurance as any coverage (or GIS/LIS membership in an alternative survey data) and we define it based on the three government provided health insurance schemes which were not fully established until 2007.

questions on their demographic characteristics, education, work status, and income sources, together with more detailed questions on their health status and functioning. This includes whether they have been diagnosed with one or more of 13 medical conditions.

We focus on five medical conditions, namely, cardiovascular disease (including hypertension, dyslipidaemia, heart problems and stroke), cancer, diabetes, respiratory disease (including chronic lung diseases), and mental health problems (including emotional, nervous or psychiatric problems, and memory-related diseases). The first four conditions encompass the main NCDs in China, and are largely caused by shared behavioural risk factors, i.e., tobacco, an unhealthy diet, insufficient physical activity, and alcohol (WHO, 2011b). We also include mental health problems as a disease category in our analysis. Figures from the WHO suggest that mental health problems will increase to 25 percent of the total disease burden in China by 2020, much higher than the world average of 11 percent (Wong et al., 2013), and as such are likely to have a disproportionate effect on economic well-being in China compared to other countries.

Another advantage of the CHARLS data set is that it collects detailed household expenditure data, which we use to construct our measure of catastrophic health spending. CHARLS asks detailed questions about expenditure on certain key items, and we define total household expenditure as the sum of annual expenditure on the following items: food, utility fees[49], durable goods, education, entertainment, clothing, medical services and transportation.

In what follows, we define a household as undergoing catastrophic health spending if its health spending exceeds 40 percent of the household's capacity to pay in the preceding year and we we will vary this for robustness checks in later sections. Many studies define capacity to pay based on income (Wagstaff, 2007; Wagstaff and Doorslaer, 2003), others use household expenditure (Engelgau et al., 2012; Knaul et al., 2011; Li et al., 2012; Mondal et al., 2010; Su et al., 2006; Van Minh and Xuan Tran, 2012; Xu, 2005). We choose the latter, since in the context of a household survey, expenditure is often viewed as a more accurate reflection of purchasing power than income (Deaton, 1997).

Following Xu (2005), we define capacity to pay as effective income remaining after

[49] This includes fees paid for utilities, fuel, nannies/housekeepers/servants, heating, and communication.

basic subsistence needs have been met, where effective income is the annual total expenditure of the household. The subsistence level is household specific, calculated by multiplying equivalent household size with food expenditure per capita at the poverty line.[50] The poverty line is a weighted average of the households' food expenditure per capita whose share of food expenditure are in the 45th to 55th percentile range of the sample. To ensure representativeness of the sample when calculating this percentile household survey weights are also applied. It should be noted that, whenever food expenditure is less than the subsistence expenditure, capacity to pay is defined as total expenditure minus food expenditure.

The 2011 national survey consists of 10,251 households (17,705 individuals). Our sample comprises of those households where we have complete data from both the respondent and spouse on all the variables used in the estimation process. In what follows we further restrict our sample to households where the youngest child is at least 16 years old. This leaves us with a final sample of 8,087 households (14,025 individuals).

4.3.2 Descriptive Statistics

Table 4.1 outlines some simple descriptive statistics of the main variables used in this chapter, disaggregated by region of residence (rural/urban). We report mean responses and then depending on the nature of the question either the standard deviation, or for the categorical variables the number reporting the highlighted response. In the final column, the p-value is reported to test the equality of the means between rural and urban areas.

[50] Xu et al. (2003) using household survey data for 59 countries estimate a log-log linear regression, where the log of household food expenditure is regressed on the log of household size and country level fixed effects (i.e. the regression is of the form: $ln(food) = \alpha + \beta \cdot ln(hhsize) + \sum \gamma_i \cdot country_i$. The value of β is estimated to be 0.56, which implies that although food consumption increases with additional household members, this increase in consumption is less than proportional to the increase in household size. It follows from this that: *equivalent household size = real household size*$^{0.56}$.

Table 4.1: Summary Statistics of the Main Variables

Sample (Number of observations)	**All (8,087)**		**Rural (4,871)**		**Urban (3,216)**		**p-value**
Variables	**Mean**	**S.D/n=x**	**Mean**	**S.D/ n=x**	**Mean**	**S.D/ n=x**	
Age of respondent	61.212	10.204	61.363	10.134	60.985	10.306	0.420
Respondent lives with spouse	0.734	0.442	0.749	0.434	0.712	0.453	0.000
Urban hukou	0.225	0.418	0.031	0.173	0.519	0.500	0.000
Household size	3.459	1.857	3.601	1.957	3.245	1.672	0.000
Number of children	2.697	1.503	2.906	1.508	2.381	1.438	0.000
Household expenditure per capita last year (RMB)	13,741	39,591	11,038	46,569	17,835	25,088	0.000
Education (respondent)							
Illiterate	0.198	n=1,604	0.243	n=1,182	0.131	n=422	0.000
Elementary	0.417	n=3,374	0.455	n=2,214	0.361	n=1,160	0.000
High school	0.321	n=2,598	0.282	n=1,375	0.380	n=1,223	0.000
Vocational or above	0.063	n=511	0.021	n=100	0.128	n=411	0.000
Main job status (respondent)							
Employed or self-employed	0.289	n=2,341	0.238	n=1,158	0.368	n=1,183	0.000
Subsistence farmer	0.393	n=3,181	0.541	n=2,634	0.170	n=547	0.000
Currently not working	0.201	n=1,628	0.199	n=971	0.204	n=657	0.000
Retired	0.116	n=937	0.022	n=108	0.258	n=829	0.000
Type of health insurance (respondent)							
UEBMI	0.132	n=1,064	0.027	n=131	0.290	n=933	0.000
URBMI	0.055	n=445	0.018	n=88	0.111	n=357	0.000
NRCMS	0.712	n=5,758	0.887	n=4,323	0.446	n=1,435	0.000
Government/private medical insurance	0.038	n=310	0.013	n=62	0.077	n=248	0.000
No insurance	0.063	n=510	0.055	n=267	0.076	n=243	0.000
Disease/Disability (respondent/spouse)							
NCD	0.819	0.385	0.826	0.379	0.809	0.393	0.110
Duration of NCD (years)	14.287	15.071	14.151	14.927	14.493	15.286	0.126
Specific NCD							

Table 4.1 Continued:

Sample (Number of observations)	**All (8,087)**		**Rural (4,871)**		**Urban (3,216)**		**p-value**
Variables	**Mean**	**S.D/n=x**	**Mean**	**S.D/ n=x**	**Mean**	**S.D/ n=x**	
Cardiovascular disease	0.496	0.500	0.464	0.499	0.544	0.498	0.000
Cancer	0.017	0.129	0.016	0.124	0.019	0.135	0.250
Diabetes	0.096	0.294	0.071	0.257	0.133	0.340	0.000
Respiratory disease	0.209	0.407	0.227	0.419	0.181	0.385	0.000
Mental health problems	0.053	0.224	0.053	0.224	0.053	0.224	0.840
Other NCDs	0.623	0.485	0.659	0.474	0.567	0.496	0.000
Communicable disease	0.080	0.272	0.086	0.281	0.071	0.257	0.001
Other diseases	0.237	0.426	0.254	0.436	0.212	0.409	0.000
Disability	0.267	0.443	0.305	0.460	0.211	0.408	0.000
Inpatient care (respondent/spouse)	0.148	0.356	0.140	0.347	0.160	0.367	0.000
Outpatient care (respondent/spouse)	0.297	0.457	0.310	0.463	0.276	0.447	0.000
Catastrophic health spending	0.224	0.417	0.252	0.434	0.181	0.385	0.000
Living arrangements							
At least one child lives at home	0.542	n=4,386	0.535	n=2,607	0.553	n=1,779	0.022
Closest child lives in the same province	0.385	n=3,117	0.389	n=1,895	0.380	n=1,222	0.102
Closest child lives in another province/country	0.042	n=343	0.046	n=225	0.037	n=118	0.012
No children	0.030	n=241	0.030	n=144	0.030	n=97	0.242
Household receives net transfers from at least one child (RMB)	0.351	0.477	0.406	0.491	0.268	0.443	0.000

Notes: The p-value is calculated using either the t-test (if continuous) or the proportion test (if binary); a pre-test of equality of variance is conducted. Other disease is a dummy variable that takes the value one if the respondent/spouse has any other medical disease or condition not previously referred to.

We find that large differences emerge between the rural and urban households in terms of their demographic and health characteristics. Respondents in the rural areas are less educated, have more children, are poorer, and are more likely to work as subsistence farmers than their urban counterparts. They are also less likely than their urban counterparts to live with their adult children, which may arise because children from rural areas are more likely to move away from home in search of better economic opportunities elsewhere. Indeed, the rural/urban Hukou status shows that migration is more likely to occur from rural-to-urban areas than vice versa. Less than 3 percent of respondents hold an urban Hukou in rural areas, while in urban areas those holding a rural Hukou are almost equal to those holding an urban Hukou.[51] In addition, we find that households in the rural areas are more likely to receive remittances from their children (40 percent versus 27 percent). These remittances include monetary and in-kind transfers from regular and non-regular sources, which we convert into annual amounts.

As already mentioned, the incidence of chronic disease is high in China. We find that overall, in 82 percent of households either the respondent or spouse has at least one NCD. In line with findings from the World Bank (Wang et al., 2011), the most common NCD is cardiovascular disease (50 percent), followed by respiratory disease (21 percent) and diabetes (10 percent). Although rural residents have a higher probability of incurring a respiratory disease, the prevalence of cardiovascular disease and diabetes are significantly higher in the urban areas.[52] Similarly, we find that the proportion of households where either the respondent or spouse has a communicable disease or disability is significantly higher in the rural areas. It is well documented that although efficient and well-developed disease surveillance systems have been implemented in many urban areas, good hygiene conditions, health services and the ability to monitor patterns of disease burden and spread are largely lacking in rural China (Peng et al., 2010; Zhang and Wilson, 2012).

Differences also emerge between rural and urban areas in terms of health insurance. In the rural areas around 89 percent of respondents are covered by the rural insurance scheme, NRCMS. However, despite this scheme being described as insurance for rural residents, 45 percent of those in the urban areas are also covered by NRCMS. This is due to their Hukou status (about 90 percent of these households have a rural Hukou). The

[51] More details about Hukou can be found in the background overview in Chapter 2.

[52] These figures are aggregated at the household level, which might be influenced by whether or not the respondent lives with a spouse. NCD prevalence is consistent when we look at these figures at the individual level.

remaining urban residents are covered by UEBMI (29 percent) and URBMI (11 percent). In addition, despite widespread health care reform, catastrophic health spending is still widespread, especially in the rural areas. Although overall the proportion of household experiencing catastrophic health spending is 22 percent, this proportion is 7 percentage points higher in the rural areas than urban areas.[53]

4.4 Empirical Strategy and Results

4.4.1 Baseline Model: Determinants of Catastrophic Health Spending

Our first model is designed to replicate existing studies, while using the CHARLS data set. We estimate the probability that a household undergoes catastrophic health spending ($y_h = 1$) using a latent variable model of the form:

$$y_h^* = \gamma \cdot NCD_h + \alpha \cdot dis_h + \omega \cdot insr_h + \kappa \cdot Z_h + \varepsilon_h \tag{4.1}$$

where y_h^* is the latent (unobserved) propensity of undergoing catastrophic health spending for household h; NCD_h is a binary variable in our baseline model indicating whether the respondent/spouse has an NCD at household level; dis_h is vector indicating whether the respondent/spouse has communicable disease, other disease and disability respectively so that we could compare the effects between non-communicable diseases and communicable diseases; $insr_h$ is a five-level categorical variable measuring the type of health insurance[54]; Z_h is a vector of exogenous demographic and socioeconomics variables including age, whether or not having any child, education of main respondent, (log of) household expenditure per capita[55], main job status of main respondent, health utilization in the last 12 month [56]; and ε_h is a random error with a logit distribution. All

[53] Meng et al. (2012) find that in 2011 around 13 percent of households experienced catastrophic health spending in China. Our figure is slightly higher (22 percent) because the sample of households in this analysis are mainly those with elderly members (at least one member is aged 45 and above) who are more likely to suffer periods of ill-health, and hence are more vulnerable to catastrophic health spending.

[54] We define household insurance based on the respondent's insurance type. This might introduce a degree of measurement error if the respondent and spouse belong to different insurance schemes, although the within household variation in insurance type is small. Despite this, we carry out a sensitivity analysis in cases where the respondent and spouse belong to different insurance schemes, assigning the household the more generous scheme, and find similar results.

[55] This household expenditure variable differs from the denominator defining our dependent variable, which is total household expenditure minus the household's subsistence spending. The two variables do not measure the same thing. The statistical correlation between the dependent variable and the explanatory household expenditure variable is further reduced due to the logarithm transformation.

[56] Here we follow Xu (2005) and include health utilization variables, although it could be controversial

analyses are coded and done using Stata version 13 and the built-in command -logit- is used to fit this logit model.

Maximum likelihood estimates of equation (4.1) are reported in Table 4.2. In column 1 we report results for the whole sample, while in columns 2 and 3 we compare rural and urban households. For each regression, the table provides details of average marginal effects and levels of significance.

Table 4.2: Maximum Likelihood Estimates of the Probability of Undergoing Catastrophic Health Spending

Variables	**(1)**	**(2)**	**(3)**
	All	**Rural**	**Urban**
	Mar. Eff.	**Mar. Eff.**	**Mar. Eff.**
Disease/Disability (respondent/spouse)			
NCD	0.097***	0.135***	0.067***
	(0.011)	(0.019)	(0.020)
Communicable disease	0.010	0.003	0.022
	(0.016)	(0.021)	(0.023)
Other diseases	0.023**	0.033**	0.009
	(0.010)	(0.013)	(0.015)
Disability	0.023**	0.007	0.049***
	(0.010)	(0.013)	(0.014)
Type of health insurance (respondent) (Base: NRCMS)			
UEBMI	-0.052***	-0.039	-0.050**
	(0.019)	(0.045)	(0.022)
URBMI	-0.025	0.046	-0.044*
	(0.021)	(0.040)	(0.022)
Government/private medical insurance	-0.080***	-0.109	-0.076**
	(0.026)	(0.073)	(0.032)
No insurance	-0.027	-0.007	-0.051**
	(0.018)	(0.026)	(0.026)
Health utilization in the last 12 months (respondent/spouse)			
Inpatient care	0.236***	0.208***	0.169***
	(0.015)	(0.015)	(0.014)
Outpatient care	0.080***	0.076***	0.076***
	(0.010)	(0.012)	(0.013)
Demographic Variables			
Age of respondent	0.004***	0.004***	0.003***
	(0.001)	(0.001)	(0.001)
Lives in an urban area	-0.010	-	-
	(0.011)		
Has children	-0.081***	-0.077**	-0.063**
	(0.028)	(0.033)	(0.031)

to do so as health utilization is potentially endogenous. Despite this, excluding these variables does not change our main results.

Table 4.2 Continued:

Variables	(1) All Mar. Eff.	(2) Rural Mar. Eff.	(3) Urban Mar. Eff.
Log (Household expenditure per capita last year)	-0.051***	-0.052***	-0.050***
	(0.005)	(0.007)	(0.008)
Education (respondent) (Base: Illiterate)			
Elementary	-0.014	-0.018	-0.008
	(0.012)	(0.015)	(0.019)
High school	-0.026*	-0.036*	-0.006
	(0.015)	(0.019)	(0.023)
Vocational or above	-0.057**	-0.073	-0.036
	(0.024)	(0.055)	(0.030)
Main job status (respondent) (Base: Employed or self-employed)			
Subsistence farmer	0.057***	0.056***	0.062***
	(0.012)	(0.017)	(0.020)
Currently not working	0.087***	0.089***	0.082***
	(0.015)	(0.021)	(0.020)
Retired	0.043**	0.054	0.045*
	(0.021)	(0.045)	(0.024)
Number of observations	8,087	4,871	3,216
Pseudo R^2	0.125	0.107	0.149

Notes: 5 dummy variables for region of residence are included in all specifications. Average marginal effects are reported and robust standard errors in parentheses. * p<0.1. ** p<0.05. *** p<0.01.

In line with other studies we find evidence of a positive and significant association between having an NCD and the probability that a household undergoes catastrophic health spending, with this effect being almost twice as big in rural than urban households (14 percent versus 7 percent). In contrast, having a communicable disease has an insignificant effect, while having a disability is only significant for urban households. Such findings provide our first insight into the financial burden that households face when confronted by different diseases. They appear to be able to cope with the medical costs associated with communicable diseases. In contrast, the treatment costs associated with managing chronic disease and disability are often expensive and lengthy and as such are likely to represent more than a one-off-cost to the household. Such findings are reflective of health care policy in China, which until recently was geared towards the treatment of acute and infectious disorders, while the majority of patients with chronic diseases received little treatment (Tang et al., 2013).

We also find that despite undergoing substantial reforms, health insurance in China is still insufficient to meet the needs of its members, especially those who belong to the rural insurance scheme, NRCMS. For urban households those covered by the two urban insurance schemes (UEBMI and URBMI) and government/private medical insurance are less likely to undergo catastrophic health spending, compared to those covered by NRCMS.[57] Similarly, urban households without insurance are also less likely to experience catastrophic health spending than those with NRCMS. Li et al. (2012) and Li et al. (2014) find similar results, and argue that this may arise because the benefit package associated with NRCMS is limited and there lacks effective cost control mechanisms on the provider side.[58] In contrast, the type of health insurance has little role to play in the rural areas, which may arise because the majority of the rural residents are covered by NRCMS.[59] For the rural residents having no insurance is also insignificant, and we argue that this provides further evidence to suggest that participation in NRCMS does not protect households from the risk of being impoverished due to medical costs.

Furthermore, we find that inpatient care has a greater impact on the likelihood that the household experiences catastrophic health spending than outpatient care, which may arise because inpatient care is usually more expensive than outpatient care. It could also imply that health insurance does not give policy holders effective protection towards inpatient costs given that over 88 percent of households are insured in our sample.[60] Indeed, as already mentioned, a limitation of health insurance in China is that the country's three main health insurance schemes have relatively low reimbursement rates for inpatient costs.

Next, we show that households with higher socioeconomic status are less likely to undergo catastrophic health spending. Li et al. (2012) and Su et al. (2006) find similar results. We find that a 1 percent increase in household expenditure per capita reduces

[57] By government/private medical insurance we mean medical aid, government health insurance or private medical insurance, which cover less than 5 percent of the sample.

[58] Both Li et al. (2012) and Li et al. (2014) use the 2008 National Health Service Survey in China, although Li et al. (2012) uses only the rural households sample. Li et al. (2014) find that households headed by a person enrolled as a member of the NRCMS have higher (though insignificant) levels of catastrophic health spending than those without insurance, indicating no protective effect. They also find that households headed by a member covered by the UEBMI and URBMI experienced a significant lower likelihood of catastrophic health spending compared to the uninsured.

[59] This finding may also arise due to multicollinearity between insurance and the socioeconomic characteristics of the rural sample, where the majority of those covered by the two more generous urban insurance schemes in the rural areas are often of a higher socioeconomic status (i.e. have a higher level of education and higher household expenditure per capita).

[60] In another exercise we do not report here, we restrict our sample to households with any insurance, still we find inpatient care has a greater impact on the likelihood that the household experiences catastrophic health spending than outpatient care.

the probability of undergoing catastrophic health spending by 5 percentage points. In addition, having a vocational education (or higher) lowers the probability of undergoing catastrophic health spending by 7 percentage points compared to those households where the respondent is unable to read or write. Finally, households where the respondent is currently not working have the highest probability of undergoing catastrophic health spending, followed by those where the respondent is engaged in subsistence farming. The explanatory power associated with socioeconomic status is greater in the rural than urban areas, that is mainly driven by level of education which has little role to play in the urban areas.

Turning to the household's demographic characteristics we find that older respondents have a higher probability of experiencing catastrophic health spending. In contrast, households with at least one child are significantly less likely to undergo catastrophic health spending compared to those with no children. This provides us with our first indication that support from children is important for managing the financial burden associated with periods of ill-health. This may arise because children are able to take care of their parents while ill, thereby providing them with a degree of physical support that enables them to successfully manage their medical conditions. Alternately, for those children who have left home this support may be in the form of remittances.

4.4.2 The Role of Children: Physical versus Financial Support

Moving on from the existing literature next we look in more detail at the role that children play in managing the financial burden of ill-health (Table 4.3). Column 1 examines the role of physical support, column 2 financial support, while column 3 examines the interaction between the two.

Table 4.3: Maximum Likelihood Estimates of the Probability of Undergoing Catastrophic Health Spending: Living Arrangements

Variables	(1)			(2)			(3)		
	All	Rural	Urban	All	Rural	Urban	All	Rural	Urban
	Mar. Eff.	Mar. Eff.	Mar. Eff.	Mar. Eff.	Mar. Eff.	Mar. Eff.	Mar. Eff.	Mar. Eff.	Mar. Eff.
Base: No children									
Has children × At least one child lives at home	-0.129***	-0.137***	-0.113***						
	(0.024)	(0.034)	(0.032)						
Has children × Closest child lives in the same province	-0.012	-0.011	-0.007						
	(0.023)	(0.033)	(0.031)						
Has children × Closest child lives in another province/country	-0.040	-0.029	-0.051						
	(0.027)	(0.038)	(0.036)						
Has children				-0.087***	-0.094**	-0.071*			
				(0.028)	(0.039)	(0.038)			
Has children × Household receives net transfers from at least one child				0.013	0.022*	0.003			
				(0.010)	(0.013)	(0.014)			
Base: No children									
At least one child lives at home							-0.126***	-0.137***	-0.105***
							(0.028)	(0.039)	(0.038)
Closest child lives in the same province							-0.018	-0.018	-0.014
							(0.029)	(0.041)	(0.040)
Closest child lives in another province/country							-0.007	0.012	-0.019
							(0.045)	(0.063)	(0.063)
At least one child lives at home × Household receives net transfers from at least one child							-0.017	-0.005	-0.039*
							(0.014)	(0.019)	(0.020)
Closest child lives in the same province × Household receives net transfers from at least one child							0.004	0.007	0.008
							(0.013)	(0.017)	(0.019)

Table 4.3 Continued:

Variables	(1)			(2)			(3)		
	All	Rural	Urban	All	Rural	Urban	All	Rural	Urban
	Mar. Eff.	Mar. Eff.	Mar. Eff.	Mar. Eff.	Mar. Eff.	Mar. Eff.	Mar. Eff.	Mar. Eff.	Mar. Eff.
Closest child lives in another province/country × Household receives net transfers from at least one child							-0.063*	-0.061	-0.092**
							(0.032)	(0.044)	(0.043)
Number of observations	8,087	4,871	3,216	8,087	4,871	3,216	8,087	4,871	3,216
Pseudo R^2	0.143	0.125	0.169	0.125	0.107	0.149	0.144	0.125	0.171

Notes: Additional covariates include all the other variables presented in Table 4.2. Average marginal effects are reported and robust standard errors in parentheses. * p<0.1. ** p<0.05. *** p<0.01.

In column 1 we examine the effect the physical presence of children has on managing the financial burden associated with periods of ill-health by introducing three dummy variables designed to capture the proximity of the closest child to the family home. These dummy variables are only significant for households where at least one child lives at home. This provides us with our first indication that the negative effect of children that we observed in the previous subsection is not a result of having children per se but is driven by the proximity these children have to the family home, and hence the physical support that they can provide when a family member is ill.

Next we examine the role of financial support by interacting the dummy variable for children with whether the household receives any net transfers from its children (column 2). Although the marginal effect on this interaction term is only significant for the rural households, its sign is positive, which implies that for these households financial support increases rather than decreases the incidence of catastrophic health spending.

We investigate this effect further in column 3, where we examine whether the role of financial support is affected by the proximity of the household to its nearest child. Adult children in China appear to trade off proximity to the family home for economic opportunities from living elsewhere, with those who live further away being more likely to send larger amounts of remittances back home on a regular basis (see Table C.2 in the Appendix). We interact the dummy variables capturing proximity of the closest child to the family home with whether the household receives net transfers (column 3). We find that for urban households, receiving financial support reduces the likelihood of experiencing catastrophic health spending when either the closest child lives at home, or in another province/country.

Several potential hypotheses stem from the juxtaposition of these results. Firstly, the protection effect from having children arises from those who still live at home. Secondly, receiving financial support does help to reduce catastrophic health spending, but only if the household has directly accessible physical support (i.e. when at least one other child lives at home) or for those households where the children have moved to another province/country when the level of net transfers is sufficiently large. In addition, these interaction effects are only significant for urban households.

4.4.3 The Role of Chronic Diseases: Duration and Disease Type

In the final subsection we look in more detail at the effect the duration and the type of chronic disease has on the household's ability to cope with the financial costs associated with ill-health (Table 4.4). We find that over and above the effect of having an

Table 4.4: Maximum Likelihood Estimates of the Probability of Undergoing Catastrophic Health Spending: Duration of and Type of NCD

Variables	**(1)**			**(2)**		
	All	**Rural**	**Urban**	**All**	**Rural**	**Urban**
	Mar. Eff.	**Mar. Eff.**	**Mar. Eff.**	**Mar. Eff.**	**Mar. Eff.**	**Mar. Eff.**
NCD	0.103***	0.128***	0.064***			
	(0.011)	(0.014)	(0.016)			
Base: NCD × Disease diagnosed in the survey year						
1 year ago	0.028	-0.003	0.081			
	(0.033)	(0.043)	(0.050)			
2 years ago	0.037	0.071*	-0.012			
	(0.032)	(0.043)	(0.048)			
3 years ago	0.011	0.029	-0.013			
	(0.032)	(0.042)	(0.048)			
4 years ago or earlier	0.064**	0.086**	0.034			
	(0.026)	(0.034)	(0.038)			
Specific NCDs (respondent/spouse)						
Cardiovascular disease				0.046***	0.062***	0.023*
				(0.009)	(0.013)	(0.014)
Cancer				0.089**	0.129**	0.045
				(0.037)	(0.053)	(0.051)
Diabetes				0.081***	0.056**	0.100***
				(0.016)	(0.024)	(0.021)
Respiratory disease				0.035***	0.038***	0.033**
				(0.011)	(0.014)	(0.017)
Mental health problems				0.016	0.008	0.025
				(0.019)	(0.025)	(0.027)
Other NCDs				0.052***	0.067***	0.030**
				(0.009)	(0.013)	(0.013)
Number of observations	8,087	4,871	3,216	8,087	4,871	3,216
Pseudo R^2	0.127	0.110	0.151	0.132	0.113	0.162

Notes: Additional covariates include all the other variables presented in Table 4.2. Average marginal effects are reported and robust standard errors in parentheses. * p<0.1. ** p<0.05. *** p<0.01.

NCD, for those living in the rural areas disease duration has a positive and significant effect on the incidence of catastrophic spending; raising the likelihood from 7 percentage points for households where the respondent/spouse has had a chronic disease for

2 years, to 9 percentage points for those who were diagnosed at least 4 years ago.

Turning to the specific disease effects, we find that having cancer has the biggest impact, raising the probability of undergoing catastrophic health spending by 9 percentage points. This is followed by diabetes (8 percentage points), cardiovascular disease (5 percentage points), and respiratory disease (4 percentage points). In contrast, having mental health problems is insignificant in this setting. Such a finding is at odds with figures from the WHO that suggest that China has growing mental health problems (Wong et al., 2013), and may arise due to the fact that there is still a stigma associated with mental health problems, especially among this age group.[61]

Differences also emerge between rural and urban China when we look at the effect specific diseases have on the incidence of catastrophic health spending, with cancer and diabetes posing the biggest threat to rural and urban households, respectively. Despite the fact that early detection and treatment is an important aspect of cancer prevention and control, primary care facilities in rural areas often lag behind their urban counterparts.[62] For diabetes, China now has one of the highest prevalence rates in the world (Xu et al., 2013) , with rapid urbanisation often being seen as a key determinant of this rise (Ramachandran et al., 2010). In addition, diabetes is expensive to treat, requiring extensive follow-up care, the costs of which are still not covered by two of the country's three main health insurance schemes (Tang et al., 2013).[63]

[61] Indeed, when we replace this self-reported indicator of mental health problems with a more objective measure derived from the 10-item version of the Centre for Epidemiologic Studies Depression Scale (CES-D), we find that in 48 percent of households the respondent/spouse reports symptoms of depression (compared to a prevalence rate of 2 percent using the self-reported measure). Using this measure, depression has a positive and significant effect on the incidence of catastrophic health spending (with a marginal effect of around 5 percentage points). These results are reported in Table C.3 in the Appendix.

[62] For example, although screening for cervical cancer and breast cancer is covered by medical insurance in urban areas, in rural areas this type of screening is still not widespread, and is only provided in 200 of the 1500 counties (Zhao et al., 2010).

[63] A recent study by the Chinese NCD Surveillance Group using a nationally representative sample of population to be 12 percent and the prevalence of pre-diabetes to be 50 percent (Xu et al., 2013). As a result, China has surpassed the UK and the US in terms of the prevalence rate and India in terms of the absolute population with this disease becoming the country with the highest proportion of the population with diabetes in the world.

4.5 Robustness Analysis

Thresholds for Catastrophic Health Spending Although 40 percent is a widely used threshold in the literature for defining catastrophic health spending, we re-estimate our model using thresholds ranging from 25 to 50 percent (in increments of 5 percent). In doing so we find that our main findings are robust to different thresholds being used (Table 4.5). We find that having an NCD has a positive and significant effect on the probability of undergoing catastrophic health spending raising this probability from 8 to 13 percentage points depending on the threshold that is used. We also find that having children helps to mitigate the financial burden associated with periods of ill-health.

Table 4.5: Robustness Test: Catastrophic Health Spending Defined at Different Thresholds

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	25%	**30%**	**35%**	**40%**	**45%**	**50%**
	Mar. Eff.	**Mar. Eff.**	**Mar. Eff.**	**Mar. Eff.**	**Mar. Eff.**	**Mar. Eff.**
NCD	0.130***	0.114***	0.107***	0.097***	0.092***	0.080***
	(0.013)	(0.012)	(0.011)	(0.011)	(0.010)	(0.010)
Has children	-0.066**	-0.067**	-0.068**	-0.081***	-0.072***	-0.051*
	(0.029)	(0.028)	(0.028)	(0.028)	(0.027)	(0.026)
No. of observations	8,087	8,087	8,087	8,087	8,087	8,087
Pseudo R^2	0.133	0.127	0.126	0.125	0.131	0.129

Notes: Additional covariates include all the other variables presented in Table 4.2. Average marginal effects are reported and robust standard errors in parentheses. * p<0.1. ** p<0.05. *** p<0.01.

In addition, we find that whatever the threshold, having children that still live at home remains the main reason behind the negative association we observe between having children and catastrophic health spending. Similarly, we find that although receiving financial support is individually insignificant, the interaction effects vary with the level of physical support in the same way as we find in our main results. These results are reported in Table C.4 in the Appendix.

4.5.1 Effect of Other Household Members

A potential limitation of this chapter is that CHARLS only collects information on the respondent and spouse, and as such we do not know the disease status of other household members. In Table 4.6 we restrict the sample to the 2,861 households where the respondent either lives alone or with just his spouse. We find that having an NCD has a positive and significant effect on the probability of undergoing catastrophic health spending, which is greater for the rural than urban households. However, since in this specification no other household members are present, the effect of having children is insignificant. This provides further support for the notion that it is children living in the household, rather than having children per se that is important for mitigating the costs of catastrophic health spending.

Table 4.6: Robustness Test: Restricted Sample – Respondent/Spouse Only

Variables	**(1)**	**(2)**	**(3)**
	All	**Rural**	**Urban**
	Mar. Eff.	**Mar. Eff.**	**Mar. Eff.**
NCD	0.149***	0.191***	0.119***
	(0.021)	(0.033)	(0.036)
Has children	-0.035	-0.035	-0.023
	(0.035)	(0.048)	(0.045)
Number of observations	2,861	1,700	1,161
Pseudo R^2	0.166	0.138	0.205

Notes: Additional covariates include all the other variables presented in Table 4.2. Average marginal effects are reported and robust standard errors in parentheses. * p<0.1. ** p<0.05. *** p<0.01.

4.5.2 Sample Disaggregated by Age and Poverty Status

Next we re-estimate the baseline specification for different sub-samples. We begin by splitting the sample between non-elderly (where both the respondent/spouse are below 60), and elderly households (where either the respondent/spouse is at least 60 or older), in order to examine the extent to which a household's reliance on its children changes with the age of the household (Table 4.7).

We find that having an NCD has a positive and significant effect on the incidence of catastrophic health spending for both household types, although the effect is greater for the elderly households. In addition, we find that having children has a negative effect on the incidence of catastrophic health spending for elderly households, but is insignificant in non-elderly households. Further sensitivity analysis shows that this switch towards a reliance on children for support occurs at the age of 65.[64]

Next, we split the sample between non-poor and poor households in order to examine the extent to which poor households are more vulnerable to the financial burden asso-

[64] Currently the cut-off point distinguishing non-elderly and elderly households is whether the older respondent/spouse is 60. We vary this cut-off point from 61 to 69 and find that the negative effect associated with having children becomes significant at 65.

Table 4.7: Robustness Test: Baseline Specification Disaggregated into Non-Elderly and Elderly Households

Variables	**Non-elderly (45-59)**			**Elderly (60+)**		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	All	**Rural**	**Urban**	**All**	**Rural**	**Urban**
	Mar. Eff.	**Mar. Eff.**	**Mar. Eff.**	**Mar. Eff.**	**Mar. Eff.**	**Mar. Eff.**
NCD	0.067***	0.090***	0.051**	0.121***	0.172***	0.076**
	(0.013)	(0.023)	(0.023)	(0.017)	(0.028)	(0.032)
Has children	-0.011	-0.043	0.062	-0.145***	-0.109**	-0.148***
	(0.031)	(0.040)	(0.057)	(0.044)	(0.055)	(0.048)
Number of observations	3,793	2,247	1,546	4,294	2,624	1,670
Pseudo R^2	0.125	0.104	0.163	0.100	0.085	0.125

Notes: A household is defined as elderly household if either the respondent/spouse is at least 60 or older. Additional covariates include all the other variables presented in Table 4.2. Average marginal effects are reported and robust standard errors in parentheses. * p<0.1. ** p<0.05. *** p<0.01.

ciated with chronic disease. It could be argued that the positive effect NCDs have on catastrophic health spending should only exist for poor households, while non-poor households should be able to cope with this financial burden. We define a household as being poor if its total household expenditure is less than its subsistence spending (see Xu, 2005).

Table 4.8 shows that having an NCD increases the probability of undergoing catastrophic health spending for both household types, although in the rural areas this effect is much more pronounced for poor than non-poor households (21 versus 8 percentage points). In addition, there might exist some households who choose to not to seek health care rather than becoming impoverished (Xu et al., 2003). In CHARLS, information on forgone inpatient and outpatient care was collected and the reasons were followed up. This allows us to exclude 307 households who forewent any health care due to 'economic reasons', we find that our results are robust to the restricted sample (results not reported here), thus this selection issue could be small in this analysis.

4.5.3 Endogeneity of Having NCDs

Finally, our estimates could suffer from reverse causality if being poor further exposes household members to the risk factors associated with chronic diseases. We address this limitation by instrumenting for NCDs using the following risk factors as instruments: whether the respondent/spouse has high blood pressure, or is overweight (BMI >25 kg$/m^2$). We treat the number of NCDs as a continuous variable so that the probit model with endogenous continuous endogenous regressor framework can be applied.

Table 4.8: Robustness Test: Baseline Specification Disaggregated by Poverty Status of the Household

Variables	Non-poor (45-59)			Poor		
	(1)	(2)	(3)	(4)	(5)	(6)
	All	Rural	Urban	All	Rural	Urban
	Mar. Eff.	Mar. Eff.	Mar. Eff.	Mar. Eff.	Mar. Eff.	Mar. Eff.
NCD	0.067***	0.080***	0.067***	0.158***	0.207***	0.075
	(0.013)	(0.023)	(0.022)	(0.021)	(0.031)	(0.049)
Has children	-0.057	-0.048	-0.053	-0.131***	-0.116**	-0.125*
	(0.037)	(0.049)	(0.038)	(0.046)	(0.048)	(0.066)
Number of observation	5,805	3,126	2,679	2,282	1,745	537
Pseudo R^2	0.134	0.121	0.145	0.099	0.097	0.147

Notes: A household is defined as poor if its total household expenditure is less than its subsistence spending. Additional covariates include all the other variables presented in Table 4.2. Average marginal effects are reported and robust standard errors in parentheses. * p<0.1. ** p<0.05. *** p<0.01. *** p<0.01.

In doing so we find that we do not have sufficient evidence to reject the null hypothesis of exogeneity (p-value 0.26) for the full sample, which implies that reverse causality is not a concern (Table 4.9). Although in rural sample we reject the null hypothesis at 10 percent significance level, the effect is highly significant and of a substantive magnitude, indicating the effect of NCD on catastrophic health spending is not due to reverse causality.

Table 4.9: Robustness Test: Estimation on Number of NCDs Using IV

Variables	(1)	(2)	(3)
	All	Rural	Urban
Number of NCDs	0.090**	0.139***	-0.007
	(0.035)	(0.039)	(0.058)
Observations	6,466	4,107	2,359
P-value of Wald exogeneity test	0.257	0.065	0.472

Notes: Number of NCDs is instrumented using two binary variables, whether the respondent/spouse has high blood pressure, and whether the respondent/spouse is overweight (BMI $>$ 25 kg/m^2). The sample size is reduced due to missing values in the two instruments. Additional covariates include all the other variables presented in Table 4.2. Average marginal effects are reported and robust standard errors in parentheses. * p<0.1. ** p<0.05. *** p<0.01. *** p<0.01.

4.6 Conclusion

This chapter uses data from a large representative sample of households in China, where the respondent in each household is aged 45 or above to examine the extent to which households are vulnerable to catastrophic health spending, and how this varies with the household's proximity to its closest child, and disease type.

We find that despite widespread coverage, health insurance in China is still not sufficient to fully protect its members from the risk of undergoing catastrophic health spending, with those covered by the New Rural Cooperative Medical Scheme being particularly vulnerable to the risk of catastrophic health spending, compared to those covered by the two urban schemes. We find that in both rural and urban areas, utilization of inpatient and outpatient care significantly increases the household's likelihood of undergoing catastrophic health spending.

In addition we show that a household's proximity to its adult children is important in managing the financial burden of disease, with physical support being more important in terms of reducing the probability of undergoing catastrophic health spending than financial support.

Finally, we show that large differences still exist between rural and urban China in terms of the impact chronic diseases have on the incidence of catastrophic health spending, with the negative effect NCDs have on the incidence of catastrophic health spending being twice as big in rural than urban areas. In terms of specific diseases, we find that cancer poses the biggest threat to rural households, while in the urban areas this disease is diabetes. Such findings persist after controlling for differences in the types of health insurance between the two areas, and arise, at least in part, due to differences in disease patterns between rural and urban areas.

Financial protection against high levels of out-of-pocket health expenditure is one of the primary goals in designing health sector reform strategies in many countries (WHO, 2000), as such this chapter provides several implications for the policy makers in order to achieve this goal as those who are prone to catastrophic health expenditure should be given attention and priority. Firstly, the treatment of chronic diseases is often expensive and lengthy, and although health care in China has undergone a series of reforms in recent years, reimbursement rates for inpatient care are still low, while the costs of outpatient care are still not covered by two of the country's three main health insurance schemes (Tang et al., 2013). These findings call for the extension of insurance coverage not only in breadth but also in depth to include all inpatient costs, and long-term care and rehabilitation for chronically ill patients. In addition, the development of chronic disease monitoring programmes could be considered as a complementary strategy.

Secondly, we find physical presence of adult children is important for the household to manage financial burden of chronic diseases. However, the effects of China's strict birth control policy, coupled with rapid urbanisation means that the elderly in China will soon have fewer children to support them physically in their old age, leaving many households with spiraling health care costs. Policy makers might consider improving the local facilities to take care of those households whose adult children are absent. Lastly, given the higher financial risk for rural households, an integration of rural and urban insurance schemes is urgently needed to improve the financial well-being of many individuals in China.

CHAPTER 5

The Migration Decision of Adult Children, Inter-generational Support and the Well-being of Older Parents

5.1 Introduction

The economic and social implications of a rapidly ageing population are increasingly becoming a challenge for many countries, especially low to middle-income countries where social support networks are often inadequate. None more so is this the case than in China where social customs, coupled with inadequate safety nets (a lack of pensions and health insurance, especially in the rural areas) means that support for the elderly often remains the responsibility of their adult children. Despite this, rapid urbanization characterised by large-scale internal migration is beginning to change traditional patterns of living arrangements and forms of support. Maintaining the well-being of the elderly in China has become even more challenging due to sharp declines in fertility which means that many parents have fewer children to support them in old age.

Although over the years a literature has developed that examines the role that migration of adult children has on the physical and emotional well-being of the elderly, the evidence on whether migration is good or bad is mixed. Kuhn et al. (2011), for example, look at the effect rural-to-urban migration has on the physical well-being of elderly parents in Indonesia, and find that internal migration is associated with a reduced risk of negative health outcomes and lower mortality. In contrast, Gibson et al.

(2010) find no significant impact of migration on the health outcomes of older adults (46+) in Tonga, where neither health behaviour (e.g. smoking and alcohol consumption), nor health outcome measures (e.g. BMI, waist-to-hip ratio and mental health) are significantly affected. Other studies examine the effect adult children have on the psychological well-being of their parents. For example, Abas et al. (2009) observe a lower incidence of depression among parents in Thailand whose children are all rural-urban migrants compared to parents who have at least one child living with them. In contrast, Adhikari et al. (2011) report a strongly negative association between the elderly's mental health and their children's migration from the parents' province in Thailand.

Among these studies endogeneity of migration is generally acknowledged as the main methodological difficulty in identifying the impact migration has on those who are left-behind. Migration is generally not random and migrants self-select, i.e. the decision to migrate may be correlated with the same factors that influence the well-being of the older parents left-behind. If this selection into migration is based on observable factors, methods such as propensity score matching can be used to take this selection issue into account (Kuhn et al., 2011).[65] However, if selection into migration also depends on unobservable factors, estimation bias would still exist. Fixed effects estimators are useful if the unobservable factor is time-invariant across individuals or families, but could still suffer omitted variable bias if the unobserved shock is not constant across time (see Mosca and Barrett, 2014). Instrumental variable (IV) estimators are widely used to deal with this endogeneity problem regardless of the availability of panel data. A valid instrument should only affect the outcome of interest through its effect on the migration variable. Possible instruments include historical migration rates (Hanson and Woodruff, 2003; Hildebrandt et al., 2005; McKenzie and Rapoport, 2011) and variables linked to economic conditions in the destination areas (Antman, 2011; Yang, 2008). However it is often the case that instruments are likely to be weakly correlated with the outcome of interest, rendering the IV estimates biased (Antman, 2013).

In this chapter, we therefore adopt a treatment-effects framework to deal with the self-selection of migration decisions to remove selection bias. In addition, we allow the outcome error terms and the treatment error terms to be correlated so that endogeneity bias can also be taken into account as well as selection bias.

[65] In other words, by estimating the assignment of migration as a function of individual and household characteristics and pairing members of the treated with members of the control whose propensity scores are similar, selection bias can be removed as migration mimics random assignment.

We apply the above identification strategy to data from the CHARLS 2011 national survey. In this nationally representative household data, over 70 percent of rural parents aged 45+ have at least one migrant child (i.e. a child who lives beyond their parent's village). We examine the process of migration from two perspectives. Firstly, from the perspective of those who migrate (the adult children) we study the determinants of an individual child's migration decision as well as their decision to remit. Then secondly, from the perspective of the parents who are left-behind, we examine the effect migration has on their physical health and subjective well-being.

We find that migration decisions in China are significantly related to the household structure including birth order, sibling size and sibling composition (i.e. age and gender).[66] We estimate the sibling size effect using instrumental variable strategy, instrumenting for sibling size with twin births and gender of the firstborn child. We find evidence of a negative relationship between sibling size and migration when this potential endogeneity is taken into account. In addition, we find that the probability of migration is not equally distributed across children within the family. Firstborn children appear less likely to migrate, especially firstborn sons. However, having more elder brothers systematically increases younger sibling's probability of migration out of the village regardless of gender. Further we find that migrant children are more likely to send transfers to their parents than their counterparts and about half of this effect can be explained by intergenerational support exchanges between children and parents.

Controlling for endogenous selectivity, we find that the migration of children is associated with a better outcome for their parents' subjective well-being including mental health and life satisfaction but has no significant effect on physical health measured by activities of daily living (ADLs). However, when a series of biomarkers are used to measure the parent's physical health, we find that migration is associated with a reduction in their risk of being underweight. To investigate the potential mechanism underlying these beneficial health effects, we use the same identification strategy and find evidence that child migration eases liquidity constraints that might obstruct a parent's access to health care.

[66] A few studies on migration make use of natural experiments to ensure that migrants are randomly assigned, and hence for them selection is no longer an issue (Gibson et al., 2010; Mergo, 2013).

The remainder of this chapter is organised as follows. Section 2 provides the conceptual framework. In section 3, we present the data and the descriptive analysis. Section 4 and 5 presents the identification strategy and main results regarding the decision to migrate and to remit, respectively. Section 6 addresses the effect migration has on the parents' health and subjective well-being. In section 7, we present robustness checks, while section 8 concludes.

5.2 Conceptual Framework

It is frequently argued that two effects arise from the migration of adult children on the well-being of their parents: an income effect (i.e. financial contribution) and a substitution effect (i.e. lack of time contribution). *A priori* it is difficult to predict which effect will dominate. As a result the overall effect migration has on the welfare of remaining family members is theoretically uncertain (Gibson et al., 2010)

The income effect arises as a result of remittances sent home by those who migrate. There are competing theories regarding the incentives of remitting for migrants.[67] It may be out of altruism, simply because migrants care about other members left-behind (Lucas and Stark, 1985). Alternatively, self-interest might dominate as they send back remittances in exchange for services such as taking care of the migrant's assets (e.g. land and cattle) or relatives. Remittances may also represent a repayment of loans made to finance migration or education as migration is usually costly. These individualistic motives may sometimes be combined with a familial arrangement such as insurance against income uncertainty inherent in agriculture production (e.g. changing climatic conditions) so that some members are sent to work in the urban labour market outside of agriculture. These remittances directly contribute to the household's income, enabling them to purchase more assets, and buy more normal goods, including education and health inputs. In some cases, they also relieve household liquidity constraints, enabling them to mitigate the impact of domestic shocks (Calero et al., 2009).

While remittances contribute to disposable income, migration can decrease household-level labour income if those who migrate were previously employed or engaged in household agricultural work. Moreover, whatever the motivation behind the decision to migrate, the absence of these individuals from the household may cause considerable disruption to informal security networks (Böhme et al., 2015; Stöhr, 2015). These

[67] See Rapoport and Docquier (2006) for an overview on this topic.

effects may counteract the positive effects of remittances received.

Gibson et al. (2010) examine the myriad of impacts that migration has on the remaining household members using data from a migration lottery programme which provides residents of Tonga with a visa to live in New Zealand. They find that households with migrants face a decrease in per-capita income by about 25 percent because the increase in remittances does not offset the loss of the migrant's previous labour income. Similarly, Antman (2010) finds that Mexican parents whose children have migrated to the US receive less monthly income from all sources and are less likely to report having access to medical services compared to parents without migrant children.

In contrast, Cai et al. (2012) examine the effect of having a migrant child on the income of elderly households in rural China. Despite a negligible effect on household income, they find that migrant children provide insurance against the loss of income arising from shocks to the local economy or periods of ill-health. Further, they find that migrant children help insure against poverty. Similarly, Abas et al. (2009) using data for Thailand find that migration of all children (defined as living beyond their parents' district) is associated with less depression in parents. In their sample, households where all the children live beyond the district receive more economic remittances and they perceive support to be as good as that for those with children who live nearby. They argue that this could be explained by pre-existing advantages in families sending more migrants (i.e. households enabling all children to migrate may have greater personal resources) and by the overriding economic benefits of migration.

Finally, this work relates to the literature on siblings' response in caring for the elderly when one sibling migrates. Antman (2012) studies the intra-household resource allocation between siblings and finds that the migration of one child could affect the overall level of financial and time contributions elderly parents receive from all their children. He finds that an increase in monetary contributions by one child is associated with an increase in contributions from the other children. Antman (2012) argues that financial contributions are complements, which might arise from the strategic bequest motive. However, time contributions appear to be substitutes. In other words, if one child migrates and therefore cannot provide the same time input to their parents, the remaining siblings are likely to make up for some of the decrease. In addition, the decision to migrate might depend on the presence of other siblings who are available as care providers especially when a parent is ill (Giles and Mu, 2007).[68] Support from adult children could also be affected by their parents' involvement in the care of grandchildren (Cong and Silverstein, 2012). Thus, any analysis of the effects of migration on the family left-behind may be complicated by these interaction effects between family members.

Building on the existing literature we examine the causal effect migration of adult children has on their parents' physical health and subjective well-being using CHARLS.

5.3 Data and Summary Statistics

5.3.1 Data and Sample Selection

This chapter uses data from the 2011 baseline national wave of CHARLS, focusing on the sample of rural households where the main respondent is aged 45+, and has at least one child whose age is above 15.[69] Here a respondent is defined as having a migrant child if the child lives beyond the village. We exclude a small number of households in which the birth of a child is reported as occurring before the respondent was 16 or after the respondent was 50 so that the children were born when their parents are of child-bearing age. This leaves us with a final sample of 2,988 households and 8,625 children.

One unique feature of CHARLS compared to other household data sets is that it collects personal information on all family members regardless of whether or not they currently reside in the household. Detailed information on time and financial transfers between family members is also collected enabling us to calculate the cash and in-kind transfers between the household and any migrant children.

We measure the amount of time non-cohabiting children spend with their parents using two measures: one is their frequency of actual visits and the other is the frequency of non-face-to-face communication with their parents. CHARLS asks each respondent how often they see their child(ren) where the response is coded into 9 levels as follows:

[68] Giles and Mu (2007) find that if an extended family includes siblings, who are potential care providers, the impact of elderly parent health on the migration decision is much less pronounced.

[69] The threshold of 15 is consistent with World Bank's definition of dependency ratio where the working age population is aged 15 to 64 years (see http://data.worldbank.org/indicator/SP.POP.DPND). This removes about 3 percent of the sample. Households without children ($<$ 3 percent) are dropped from the sample and are not the focus of the thesis.

(1) 'almost every day', (2) '2-3 times a week', (3) 'once a week', (4) 'every two weeks', (5) 'once a month', (6) 'once every three months', (7) 'once every six months', (8) 'once a year', or (9) 'almost never'. If a child visits their parents less than 'once a week', respondents are asked how often do they have contact with that child either by phone, text messages, mail or email and the same levels of response are used. In what follows, we code the two variables as continuous ranging from 1 to 9 where higher values indicate a lower level of time contribution.

The financial contribution of non-cohabiting children is calculated as the monetary sum of their cash and in-kind transfers from regular and non-regular sources in the last year. For the few respondents who are unable or refuse to give an exact amount of any transfers, unfolding brackets are asked for each type of support. Unfolding brackets are designed to elicit a minimum and maximum number defining a range or 'closed band' within which the value lies.[70] Based on the thresholds provided in the unfolding brackets, imputation is used to group the non-missing values into different brackets and using this information we calculate the mean for each bracket.

Finally, we assess the physical and subjective well-being of our sample of parents using three dummy variables based on health variables we discussed in previous chapters.[71] Firstly, we use the activities of daily living (ADLs) variable to measure physical health. An individual is defined as having good physical health if their ADLs index is above the mean of the entire sample. We measure subjective well-being based on an index of depression and a five-level response on life satisfaction. Our measure of depression is derived from the 10-item version of the Centre for Epidemiologic Studies Depression Scale (CES-D). We also measure subjective well-being using self-reported life satisfaction where respondents are asked to rate their satisfaction with their life as a whole as being (1) 'not at all satisfied', (2) 'not very satisfied', (3) 'somewhat satisfied', (4) 'very satisfied', or (5) 'completely satisfied'. We classify respondents as being satisfied with their life if their rating is at the level of 'somewhat satisfied' or above. It should be

[70] The thresholds selected in CHARLS are 100, 200, 400, 800 and 1600 Yuan. Unfolding brackets differ from conventional brackets where respondents are presented with a list of ranges to select from. Instead, on entering the unfolding brackets, respondents are asked to say whether they have more, less or about a particular value. It is found using unfolding brackets can reduce non-response items in surveys (Heeringa et al., 1995). This question is repeated using the above threshold values (which will be a lower or higher number depending on the answer to the preceding question). The procedure stops at the point when either an upper and lower bound is provided, the respondent refuses or says 'do not know', or the respondent places themselves in the top bracket.

[71] A data overview can be found in Chapter 2.

noted that our results are also robust to a stricter definition of satisfaction, i.e., those who report that they are âĂŸvery satisfied'.

5.3.2 Summary Statistics

Table 5.1 illustrates the summary statistics for our sample of households. For the full sample, we report mean responses and then depending on the nature of the question either the standard deviation, or for the categorical variables the number reporting the highlighted response. In the final three columns, we report the mean disaggregated by the migration status of their children and the p-value to test the equality of the means between the two subsamples.

The main respondent in our sample is on average 60 and lives in a household with 2 other household members. About 80 percent of our respondents live with their spouse/partner while the proportion of those living with children and grandchildren is 56 percent and 40 percent, respectively. The majority of our respondents have an education of elementary school or below (75 percent) and mainly work as subsistence farmers (64 percent). The average number of children in each household is 3 and the eldest child is on average 36 years old. Although China has a 'one child policy' this did not start until 1979. In rural areas, families are allowed two children if the first is a girl. The main respondent in CHARLS 2011 were all born before 1966, and around 24 percent of them had not reached 20 (childbearing age) in 1979. In fact, only 11 percent of households have only one child (Table D.2 in the Appendix).

Around one third of households live below the poverty line and around 24 percent experience catastrophic health spending. Less than 8 percent of respondents receive any kind of pension although more than 90 percent are covered by the New Rural Cooperative Medical Insurance Scheme. The incidences of non-communicable disease and disability are high, which affect up to two-thirds and one-fifth of respondents, respectively.

In terms of the well-being measures, 56 percent of respondents have an ADLs score above the average of the sample while 60 percent have no mental health problems (i.e. a CESD-10 score below the cut-off), and around 80 percent report being satisfied with their life in general.

Table 5.1: Summary Statistics: Parents

Sample	**All**		**No migrant child**	**Has migrant child**	**t-test**
Number of observations	**N=2,988**		**N=867**	**N=2,121**	
Variable	**Mean**	**S.D./n**	**Mean**	**Mean**	**P-value**
Has migrant child	0.710	0.454	-	-	0.000
Good physical health	0.564	0.496	0.623	0.540	0.000
Good mental health	0.598	0.490	0.634	0.584	0.000
Good life satisfaction	0.843	0.364	0.833	0.847	0.299
Demo. characteristics					
Age	59.548	8.930	56.063	60.972	0.000
Male	0.503	0.500	0.497	0.505	0.126
Live with spouse/partner	0.799	0.401	0.822	0.789	0.211
Lives with children	0.561	0.496	0.854	0.441	0.000
Lives with grandchildren	0.401	0.490	0.451	0.380	0.002
Household size	3.608	1.905	4.427	3.273	0.000
Number of children	2.913	1.361	2.143	3.228	0.000
Age of the eldest child	35.532	9.232	31.074	37.354	0.000
Has any pension	0.079	0.269	0.061	0.086	0.052
Has NCDs	0.670	0.470	0.627	0.687	0.000
Has disability	0.178	0.383	0.148	0.190	0.000
Education					
Illiterate	0.321	n=958	0.280	0.337	0.000
Elementary	0.427	n=1,277	0.408	0.435	0.000
High school	0.239	n=713	0.293	0.216	0.000
Vocational or above	0.013	n=40	0.018	0.011	0.000
Employment					
Employed or self-employed	0.170	n=509	0.212	0.153	0.000
Subsistence farmer	0.644	n=1,925	0.633	0.649	0.000
Currently not working	0.172	n=513	0.144	0.183	0.005
Retired	0.014	n=41	0.010	0.015	0.038
Health insurance type					
NRCMS	0.912	n=2,726	0.917	0.910	0.000
Other insurance	0.042	n=125	0.044	0.041	0.000
No insurance	0.046	n=137	0.039	0.049	0.845

Notes: The p-value is calculated using either the t-test (if continuous) or the proportion test (if binary); a pre-test of equality of variance is conducted.

Table 5.2: Summary Statistics: Children

Sample	**All**		**Non-migrant child**	**Migrant child**	**t-test**
Number of observations	**N=8,625**		**N=4,385**	**N=4,240**	
Variable	**Mean**	**S.D./n**	**Mean**	**Mean**	**P-value**
Migrant child	0.492	0.500	0.000	1.000	0.000
Demo. characteristics					
Age	34.331	8.797	33.449	35.244	0.000
Male	0.548	0.498	0.728	0.362	0.000
Married	0.787	0.409	0.778	0.798	0.744
Has job	0.900	0.300	0.901	0.899	0.986
Sibling size	2.531	1.494	2.434	3.631	0.000
Eldest child	0.362	0.481	0.362	0.362	0.009
Education					
Elementary	0.450	n=3,881	0.443	0.457	0.001
High school	0.428	n=3,690	0.456	0.399	0.000
Vocational or above	0.122	n=1,054	0.101	0.144	0.000
Child lives with the respondent	0.149	0.356	0.239	0.056	0.000
Lives with the respondent	0.263	0.440	0.517	0.000	0.000
Time and financial contribution of non-cohabiting children	**N=6,357**		**N=2,117**	**N=4,240**	
Frequency of visits to respondents[1]	5.210	2.636	3.361	6.133	0.000
Frequency of contact with respondents[2]	4.679	2.193	5.377	4.525	0.000
Provides transfers	0.471	0.499	0.427	0.494	0.000
Amount of transfers	821	4195	554	954	0.000
Their child lives with parents	0.048	0.214	0.033	0.056	0.000

Note: The p-value is calculated using either the t-test (if continuous) or the proportion test (if binary); a pre-test of equality of variance is conducted. [1]Higher value of frequency variable indicates lower frequency where the values are coded as below: (1) 'almost every day', (2) '2-3 times a week', (3) 'once a week', (4) 'every two weeks', (5) 'once a month', (6) 'once every three months', (7) 'once every six months', (8) 'once a year', or (9) 'almost never'. [2]Non-missing response for children whose frequency of actual visits lower than 'once a week'.

Large differences exist between the characteristics of parents with and without migrant children. Those with migrant children tend to be older, less educated and more likely to work as subsistence farmers. They also tend to be poorer and are more likely to undergo catastrophic health spending. Parents with migrant child on average have more children and live in a smaller household. Among parents with migrant child, the proportion of respondents living with spouse/partner, any child or any grandchild are significantly lower than that among those without migrant child. Due to their older age, these respondents are also more likely to have non-communicable disease or disability. When we compare their well-being outcomes, on average, the proportion of respondents with good physical health or good mental health is significantly lower among those with migrant child while life satisfaction measure does not significantly differ between the two groups of parents.

Next we look at the summary statistics of our sample of children (Table 5.2). Among our 8,625 children, around half are migrants. The average age of the children is 34 and males slightly outnumber females. On average they have 2 more siblings and around 36 percent are identified as the oldest child. The majority of our adult children are married and working. More than half of them have an education above elementary school and 12 percent have an education of vocational or above.

When we compare the characteristics of migrant and non-migrant children, large differences arise between the two subsamples. Migrant children tend to be older, are more likely to be female, have more siblings and their education is more likely to be distributed at the two ends of the education spectrum. Around 6 percent of migrant children are characterized by having their own children living with their parents, while more than 20 percent of non-migrant children do so. This may arise because the vast majority of migrant children are female, who are more likely to leave their children with their parents-in-law (Ai-li and Freedman, 1970).

Turning to measures of physical and financial support we find that children visit their parents on average once a month. Those children who live in the same village as their parents are able to visit their parents more often (at least once a week or every two weeks) than those who migrate beyond the village (once every three months). Despite this, when the frequency of actual visits is less than once a week, migrant children appear to contact their parents more often (between 'every two weeks' and 'once a month') than their non-migrant siblings (less than 'once a month').[72] In terms of financial support, 47 percent of children provide at least one type of transfer to their parents and this proportion is 6 percentage points higher among those who migrate (49 percent *versus* 43 percent). The average value of transfers equates to 954 RMB for migrant children and 554 RMB for non-migrant children, the former being 72 percent higher. In addition, among those who live in the same village, only 3 percent of children leave their children with their parents, which is significantly lower than that for migrant children, showing that grandparents are more likely to take care of their grandchildren when their children migrate.

5.4 Determinants of Child Migration

5.4.1 Empirical Strategy

We begin our empirical analysis by examining the factors that determine the migration decision of each individual child. In particular, we are interested in the role household structure including sibling size, birth order and sibling composition has on the migration outcome. A spurious correlation between a child's decision to migrate and sibling size may arise if adult children as migrants assume the unique role of financial intermediaries in an economy where the security system is inadequate and institutional sources of credit are limited (Stark, 1981). This maybe the case in China where safety nets are limited and children are often viewed as the main source of old-age support (in the form of intra-household transfers or coresidence with children especially sons). In order to correct for this potential endogeneity, we use a two-stage least squares (2SLS) linear probability model for the migration decision.[73] Here sibling size is instrumented using two exogenous variables in the first stage as follows:

$$M_{ih} = \beta_0 + \beta_1 \cdot \hat{sib}_{ih} + \beta_2 \cdot X_{ih} + \varepsilon_{ih} \quad (5.1)$$

$$sib_{ih} = \alpha_0 + \alpha_1 \cdot twin_{ih} + \alpha_2 \cdot girl\_first_h + \alpha_3 \cdot X_{ih} + v_{ih} \quad (5.2)$$

where M_{ih} equals 1 if a child lives beyond their parent's village; sib_{ih} measures sibling size ($\hat{sib}_{ih}$ is the predicted value of sib_{ih} in Equation 5.2); X_{ih} is a vector of individual

[72] It is worth noting that the majority of migrant children could not visit their parents at least once a week (88 percent) compared to 38 percent among the non-migrant children.

[73] Although we have a dichotomous dependent variable, we choose a linear probability model here because the estimated coefficients are easier to interpret than otherwise using a non-linear specification such as logit or probit. Despite this, using a probit model with continuous endogenous regressors we find similar results in terms of marginal effects.

covariates including child birth order; $twin_{ih}$ equals 1 if the child has a twin. Rosenzweig and Wolpin (1980) first discuss the idea of using twin births as unplanned and therefore exogenous variation in family size. In their model, parents have an optimal number of children and the birth of twins can vary the actual family size from the desired size. $girl\_first_h$ is also a dichotomous variable which equals 1 if the child lives in a household where the firstborn child is a girl. Like many other Asian countries, Chinese parents have a strong preference for sons and parents are more likely to give birth to another child when their firstborn is a girl (Lee, 2008). This is also consistent with the observation in our data (see Figure D.1). There is a downward-sloping relationship between the proportion of boys and the family size in a household, which is robust at each birth order.[74] Thus, we expect households with firstborn girl to be larger than households with firstborn boy. In the above equation, ε_{ih} and v_{ih} are idiosyncratic errors, which are allowed to be correlated within the same household. All analyses are coded and done using Stata version 13 and the built-in command -ivregress 2sls- is used to fit this 2SLS model.

5.4.2 Results: Sibling Size and Birth Order Effects

The 2SLS estimates are presented in Table 5.3, along with the first-stage estimates and the OLS estimates using the full sample of children. We also present the 2SLS estimates for the subsamples of females (column 3) and males (column 4). The first stage regression suggests that a twin birth increases sibling size by 0.78 while being born in a household where the firstborn is a girl increases the family size by 0.20.[75] The F-statistic from the first stage is 152, which is substantially greater than the threshold of 10, indicating that there are no concerns about weak instruments in this application. We also test for the exogeneity of instruments. The p-value for the Hansen's J statistic is greater than 10 percent, so we do not reject the null hypothesis and conclude that our instruments are exogenous. Lastly, we test whether sibling size is indeed endogenous and reject the null hypothesis that all variables are exogenous at the 5 percent level, indicating that OLS would have been biased.

[74] From Figure D.1, we find that over 70 percent of households have boys in families with one child and this proportion decreases to 57 percent when the family size is two. In households with three or more children, less than half of firstborn children are boys. In addition, the last-born of a family (including the firstborn in one child families) is more likely to be a boy, which is also consistent with the gender preference of parents in China - they prefer to have another child if the last child is a girl.

[75] Although these coefficients are not straightforward to interpret, the two instruments have positive sign, showing that having a twin or firstborn girl in the household increases the family size.

Table 5.3: Estimates of Migration Decision: Sibling Size, Birth Orders – 2SLS

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
	All	**All**	**All**	**Female**	**Male**
	OLS	**1st stage**	**2nd Stage**	**2nd Stage**	**2nd Stage**
Sibling size	-0.006		-0.075***	-0.094***	-0.061*
	(0.006)		(0.028)	(0.036)	(0.037)
Birth order (Base: First child)					
Second child	0.012	0.467***	0.044**	0.056**	0.036
	(0.012)	(0.018)	(0.018)	(0.024)	(0.025)
Third child	0.043***	1.122***	0.121***	0.143***	0.097*
	(0.016)	(0.030)	(0.035)	(0.043)	(0.050)
Fourth child	0.060***	1.929***	0.193***	0.225***	0.166**
	(0.023)	(0.047)	(0.058)	(0.070)	(0.082)
Fifth child	0.034	2.723***	0.222***	0.272***	0.189*
	(0.033)	(0.068)	(0.081)	(0.105)	(0.112)
Sixth + child	0.020	4.006***	0.293**	0.326**	0.271*
	(0.048)	(0.118)	(0.118)	(0.156)	(0.157)
Child characteristics					
Age	0.008***	0.093***	0.014***	0.019***	0.010**
	(0.002)	(0.004)	(0.003)	(0.004)	(0.004)
Male	-0.391***	-0.215***	-0.410***		
	(0.011)	(0.020)	(0.013)		
Education (Base: Below elementary)					
Middle school	0.055***	-0.112***	0.047***	0.048**	0.056***
	(0.012)	(0.030)	(0.012)	(0.019)	(0.014)
Vocational or above	0.203***	-0.200***	0.190***	0.024	0.317***
	(0.019)	(0.037)	(0.018)	(0.029)	(0.023)
Married	0.027	0.091	0.033**	0.027	0.033*
	(0.017)	(0.059)	(0.014)	(0.021)	(0.019)
Has job	0.075***	-0.022	0.074***	0.038*	0.133***
	(0.017)	(0.040)	(0.017)	(0.021)	(0.028)
Family characteristics					
Age of respondent/10	0.376***	-0.666***	0.326***	0.426***	0.247***
	(0.007)	(0.026)	(0.007)	(0.010)	(0.009)
Age of respondent/10 square	-0.030***	0.044**	-0.026***	-0.036***	-0.019***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Education of respondent (Base: Illiterate)					
Elementary	0.040**	-0.020	0.039***	0.029	0.047**
	(0.018)	(0.061)	(0.014)	(0.021)	(0.019)
High school	0.035*	-0.008	0.034**	0.014	0.057**
	(0.021)	(0.063)	(0.017)	(0.025)	(0.023)
Vocational or above	-0.049	-0.019	-0.050	-0.024	-0.073
	(0.041)	(0.129)	(0.035)	(0.051)	(0.047)
Employment status of respondent					
Subsistence farmer	0.025	-0.082*	0.020	0.021	0.017

Table 5.3 Continued:

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
	All	**All**	**All**	**Female**	**Male**
	OLS	**1st stage**	**2nd Stage**	**2nd Stage**	**2nd Stage**
	(0.017)	(0.045)	(0.015)	(0.022)	(0.020)
Unemployed	-0.026	0.052	-0.023	-0.013	-0.027
	(0.022)	(0.066)	(0.018)	(0.028)	(0.024)
Retired	0.027	0.113	0.039	0.080	-0.008
	(0.049)	(0.203)	(0.041)	(0.061)	(0.054)
Poor household	0.001	0.001	0.001	-0.001	0.001
	(0.013)	(0.039)	(0.011)	(0.016)	(0.014)
Respondent has household ownership	-0.126***	0.114*	-0.118***	-0.105***	-0.132***
	(0.021)	(0.066)	(0.018)	(0.028)	(0.022)
Instruments					
Twin		0.785***			
		(0.086)			
Firstborn child is a female		0.205***			
		(0.035)			
Constant	-0.728***	2.178***	-0.562***	-0.824***	-0.772***
	(0.224)	(0.752)	(0.209)	(0.312)	(0.269)
Observations	8,625	8,625	8,625	3,900	4,725
R^2	0.203	0.612	0.186	0.039	0.128
F-stat at first stage		151.70	84.83	86.97	
P-value of Hansen's J stat		0.695	0.723	0.339	
P-value of endogeneity test		0.011	0.014	0.011	

Note: binary variable indicating whether a child lives beyond his/her parent's village. Additional control variables include 27 provincial dummy variables. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Indeed looking at the OLS estimates in column 1 we find that the effect of sibling size is not statistically different from zero. However, once we account for endogeneity, we find highly significant and negative effect of sibling size - children with one more sibling are 7.5 percentage points less likely to migrate. This finding is in line with Giles and Mu (2007). Having more siblings might discourage a child's decision to migrate because larger families may be engaged in more extensive family business activities in which an adult child could find local employment. In addition, this sibling size effect is more pronounced among females, who are also more likely to migrate (column 4).[76] As part of the robustness tests in section 1.7, we test whether this negative relationship still holds when the family size is small due to the implementation of the one child policy.

[76] To avoid the problem that children from the same household have the same number of siblings, we also run the family-level regression for firstborn children only and find the same negative relationship between sibling size and the decision to migrate.

Next we turn to the other child characteristics. In order to estimate the effect sibling size has on children's outcomes, Black et al. (2005) suggest that children's birth order must be taken into account as birth order could confound with the family size effect.[77] We find that the birth order effects are positive in our model - later-born children are more likely to migrate than firstborn children and there appears to be a monotonic relationship whereby older children are more likely to migrate. Although this might run counter to the birth order effects where later-born children are more likely to migrate than firstborns who are older, the birth order effect is an intra-household characteristic whereas age can differ across households.[78] Female children have a higher likelihood to migrate than their brothers by 41 percent, which is consistent with the fact that older parents in China prefer to live with their sons than with their daughters in old age (Chen and Silverstein, 2000; Parish William and King, 1978). In addition, children with higher education are more likely to migrate, consistent with the fact that high skilled children migrate while low skilled children are more likely to stay with their parents (Borjas et al., 1992). Lastly, being married or employed increases a child's likelihood to migrate out of the village, showing that children's decision to migrate depends on the job opportunities or sometime a marital arrangement (Rosenzweig and Stark, 1989).

Turning to family characteristics we find that the age of parents has an n-shape effect on the likelihood that a child migrates.The likelihood that a child migrates reaches the greatest when his/her parent is around 63 then decreases as their parent gets older. In fact, migrants often face pressure to return to the countryside to fulfill obligations to parents who are too ill to care for themselves (Pang et al., 2004). Parent's education is also significantly related to a child's decision to migrate - children whose parents have an elementary or high school education are more likely to migrate than those whose parents are illiterate.[79] In addition, children are more likely to migrate if their parents are subsistent farmers compared to being employed or self-employed. Children's migration decision is not significantly affected by the poverty status of their family home although they are less likely to migrate when their parents own their own house, which might arise because housing is an important asset and they care for their parents by living with them or in a close proximity anticipating an inheritance (Lei et al., 2012b) .

[77] That is to say, family size effect diminishes in magnitude and significance when birth order variables are included.

[78] In other words, the eldest child in one household can still be younger than the youngest child in another household.

[79] Less than 2 percent of our respondent have an education of vocational or above.

5.4.3 Results: Sibling Gender Composition

The estimates shown above suggest that gender and birth orders are two robust predictors of migration and, ceteris paribus, females are significantly more likely to migrate out of home villages than males while the firstborn children are more likely to live in the same village as their parents. This suggests that parents' preference and social traditions may dominate a child's migration decision because gender preference for sons is very strong in China. Parents prefer living with sons at old age and the oldest child is considered to assume the main responsibility of looking after their parents (Chen and Silverstein, 2000). In order to test this prediction, we estimate separate regression for males and females' migration decision as a function of the number of their older brothers (and the square), while controlling for the number of sisters.

Results in Table 5.4 show that being the eldest daughter has similar likelihood to migrate as their younger sisters while being the eldest sons significantly decreases their likelihood to migrate compared to their younger brothers (columns 1 and 4). In addition, the number of older brothers significantly affects the sons' as well as the daughters' likelihood to migrate (columns 2 and 5). The negative estimate on the quadratic term (-0.015) and the positive estimate on the linear term (0.061) suggest that a female child's likelihood to migrate is the greatest when she has two brothers and then decreases with more brothers and this is also true for a male child.[80] On average, the presence of older brothers increases a daughter's likelihood to migrate by 5.3 percentage points, which is around 1 percentage point greater than that for a son (columns 3 and 6).

5.5 Financial Support and Migration

5.5.1 Empirical Strategy

Children's migration behaviour might differ from their behaviour of remitting (Rapoport and Docquier, 2006). We examine the determinants of children's decision to make transfers to their parents' household, in particular, the role that support exchanges play and to what extent it explains the migration effect. It is commonly viewed that both physical support and financial support from children are important for the older parents but are largely viewed as substitutes by children (Antman, 2013). This is evidenced in Chapter 4 where adult children are found to trade-off their proximity to their

[80] For males, this figure is calculated by the formulae $0.046/(2 \times 0.010)$ in column 5.

Table 5.4: Estimates of Migration Decision: Sibling Composition – 2SLS

Variables	(1) Female	(2) Female	(3) Female	(4) Male	(5) Male	(6) Male
Firstborn son/daughter	-0.003			-0.039***		
	(0.017)			(0.014)		
Number of older brothers		0.061***			0.046***	
		(0.022)			(0.015)	
Number of older brothers square		-0.015*			-0.010**	
		(0.008)			(0.005)	
Number of older sisters		0.016			0.022	
		(0.019)			(0.018)	
Number of older sisters square		-0.009			-0.005	
		(0.006)			(0.006)	
Has older brothers			0.053***			0.042***
			(0.017)			(0.014)
Has older sisters			0.001			0.017
			(0.017)			(0.016)
Observations	3,900	3,900	3,900	4,725	4,725	4,725
R^2	0.071	0.074	0.073	0.139	0.139	0.139

Notes: binary variable indicating whether a child lives beyond his/her parent's village. Additional control variables include child age, education, marital status and working status; parent's age, education, employment status, household poverty, household ownership and 27 provincial dummy variables. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

parents for better economic opportunities living elsewhere. To take into account of the substantial number of zeros in our outcome variable (53 percent of our children do not provide any type of transfers to their parents), we estimate the following Tobit model:

$$S^*_{ih} = \beta_0 + \beta_1 M_{ih} + \beta_3 X_{ih} + \varepsilon_{ih} \quad (5.3)$$

$$S_{ih} = 0 \quad if\ S^*_{ih} \leq 0 \quad (5.4)$$

$$S_{ih} = S^*_{ih} \quad if\ S^*_{ih} > 0 \quad (5.5)$$

where S^*_{ih} is the latent amount of total transfers (cash and in-kind) each child provided to their parents transformed into the logarithm form, which is proportional to the underlying utility of children from sending transfers; X_{ih} are defined in a similar way as earlier; ε_{ih} is assumed to have a normal distribution.

5.5.2 Results

In Table 5.5 we report separately the marginal effects with regard to the likelihood of providing any transfers (i.e. the extensive margin) and the average amount of transfers (i.e. the intensive margin) for the whole sample (column 1) and by gender (columns 2 and 3). We show that among all the children not living with their parents, migrant children are 8.9 percentage points more likely to send transfers to their parents and the average amount sent by migrant children are 54 percent greater than the average amount sent by those who do not migrate (column 1). The extensive and intensive margin of this migration effect appears stronger among males than females although males are less likely to migrate. Also notice that there is no significant difference between males and females in the likelihood of sending any transfers. According to the Chinese traditions, sons often bear the main responsibility of supporting their families while a daughter's responsibility is usually offset by her expected role of caring for her parents-in-law (Jin et al., 2006; Yang, 1996). This gender difference does not show in our sample which might arise because our sample includes only children not living with their parents, who are more likely to be females and later-born males, both of whom are less likely to assume the responsibility of taking care of the respondents. We do not find evidence that sibling size has any effect on a child's likelihood to remit.[81] By contrast, birth order effects are consistently positive, implying that later-born children are more likely to send transfers than firstborn children.

Turning to other child characteristics, older children are more likely to send transfers, which is significant for females only. Compared to those with an education below elementary, children who attended middle school or above are significantly more likely to send transfers to their parents. These effects are more pronounced for males, who are on average better educated. In addition, employed children, especially among males are significantly more likely to send any transfers to their parents than those who do not have jobs.

Building on this baseline model, we include variables indicating intergenerational support exchanges to examine to what extent these support exchanges explain the migration effect. These consist of dummy variables indicating the presence of siblings living with parents; whether or not a child has his/her own children living with the respondent; whether the frequency of actual visits is more than once a week. For those whose frequency of actual visits is less than once a week, we also examine whether the frequency of non-face-to-face contact with parents using phones, letters or internet is associated with their decision to remit.

[81] When instrumenting sibling size using the same instruments as in the last section (using command -ivtobit- in Stata 13), we could not find sufficient evidence to reject the null hypothesis of exogeneity of sibling size.

Table 5.5: Estimates of Financial Support to Parents: Migration – Tobit

	(1)		(2)		(3)	
	All	**All**	**Female**	**Female**	**Male**	**Male**
Variables	$Pr(S^* > 0)$	$E(S^*S^* > 0)$	$Pr(S^* > 0)$	$E(S^*S^* > 0)$	$Pr(S^* > 0)$	$E(S^*S^* > 0)$
Migration	0.089***	0.536***	0.065***	0.388***	0.110***	0.704***
	(0.014)	(0.084)	(0.020)	(0.119)	(0.020)	(0.129)
Sibling size	0.001	0.009	0.002	0.012	-0.001	-0.008
	(0.008)	(0.047)	(0.010)	(0.058)	(0.010)	(0.062)
Birth order (Base: First child)						
Second child	0.026**	0.154**	0.018	0.107	0.034*	0.220*
	(0.011)	(0.067)	(0.017)	(0.102)	(0.018)	(0.117)
Third child	0.042**	0.256**	0.045*	0.266*	0.048*	0.308*
	(0.017)	(0.103)	(0.023)	(0.140)	(0.025)	(0.160)
Fourth child	0.049**	0.299**	0.061*	0.366*	0.046	0.295
	(0.024)	(0.151)	(0.033)	(0.197)	(0.035)	(0.224)
Fifth child	0.061**	0.382*	0.098**	0.586**	0.039	0.250
	(0.031)	(0.201)	(0.043)	(0.258)	(0.046)	(0.296)
Sixth + child	0.060	0.373	0.074	0.443	0.066	0.426
	(0.047)	(0.308)	(0.067)	(0.403)	(0.064)	(0.414)
Child characteristics						
Age	0.005**	0.029**	0.006**	0.034**	0.004	0.026
	(0.002)	(0.012)	(0.002)	(0.015)	(0.003)	(0.016)
Male	0.002	0.012				
	(0.013)	(0.079)				
Education (Base: Below elementary)						
Middle school	0.038**	0.230**	0.008	0.045	0.061***	0.394***
	(0.015)	(0.090)	(0.020)	(0.117)	(0.019)	(0.121)
Vocational or above	0.071***	0.450***	0.067**	0.402**	0.068**	0.439**
	(0.024)	(0.156)	(0.033)	(0.199)	(0.031)	(0.202)
Married	0.014	0.085	0.003	0.018	0.013	0.082
	(0.023)	(0.141)	(0.037)	(0.219)	(0.029)	(0.186)
Has job	0.057***	0.335***	0.041*	0.243*	0.132***	0.848***
	(0.021)	(0.122)	(0.024)	(0.143)	(0.047)	(0.301)
Observations	6,357	6,357	3,418	3,418	2,939	2,939
Pseudo R^2	0.026		0.026		0.032	

Note: Dependent variable: logarithm (total transfer) (if the amount is greater than zero). Additional control variables include parent's age, age squared education, employment status, household poverty, household ownership and 27 provincial dummy variables. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 5.6 reports marginal effects of the augmented model. We also report the marginal effect of migration before support exchange variables are included for ease of comparison (column 1). We find children are significantly less likely to provide any transfers when they have siblings living with their parents (column 2). This may arise because non-cohabiting children perceive siblings living with parents as a form of accessible physical support and thus have a lower incentive to provide financial support (Antman, 2012). On the contrary, children are 12.8 percentage points more likely to provide any transfers when they leave their children to live with their parents, and the amount they provide is over 80 percent higher compared to those who do not all else constant. This finding is in line with (Cong and Silverstein, 2012) , who find that grandparents in China are more likely to receive financial support reciprocally from children when they take care of their grandchildren to facilitate their children's migration. Compared to the estimate on migration dummy, this effect is more than twice as big in magnitude, which implies reciprocity might be an overriding incentive behind a child's decision to remit (Yang, 1996).

Table 5.6: Estimates of Financial Support to Parents: Support Exchange and Emotion Cohesion - Tobit

Variables	**(1)**		**(2)**		**(3)**	
	All		**All**		**All**	
	$Pr(S^* > 0)$	$E(S^*S^* > 0)$	$Pr(S^* > 0)$	$E(S^*S^* > 0)$	$Pr(S^* > 0)$	$E(S^*S^* > 0)$
Migration	0.089***	0.536***	0.053***	0.322***	0.046***	0.277***
	(0.014)	(0.084)	(0.016)	(0.096)	(0.016)	(0.096)
Support exchange						
Has siblings living with respondent			-0.049***	-0.299***	-0.049***	-0.298***
			(0.019)	(0.112)	(0.019)	(0.111)
Leaves child with respondent			0.128***	0.888***	0.105***	0.713***
			(0.025)	(0.199)	(0.026)	(0.194)
Visits less than once a week			0.054***	0.325***	/	/
			(0.016)	(0.095)	/	/
Visits less than once a week × Frequency of communicating					-0.034***	-0.219***
					(0.004)	(0.024)
Observations	6,357	6,357	6,357	6,357	6,357	6,357
Pseudo R^2	0.026		0.028		0.033	

Note: Dependent variable: logarithm (total transfer) (if the amount is greater than zero). Additional control variables include those included in Table 5.5. *** p<0.01, ** p<0.05, * p<0.1.

As expected we find that a child's physical and financial supports are substitutes.

Those who visit less than once a week are 5.4 percentage points more likely to send any transfers to their parents. We also find that a higher frequency of non-face-to-face contact is associated with a higher likelihood of sending any transfers (column 3).[82] For example, compared to children who contact their parents 'once a year' (i.e. an ordinal value of 8), children who contacted their parents 'almost every day' (i.e. an ordinal value of 1) are over 20 percentage points more likely to send any transfers back home (0.034×7).[83] This suggests that those who are emotionally closer to their parents are more likely to send more transfers because communication via text messages, mails or emails is not restricted by the geographic proximity and could indicate a degree of cohesion between children and their parents.

It is interesting to note that both the extensive and intensive margins of migration decrease after the support exchange variables are included. The estimate on migration variable drops from 8.9 to 5.3 percentage points when support exchanges are included, and further reduces to 4.6 percentage points when emotional cohesion is also controlled for. The implication is that about half of migration effect could be explained by these support exchanges.

5.6 Migration and the Physical and Subjective Well-Being of Parents

5.6.1 Empirical Strategy

Next we turn to examine the effects children's migration has on their parents' well-being. We begin with a simple regression model where the well-being of a respondent is a function of their children's migration status and other characteristics thought to determine the older parents outcomes.

$$y_h = \beta_0 + \beta_1 M_h + \beta_2 X_h + \varepsilon_h \tag{5.6}$$

where the dependent variable y_h denotes the outcome of the parents (the main respondent in each household), either physical health, mental health or life satisfaction indi-

[82] We have to interact this dummy variable with the frequency of non-face-to-face communication in another specification because the latter only varies when the frequency of actual visit is less than once a week.

[83] Alternatively, we allow frequency of communicating to enter into the regression as a binary variable, which equals 1 if more than once a week, 0 otherwise. Children who contact their parents once a week are around 11 percentage points more likely to send any transfers than those who do not; the average amount sent would be 77 percent higher.

cator.[84] M_h is defined as a dummy variable which indicates whether the respondent in the household has migrant child. X_h is the vector of covariates. As discussed in the introduction, migration status of the household is not likely to be random, but determined by some common characteristics determining the outcome of the respondent. We try to address this endogeneity issue by estimating the relationship between outcomes of older parents and migration of children simultaneously using a potential-outcomes framework used in the microeconometrics evaluation literature (Wooldridge, 2010, Chapter 21).[85]

Our treatment variable is M_h, which equals 1 if a respondent has migrant child, 0 otherwise. The two potential outcomes for each respondent are then y_{0i} and y_{1i}; y_{0i} is the outcome that would be obtained if i does not have any child who migrates, and y_{1i} is the outcome that would be obtained if i has migrant child. y_{0i} and y_{1i} are realizations of the random variables y_0 and y_1. The parameters of interest are average treatment effect (ATE):

$$ATE = E(y_1 - y_0) \quad (5.7)$$

which summarizes the distribution of the unobservable individual-level treatment effect $y_1 - y_0$; and average Potential Outcome Mean (POM) for each treatment level t as:

$$POM_t = E(y_t) \quad (5.8)$$

Thus, ATE can be further written as $ATE = POM_1 - POM_0$. Another parameter of interest in this framework is average treatment effect on the treated (ATET):

$$ATET = E(y_1 - y_0 | t = 1) \quad (5.9)$$

which is the mean of the difference $y_1 - y_0$ among the subjects that actually receive the treatment, e.g. the migration effect among households whose children migrate. In observational data, for each individual, either y_{0i} or y_{1i} can be observed, which can be viewed as a missing-data problem, and treatment-effects methods account for that problem. We specify the potential-outcome model for each treatment and the binary-treatment assignment model as below:

$$y^*_{0h} = \beta_0 \cdot X_h + \varepsilon_{0h} \quad if \;\; M_h = 0 \quad (5.10)$$

$$y^*_{1h} = \beta_1 \cdot X_h + \varepsilon_{1h} \quad if \;\; M_h = 1 \quad (5.11)$$

$$M^*_h = \gamma \cdot W_h + \eta_h \quad (5.12)$$

[84] We use a subscript *h* not *i* to distinguish from the earlier analyses at child level.

[85] This is also known as counterfactual framework.

The variables y_h^*, M_h and X_h are defined as before, M_h^* is the latent (unobserved) propensity that a respondent has migrant child and X_h and W_h are the respective covariates vectors used to model the outcome and treatment assignment. The unobservable error term η_h in the assignment model is assumed to be not related to either X_h or W_h. In our specification, X_h includes typical control variables used in the literature and we allow W_h to include two additional variables - the fraction of sons and the fraction of children that are married for each respondent. In our early analysis in section 1.4, gender and marital status are found to be two robust predictors of an individual child's decision to migrate, where sons are less likely to migrate than daughters and married children are more likely to migrate than unmarried ones. In addition, Antman (2010) uses the two variables as instruments to identify the impact children's migration to US has on the health of their elderly parents in Mexico.[86]

In order to estimate the above models and derive the average treatment effect of having migrant child with respect to the potential outcome of the respondents, three assumptions need to be justified and we discuss each of them.

1. Conditional independence assumption (CIA). It requires that the unobserved error term in the treatment model η is independent of the vector $(\varepsilon_0, \varepsilon_1)$. That is to say, unobserved shocks that affect whether a respondent has any migrant child do not have any effect on the potential outcome of the elderly, and unobserved shocks that affect a potential outcome of the older parents do not affect whether or not they have migrant child. This assumption could be difficult to justify and we relax this assumption and allow the error terms to be correlated with a specific distribution.

2. Overlap assumption. It ensures that each individual could receive any treatment level. The overlap assumption is satisfied when there is a chance of seeing observations in both the control and the treatment groups at each combination of covariate values. To this end, we plot the estimated densities of the probability of having migration child after estimating the treatment effect model. Figure 5.1 displays the estimated density of the predicted probabilities that a respondent without migrant child has a migrant child (black line) and the estimated density

[86] Although the two additional variables can be seen as instrumental variables, the model does not assume X_h and W_h to include distinct regressors. That is to say, we do not need to specify exclusion restrictions on the two variables to achieve model identification. That being said, we do not think it is appropriate to include the two variables in the outcome model as having sons *per se* should not have a direct effect on the health and well-being of respondents.

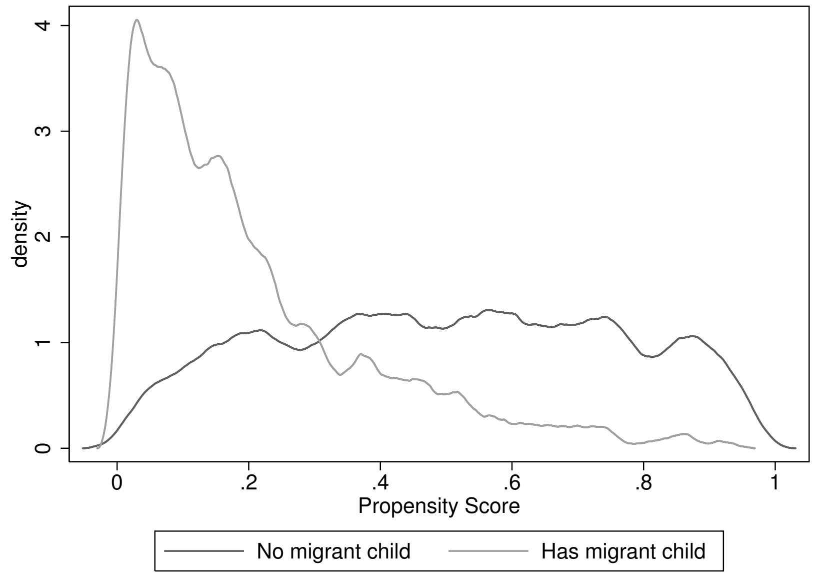


Figure 5.1: Estimated Density of the Predicted Probabilities

of predicted probabilities that a respondent with migrant child has no migrant child (gray line). Although the predicted probability that a respondent having migrant child does not have migrant child has a large mass in the region of 0 to 0.2, the two estimated densities have a large proportion of their respective masses in regions in which they overlap each other. Thus there is no strong evidence that the overlap assumption is violated.

3. The independent and identically distributed (i.i.d.) sampling assumption. It ensures that the potential outcomes and the treatment status of each individual are unrelated to the potential outcomes and treatment statuses of all other individuals in the population. The i.i.d. assumption, also called stable unit treatment value assumption (SUTVA) in the treatment literature, is generally satisfied in our analysis because the data source we use is a random sample of the targeted popuation, which implies SUTVA (Wooldridge, 2010).

There are several methods in estimating the above models. Regression adjustment method (RA) and inverse-probability weighting method (IPW) are two commonly used methods but crucially rely on the correct specifications of both the outcome model and the treatment model. Briefly speaking, RA fits separate models for each treatment level to estimate each POM; and ATEs and ATETs are differences in estimated POMs. IPW estimators use weighted averages of the observed outcome variable to estimate POMs where each weight is the inverse of the estimated probability that an individual receives a treatment level. In our estimation, we use two doubly robust estimators which are combination of RA and IPW. These are the augmented inverse-probability-weighted (AIPW) and inverse-probability-weighted regression adjustment (IPWAR) estimators. AIPW is an IPW that includes an augmentation term that corrects the estimator when the treatment model is misspecified. IPWRA estimators use the inverse of the estimated treatment-probability weights to estimate missing-data-corrected regression coefficients that are subsequently used to compute the POMs.[87] These estimators are robust even when either of the outcome or treatment assignment equations is misspecified.[88]

Selection of having migrant children could be potentially endogenous (i.e. selection on unobservables). This is to say, conditional independence assumption in a treatment-effects model is not satisfied. In this scenario, we resort to endogenous binary-treatment model. In this model, the CIA is replaced by specifying a model of the joint dependence among the unobservables where the error terms are identically distributed as bivariate normal with zero mean, unit variance and correlation coefficient, independently across observations.

To illustrate, suppose the vector of unobservables (ε_0, ε_1, η) is normally distributed as below:

$$\begin{pmatrix} \varepsilon_0 \\ \varepsilon_1 \\ \eta \end{pmatrix} \sim N \left\{ \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_0^2 & \rho_{01}\sigma_0\sigma_1 & \rho_{\eta 0}\sigma_0 \\ \rho_{01}\sigma_0\sigma_1 & \sigma_1^2 & \rho_{\eta 1}\sigma_1 \\ \rho_{\eta 0}\sigma_0 & \rho_{\eta 1}\sigma_1 & 1 \end{pmatrix} \right\} \tag{5.13}$$

where σ_0 is the standard deviation of ε_0, ρ_{01} is the correlation between ε_0 and ε_1, σ_1 is the standard deviation of ε_1, $\rho_{\eta 0}$ is the correlation between η and ε_0, and $\rho_{\eta 1}$ is the correlation between η and ε_1. The variance of η is normalized to 1, as is standard in the normally distributed latent-variable specification of a binary-dependent variable.

CIA in treatment framework specifies that $\rho_{\eta 0} = \rho_{\eta 1} = 0$ so that we can write equation (5.13) as follows:

$$\begin{pmatrix} \varepsilon_0 \\ \varepsilon_1 \\ \eta \end{pmatrix} \sim N \left\{ \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_0^2 & \rho_{01}\sigma_0\sigma_1 & 0 \\ \rho_{01}\sigma_0\sigma_1 & \sigma_1^2 & 0 \\ 0 & 0 & 1 \end{pmatrix} \right\} \tag{5.14}$$

[87] See Wooldridge (2010) for a comprehensive discussion on the four methods.

[88] The double robust property means although we are required to build two models (potential outcome model and treatment assignment model), we only need to specify one of the two models correctly (Wooldridge, 2010).

In an endogenous binary-treatment framework, we do not distinguish ε_0 and ε_1 and the error terms ε and η are bivariate normal with mean zero and covariance matrix:

$$\begin{pmatrix} \varepsilon \\ \eta \end{pmatrix} \sim N \left\{ \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma^2 & \rho\sigma \\ \rho\sigma & \sigma^2 \end{pmatrix} \right\} \tag{5.15}$$

ρ is the correlation coefficient to be estimated. The hypothesis testing on $\rho = 0$ will provide us a guidance as to the justification using an endogeneous binary-treatment model. Maximum likelihood or a two-step approach can be used to estimate the parameters of this model.

5.6.2 Results

Table 5.7 reports 4 estimators of migration effect across the three outcomes we discussed above using OLS, treatment-effects model and endogenous binary-treatment model. While enormous difference arise, it also justifies the different assumptions underlying each model.

The OLS results suggest that none of the outcomes are significantly affected by migrant children (Panel A). When correcting for selection on observables, we find the average treatment effect on mental health and life satisfaction is negative and significant at 1 percent level, which implies that mental health and life satisfaction of respondents who have migrant child are significantly worse than those without migrant children (Panel B).[89] However, when we allow selection of migration to be endogenous, we find the effects migration have on the mental health and life satisfaction change sign which implies that an elderly individual with migrant children are less likely to have depression and more likely to be satisfied with his/her life (Panel C). This is in line with Böhme et al. (2015) and Kuhn et al. (2011), who also find a positive effect of migration on subjective health of older parents.[90]

In addition, we report the Wald statistics testing the null hypothesis $\rho = 0$ (in Panel C) and find there is a statistical evidence of a significant correlation in the disturbance terms between the outcome model and treatment model for the mental health outcome

[89] Similar results can be found using AIPW estimator.

[90] Kuhn et al. (2011) use a propensity score matching approach to analyze the impact of internal migration in Indonesia on elderly parents' self-reported health status, self-reported mobility status and mortality; while Böhme et al. (2015) adopt an instrumental variable approach to examine the effect international migration of children has on various dimensions of health of elderly parents living in Moldova, including body mass index (BMI), mobility and self-reported health.

Table 5.7: Effect of Migration on Three Health Outcome Variables of Older Parents - OLS and Treatment-effects Model

Variables	**(1)**	**(2)**	**(3)**
	Physical health	**Mental health**	**Life satisfaction**
Panel A: OLS			
Has migrant child	0.004	-0.026	-0.014
	(0.020)	(0.021)	(0.015)
R^2	0.219	0.122	0.077
Panel B: Treatment- effects model (IPWRA estimator)			
Has migrant child	-0.029	-0.064***	-0.042***
	(0.022)	(0.024)	(0.014)
Panel C: Endogenous binary-treatment model (ML estimator)			
Has migrant child	0.003	0.121*	0.380***
	(0.062)	(0.062)	(0.038)
ρ	0.001	-0.209	-0.659
Wald statistics	0.000	6.270	95.74
P-value for Wald statistics	0.989	0.012	0.000
Log likelihood	-3115	-3252	-2426
Panel D: Endogenous binary-treatment model (Two-step estimator)			
Has migrant child	0.009	0.104*	0.139***
	(0.055)	(0.059)	(0.045)
ρ	-0.008	-0.186	-0.279
Sample size	2,988	2,988	2,988

Notes: Dependent variable: binary variables indicating the positive outcomes of physical health, mental health and life satisfaction. Covariates in outcome models include respondent age, age squared, gender, lives with spouse/partner, number of children, has NCDs, has disability, education attainment, employment status, health insurance type and pension status. Additional covariates in treatment assignment model include the proportion of sons and proportion of children getting married. Robust standard errors in parentheses. * p<0.1. ** p<0.05. *** p<0.01.

(p-value is 0.012) and life satisfaction outcome (p-value is 0.000), suggesting that for the two outcomes, selection of migration is endogenous, justifying our estimation using endogenous binary-treatment model.

To compare and test the robustness of our results in Panel C, we also present results using two-step estimation method outlined in Maddala (1986) in Panel D. Compared to the results estimated using maximum likelihood method, the absolute value of correlation coefficient shrinks (-0.279 *versus* -0.659), resulting in a much reduced effect of migration on life satisfaction outcome (0.139 *versus* 0.380). The correlation in the disturbance terms using the two methods, however, is consistently negative, which implies that there are unobserved factors that make our respondent more prone to depression or dissatisfaction with their life, while at the same time making them more likely to have at least one migrant child (e.g. the local economic development, the provision of community facilities, etc.). Full estimation results for endogenous binary-treatment effects model using two-step estimation are shown in Table D.3.

There are three possible ways to explain the positive migration effects on parents' mental health and life satisfaction. As discussed in the conceptual framework, an overall positive effect of migration would arise if the income effect of migration overrides the substitution effect due to their physical absence at the family home. In addition, parents' subjective well-being is not only affected by children's physical support but also by the emotional cohesion with children (Silverstein et al., 2006), which is not restricted by children's geographic proximity to their parents. If this is true, those whose children migrate can still keep a close contact with children via text messages, mails or emails; at the same time, they receive more economic transfers, both of which could protect them from suffering mental health problems. Alternatively, substitution effect might have little role to play because parents perceive support from migrant children as good as that of those children living nearby (Abas et al., 2009).

Another implication of the above is that some of the findings in the literature could be misleading when selection into migration is not carefully modelled. It seems that contrasting results of migration effect arise when we impose different restrictions on the selection model of children's migration. Taking into account the endogenous selection of having migrant child for the older parents, migration of children has positive effects on their mental health and subjective satisfaction.

5.6.3 Heterogeneity

In Table 5.8 we test the sensitivity of our results to various stratifications of our sample in the endogenous binary-treatment framework. We firstly split up the sample by gender and then the age of the respondent to explore which subgroups drive the migration effect that we find across the three outcomes. For brevity, we report only estimates using the two-step method.

Table 5.8: Heterogeneity of Migration Effect - Two-step Estimator

Variables	**(1)** **Physical health**	**(2)** **Mental health**	**(3)** **Life satisfaction**
Females			
Has migrant child	0.036	0.075	0.123**
	(0.069)	(0.071)	(0.056)
ρ	-0.060	-0.164	-0.259
Sample size	1,485	1,485	1,485
Males			
Has migrant child	0.009	0.142	0.155**
	(0.087)	(0.093)	(0.070)
ρ	0.020	-0.212	-0.323
Sample size	1,503	1,503	1,503
Aged 45-60			
Has migrant child	0.022	0.144*	0.151**
	(0.070)	(0.075)	(0.060)
ρ	-0.035	-0.224	-0.276
Sample size	1,584	1,584	1,584
Aged 60+			
Has migrant child	0.053	0.017	0.034
	(0.100)	(0.103)	(0.075)
ρ	-0.066	-0.111	-0.156
Sample size	1,404	1,404	1,404

Notes: Dependent variable: binary variables indicating the positive outcomes of physical health, mental health and life satisfaction. For additional notes, please refer to Table 5.7. Robust standard errors in parentheses. * p<0.1. ** p<0.05. *** p<0.01.

As for the whole sample, we find no evidence for a significant migration effect on physical health when analyzing subgroups. Despite a positive effect of migration on mental health found for the whole sample, we find the estimates within groups of females and females is too variable to conclude that mental health of either gender is significantly affected by migration. If anything, migration effect is stronger among male respondents than among female respondents. This gender difference might arise because females are more vulnerable to depression than males in response to life events (Piccinelli and Wilkinson, 2000). When children migrate, females are more concerned with children's physical absence, counteracting the positive income effect associated with migration. On the contrary, the resilience in coping with negative events might help males perceive an overriding positive income effect associated with migration. The point estimate of migration effect for the 45-60 years old cohort is positive and significant at 10 percent level and of similar magnitude as Table 5.7 shows. Among the older age cohort (60+), we cannot credibly infer a positive or negative sign of the migration effect. In terms of mental health, men and the younger cohort (aged 45-60) seem to benefit more from their children's migration.

The positive effect of migration on life satisfaction is found to be positive and significant for both females and males. However, life satisfaction is affected significantly for the younger cohort only; younger respondents (aged 45-60) with migrant children have a lower likelihood of experiencing depression (by around 15 percentage points). Thus, for both mental health and life satisfaction, the positive migration effect appears to be mainly driven by the younger respondents, which is consistent with the notion that physical support from children are more important for parents who are older (Section 4.5 in Chapter 4).[91]

5.6.4 Alternative Physical Health Outcomes Using Biomarkers

Recall we do not find any significant effect associated with the physical health of the respondents measured using a composite index of ADLs.[92] In this subsection we test whether any aspect of physical health of older parents is affected by their children's migration using a series of biomarkers. CHARLS provides rich information on the biomarkers of respondents, e.g. lung capacity, blood pressure, weights, heights, etc. This enables us to use clinically based indicators to test the effect migration of children has on the physical health of their parents. Similar to the summary statistics of biomarker measurements for the full sample presented in Chapter 2, a typical respondent in our rural sample under analysis has a lung capacity of 269 litres per minute, weights 57 kg and is 157 cm tall. Around 10 percent of our respondents have high blood pressure defined as the systolic blood pressure above 140 mmHg and diastolic blood pressure above 90 mmHg. The BMI of our respondent is on average 23 kg/m2.

[91] Overall we find a positive effect of migration instead of an adverse effect - the older elderly parents are more vulnerable than their younger counterparts to the extent that they could not be better off as a consequence of their children's migration.

[92] Using the continuous ADLs index we still find insignificant result.

Around 8 percent of our sample are underweight (i.e. BMI under 18.5) and 26 percent are overweight (i.e. BMI 25 and over).

In Table 5.9, we report the results using the 7 biomarker measurements in the endogenous binary-treatment framework. We find that lung capacity of a respondent is not significantly affected by the migration of children (column 1). There is no significant difference in the incidence of having high blood pressure between parents whose children migrate and parents whose children do not (column 2). However, the effect migration of children has on the body-weight of a respondent is positive and highly significant and this increase is driven more by females and the relatively younger cohort. Parents with migrant children are put on weight by 4.0 kg compared to parents whose children do not migrate (column 3). The height of a respondent is not significantly affected by the migration of children as expected (column 4). This increase in weight results in an increase in BMI of a respondent (defined as weight divided by the square of height). The point estimate suggests that having a migrant child leads to an increase of almost 1.3 BMI points in the average elderly person, which is equivalent to an increase of 3.2 kg in body-weight for a 158 cm tall individual (column 6). Böhme et al. (2015) find that international migration of children increases nutritional diversity of parents left-behind in Moldova, resulting in an increased BMI by 5 points. We do not have the dietary diversity information, yet we find migration increases the food expenditure of the household significantly (Table D.4 in the Appendix), which suggests that the income effect of migration significantly improves their diet. If higher food expenditure goes along with more calorie intake, increase in food expenditure can explain the significant increase in BMI.

Table 5.9: Effect of Migration on Physical Health of Older Parents Using Biomarkers - Two-step Estimator

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Lung Capacity	**HBP**	**Weight**	**Height**	**BMI**	**Underweight**	**Overweight**
All							
Has migrant child	8.253	-0.007	3.987***	0.717	1.275***	-0.084*	0.032
	(12.510)	(0.056)	(1.179)	(0.734)	(0.433)	(0.045)	(0.057)
ρ	-0.079	-0.029	-0.228	-0.062	-0.197	0.085	-0.039
Sample size	2,652	2,714	2,744	2,742	2,736	2,024	2,524
Females							
Has migrant child	0.543	0.044	4.071***	0.800	1.396**	-0.093*	0.041
	(12.725)	(0.069)	(1.460)	(0.854)	(0.568)	(0.056)	(0.074)
ρ	-0.031	-0.165	-0.228	-0.031	-0.219	0.086	-0.050
Sample size	1,299	1,335	1,352	1,350	1,349	915	1,245
Males							
Has migrant child	3.634	-0.029	3.557*	0.682	1.009	-0.067	0.017
	(22.253)	(0.089)	(1.841)	(1.216)	(0.632)	(0.068)	(0.085)
ρ	-0.034	0.054	-0.215	-0.098	-0.157	0.065	-0.027
Sample size	1,353	1,379	1,392	1,392	1,387	1,109	1,279
Aged 45-60							
Has migrant child	12.764	0.043	4.692***	0.404	1.536***	-0.028	0.092
	(16.752)	(0.066)	(1.546)	(0.908)	(0.552)	(0.048)	(0.075)
ρ	-0.153	-0.138	-0.263	-0.009	-0.241	-0.053	-0.135
Sample size	1,411	1,431	1,443	1,441	1,437	982	1,376
Aged 60+							
Has migrant child	-10.471	-0.094	3.877*	2.081	1.022	-0.171**	0.015
	(20.165)	(0.105)	(1.980)	(1.320)	(0.750)	(0.081)	(0.096)
ρ	0.107	0.114	-0.217	-0.221	-0.136	0.261	0.048
Sample size	1,241	1,283	1,301	1,301	1,299	1,042	1,148

Notes: Dependent variable: lung capacity is the average of three deep breaths; HBP is the systolic blood pressure above the cut-off of 140 and the diastolic blood pressure above 90; weight and height are self-explained. BMI is defined as body weight divided by the square of body height. Underweight is an indicator which equals 1 if BMI $\leq$ 18.5, 0 if 18.5 $<$ BMI $<$ 25; overweight is an indicator which equals 1 if BMI $\geq$ 25, 0 if 18.5 $<$ BMI $<$ 25. For additional notes, please refer to Table 5.7. Robust standard errors in parentheses. * p<0.1. ** p<0.05. *** p<0.01.

Based on this BMI measure, we find respondents with migrant children are significantly less likely to be underweight and this is mainly pronounced for the relatively older respondents. Among these elderly parents, migration of children could lead to a lower likelihood of being underweight by 14 percentage points. However, the probability of being overweight is not significantly affected by the migration of children.

5.6.5 Exploring Potential Mechanisms

Next we explore the potential mechanism underlying the beneficial effect of migration we find so far. An income effect could be pronounced if remittances eased liquidity constraints that might obstruct access to health care. To test this, we estimate the effects migration has on four additional outcomes associated with the well-being of members left-behind, i.e. forgoing inpatient health care, forgoing outpatient health care, the incidence of living below the poverty line and the incidence of undergoing catastrophic health spending. In our sample, the forgone inpatient care rate and forgone outpatient care rate are 43 percent and 24 percent respectively while the proportion of households experience poverty and catastrophic health spending is 34 percent and 24 percent respectively.

In Table 5.10 we report the results similar to Table 5.7 using endogenous binary-treatment model for the four outcome variables. We find a negative migration effect on the probability of forgoing inpatient care - respondents with migrant children are 29 percentage points less likely to forgo inpatient care. However, the standard error of the estimate is too large to enable us to conclude a significant estimate. The imprecise estimate may be due to the relatively small sample size of parents being ill last year (333 observations). On the contrary, the probability of forgoing outpatient care is not significantly affected by migration of children (column 2). In column 3 we find evidence of a sizable and highly significant negative effect of migration on the household's likelihood of living below the poverty line - households with migrant children are 17.8 percentage points less likely to be poor compared to households without migrant children. This is in line with Cai et al. (2009). In contrast, we find migration has insignificant effect on the household's likelihood of undergoing catastrophic health spending. This might arise because physical presence of children is more important than financial support to manage the financial burden of diseases as we find in Chapter 4. In addition, migration of children is related to increased out-of-pocket health expenditure in the household (Table D.4 in the Appendix). Although this increased out-of-pocket health expenditure can be seen as an increase in health inputs, it also increases the household's likelihood of undergoing catastrophic health spending proportionately. Migration of children thus seems to play a role of protecting their parents from forgoing inpatient care due to economic reasons and lifting the households left-behind out of poverty.

Table 5.10: Effect of Migration on Four Additional Outcomes - Two-step Estimator

Variables	**(1)**	**(2)**	**(3)**	**(4)**
	Forgoing inpatient care	**Forgoing outpatient care**	**Poverty**	**Catastrophic health spending**
Has migrant child	-0.289	-0.025	-0.178***	-0.067
	(0.183)	(0.100)	(0.057)	(0.052)
ρ	0.382	0.045	0.220	0.103
Sample size	333	792	2,988	2,988

Notes: Dependent variable is defined as follows: forgoing inpatient care = 1 if ill last year and did not go to hospital for inpatient care, 0 otherwise; forgoing outpatient care = 1 if ill last month and did not go to hospital for outpatient care, 0 otherwise; catastrophic health spending = 1 if out of pocket health spending exceeds 40% of the household's capacity to pay, 0 otherwise; poverty = 1 if the household's equivalized food expenditure is lower than the 45-55 percentile of the entire sample, 0 otherwise. For additional notes, please refer to Table 5.7. Robust standard errors in parentheses. * p<0.1. ** p<0.05. *** p<0.01.

5.7 Robustness Analysis

5.7.1 Migration of Children Born After the One Child Policy

One concern for the effect sibling size has on the migration decision of an individual child is whether the effect is robust to households with small family size. We can investigate this in China due to an exogenous shock of one child policy officially launched in 1979. The fertility choice for households affected by one child policy is less likely to be endogenous because the birth of the second child in most cases is determined by the gender of the first child. The one child policy is relatively less rigid in the rural areas than in the urban areas and families are allowed another child when the first child is a girl. We could further restrict our sample to one/two-child families whose children were born after the implementation of the one child policy to avoid the problem of endogenous fertility choice of parents. In this case, OLS would give an unbiased estimate of the difference in the likelihood to migrate between only children and children with another sibling.

In Table 5.11 we report the OLS estimates for the selected sample of children from households with no more than 2 children and the eldest child is younger than 32 (born before 1979). We find that only children are less likely to migrate than children with one more sibling. We also find that the birth order no longer plays a role in this process. However, sons are still significantly less likely to migrate than daughters. We also include sibling composition variables, but none of them significantly affect the child's decision to migrate.

Table 5.11: Robustness Test: Estimates of Migration Decision with Selected Sample to Children Affected by the One Child Policy

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	All	**Female**	**Male**	**Female**	**Female**	**Male**	**Male**
Number of children	0.119***	0.195***	0.086**	0.179***	0.207***	0.086**	0.090**
	(0.036)	(0.072)	(0.042)	(0.067)	(0.072)	(0.039)	(0.042)
Second child	-0.002	-0.017	0.014				
	(0.027)	(0.050)	(0.032)				
Age	0.027***	0.039***	0.017***	0.041***	0.037***	0.017***	0.016***
	(0.005)	(0.008)	(0.006)	(0.007)	(0.008)	(0.005)	(0.006)
Male	-0.308***						
	(0.025)						
The first son/daughter				-0.060		-0.043	
				(0.073)		(0.034)	
Has older brother					-0.060		0.033
					(0.054)		(0.037)
Has older sister					0.014		-0.008
					(0.077)		(0.041)
Observation	1,453	573	880	573	573	880	880
R^2	0.219	0.205	0.216	0.206	0.207	0.217	0.217

Notes: Dependent variable: binary variable indicating whether a child lives beyond his/her parent's village. For additional notes, please refer to Table 5.4. Robust standard errors in parentheses. * p<0.1. ** p<0.05. *** p<0.01.

5.7.2 Threshold in Defining Migration

Next we investigate to what extent our results are robust to an alternative definition of migration. Although village is a reasonable threshold in defining the migration status of child, in other literatures where the detailed information on proximity of children is not available, county is used to define the migration status of children. Living in the same village is potentially important in terms of caring for parents, i.e. a close proximity so to enable visiting parents. Based on whether the proximity of children to the family home is beyond the same county, this narrower threshold will exclude the children living in the same county but out of the same village of their parents from the migrants. An indirect method to tackle this is to test whether living in the same county differs significantly from those who live beyond the county. To this end, we re-define the migration status of an individual child based on the county threshold and estimate our results for children living beyond their parents' village in Table 5.12.

Table 5.12: Robustness Test: Redefine Migration Status with Restricted Sample to Children Living in another Village or Further from Their Parents

Variables	**(1)**	**(2)**	**(3)**
	All	**Female**	**Male**
Sibling size	-0.014	-0.011	-0.013
	(0.009)	(0.010)	(0.013)
Birth order (Base: First child)			
Second child	0.016	0.017	0.024
	(0.017)	(0.022)	(0.028)
Third child	0.029	0.017	0.037
	(0.023)	(0.029)	(0.039)
Fourth child	0.031	0.040	0.006
	(0.032)	(0.040)	(0.053)
Fifth child	0.081*	0.112*	0.026
	(0.047)	(0.060)	(0.074)
Sixth + child	0.110	0.189*	-0.030
	(0.076)	(0.102)	(0.099)
Child characteristics			
Age	-0.006***	-0.004	-0.009***
	(0.002)	(0.003)	(0.003)
Male	0.299***	-	-
	(0.016)		
Education (Base: Below elementary)			
Middle school	0.043***	0.054***	-0.000
	(0.017)	(0.021)	(0.026)
Vocational or above	0.140***	0.236***	0.025
	(0.025)	(0.036)	(0.035)
Married	-0.006	0.007	-0.019
	(0.022)	(0.025)	(0.033)
Has job	0.036	0.040	-0.050
	(0.025)	(0.026)	(0.072)
Number of observations	4,240	2,706	1,534
R^2	0.215	0.114	0.185

Note: Dependent variable: binary variable whether a child lives beyond his/her parent's county. Additional control variables include those included in Table 5.3. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Although the validity of instruments are justified, the endogeneity test shows that the estimates do not differ significantly from the ones estimated using OLS, thus we only present the results using OLS. We find the effect of sibling size is insignificant and later-born children do not differ from their older siblings in their likelihood of migration out of county. The gender difference remains highly significant at the 1 percent level.

There is no significant difference in terms of moving out of county for children living beyond the village, as such setting the threshold at county level could decrease the size of the effects we find earlier when migration is defined at village threshold. In fact we re-estimate the migration decision model (Table D.5 in the Appendix) and we find the effect of sibling size shrinks in magnitude compared with Table 5.3 although later-born children are consistently more likely to move out of the county than the firstborn children.

5.8 Conclusion

There is a large literature that examines the role that migration of adult children has on the physical and emotional well-being of the elderly. However, the evidence on the beneficial or otherwise effects remains mixed. In this chapter we examine this issue using China as a case study, and paying particular attention to the selection into migration issue that plagues much of this literature. This topic is particularly pertinent to China as rapid urbanization characterised by large-scale internal migration is beginning to change traditional patterns of living arrangements and forms of support. At the same time, although health care and the pension system in China have undergone significant reform over the past decade, its social support networks are still not sufficient enough to meet the needs of their elderly population.

We start by looking at the determinants of an individual child's migration decision. In particular, we examine the effects of household structure including sibling size, birth order and sibling composition has on the migration and remitting outcomes. We find daughters are more likely to migrate compared to sons, while later-born children are more likely to migrate than their elder siblings. We also examine the role that inter-generational support exchanges play. We find siblings' financial support and physical support act as substitutes. Children are less likely to send any transfers either when they have other siblings living with their parents or when they are able to visit their parents often. A stronger emotional cohesion measured by frequency of non-face-to-face contact, however, is positively associated with the likelihood that a child sends remittances to their parents. In addition, grandchildren care provided by their parents is an important reason why children send remittances to their parents.

Thereafter, we move to the effect migration of children has on the physical health and subjective well-being of their parents who are left behind. We use an endogenous binary-treatment model to effectively tackle the potential selection bias of migration and find strong positive effect of migration of children on their parents' mental health and subjective life satisfaction. Although we find no systematic effect of migration on physical health measured by ADLs, similar to Böhme et al. (2015), we find that migration leads to an increase in the weight of the elderly and translates into a sizable effect on BMI which if not excessive is seen as a positive health indicator in the elderly. We also unearthed evidence that the migration provides security for the elderly by reducing the likelihood of forgone inpatient health care and falling into poverty. In light of the increasing rural-to-urban migration and rapidly ageing population in China, a critical public policy concern is who cares for the elderly when their children migrate. In the case of China, our study implies that elderly parents should benefit from the migration of their children and local governments might consider to improve the local policies to broaden this benefit.

CHAPTER 6

Conclusion

China is currently facing unprecedented challenges associated with a rapidly aging population. Growing life expectancy coupled with strict birth control polices means that the old-age dependency ratio in China is likely to more than double between 2013 and 2030, from 11 percent to 23 percent (UN, 2014). At the same time living arrangements in China are beginning to change due to rapid urbanization characterised by large scale internal migration. As a result, an increasing proportion of elderly parents are living separately from their adult children. This, coupled with inadequate pensions and a lack of proper health insurance, has implications for how elderly households are going to manage the growing financial burden associated with periods of ill-health. This dissertation has examined the extent to which the economic well-being and health of the aged population in China are affected by these demographic and social changes using a large representative household survey data in China.

6.1 Summary of the Three Main Chapters

The first study (Chapter 3) examined the effects that different NCDs have on multiple dimensions of health of the elderly. In order to account for the potential correlation among multiple health measurements which are often ignored in previous studies, we use factor analysis to determine the factor structure of eight key health measurements. An oblique rotation delivers three factors, which describe 'physical health', 'subjective health' and 'cognitive health'. We find that NCDs have strong significant effects on 'subjective health' and 'physical health' but have very little impact on 'cognitive health'. Applying a system approach we show that depression has the largest effect on worsening subjective and physical health compared with other chronic conditions. Conducting a series of cross-equation tests, we find that the effects different

NCDs have on subjective and physical health do not differ except for respiratory disease. Furthermore, we show that when depression is comorbid with other chronic physical diseases it produces a significantly greater deterioration in health than any chronic physical disease alone, and that this additive effect is substantially amplified in the case of depression comorbid with cardiovascular diseases and comorbidity with diabetes for physical health. These findings are robust to a series of sensitivity tests, including splitting the sample by gender and replacing the three factors with the eight original health measures. The findings from this study help to delineate the relative impacts of different NCDs on the health of the elderly in a quite global sense and the equation system approach used in this paper fully explores the unobserved correlation among the commonly used health measurements which is ignored in previous studies. This study could be of great interest to clinicians and policy makers because estimates of health effects of NCDs are usually used to justify funds for training, research and service provision (Wells et al., 1989). The exacerbated health outcome comorbid with depression on the elderly in China also implies that depression has been overlooked given its insufficient coverage in the health care system.

As with most studies using factor analysis, there are certain limitations with this work. The health measures we used to identify NCD effects on health are constructed after obtaining the factor structure of our six health measurements. These factor scales rank the health level for each observation in our sample, but does not necessarily give a cardinal meaning, especially after standardization. Another limitation of this work is we do not include biomarker variables to prepare for the correlation matrix for factor analysis. Lastly, although we allow the error terms to be correlated within each household, we do not consider intra-household effect which might prevail if diseases of spouse play a role, especially on subjective health outcomes and this could be a direction for future research.

The second study as presented in Chapter 4, examines the extent to which households are able to continue to finance their consumption in the presence of ill-health (i.e. catastrophic health spending), and in particular, the extent to which health insurance and family support from children play a role. We find that despite widespread coverage, health insurance in China is still not sufficient to fully protect its members from the risk of undergoing catastrophic health spending, with those covered by the New Rural Cooperative Medical Scheme being particularly vulnerable to the risk of catastrophic health spending, compared to those covered by the two urban schemes. We find that in both rural and urban areas, utilization of inpatient and outpatient care significantly increases the household's likelihood of undergoing catastrophic health spending. In addition we show that a household's proximity to its adult children is important in managing the financial burden of disease, with physical support being more important in terms of reducing the probability of undergoing catastrophic health spending than financial support. Finally, we show that large differences still exist between rural and urban China in terms of the impact chronic diseases have on the incidence of catastrophic health spending, with the negative effect NCDs have on the incidence of catastrophic health spending being twice as big in rural than urban areas. In terms of specific diseases, we find that cancer poses the biggest threat to rural households, while in the urban areas this disease is diabetes. Such findings persist after controlling for differences in the types of health insurance between the two areas, and arise, at least in part, due to differences in disease patterns between rural and urban areas.

Although we deal with the potential selection problem where poor households might choose not to seek health care rather than become impoverished by excluding households who forwent health care due to economic reasons, we do not observe the information on other household members. In addition, there might exist endogeneity problem with our proximity variable. This may be a problem, but actually I do not think it will be because of the disease/disabilities variables included. Lastly, we do not distinguish the households who fall into catastrophic health spending by large out-of-pocket health spending from those whose capacity to pay is too low to afford modest health care services.

In the third study (Chapter 5), we investigate the causal relationship between adult children's migration and the well-being of their parents left-behind in rural China. As an extension of Chapter 4, we look into the migration process from two perspectives. We start by looking at the determinants of an individual child's migration decision. In particular, we examine the effects of household structure including sibling size, birth order and sibling composition has on the migration and remitting outcomes. We find daughters are more likely to migrate compared to sons, while later-born children are more likely to migrate than their elder siblings. We also examine the role that intergenerational support exchanges play. We find siblings' financial support and physical support act as substitutes. Children are less likely to send any transfers either they have other siblings living with their parents or they are able to visit their parents often. A stronger emotional cohesion measured by frequency of non-face-to-face contact, however, is positively associated with the likelihood that a child sends remittances to their parents. In addition, grandchildren care provided by their parents is an important reason why children send remittances to their parents.

Thereafter, we move to the effect migration of children has on the physical health and subjective well-being of their parents who are left behind. We use an endogenous binary-treatment model to effectively tackle the potential selection bias of migration and find strong positive effect of migration of children on their parents' mental health and subjective life satisfaction. Although we find no systematic effect of migration on physical health measured by ADLs, similar to Böhme et al. (2015), we find that migration leads to an increase in the weight of the elderly and translates into a sizable effect on BMI which if not excessive is seen as a positive health indicator in the elderly. We also unearthed evidence that the migration provides security for the elderly by reducing the likelihood of forgone inpatient health care and falling into poverty. A potential limitation of this chapter is we consider only effect of migration in a binary-treatment setting and the number of children who migrate might also be considered in a framework with multiple treatments.

6.2 Future Directions

The data source used in this dissertation is unique in China and is still at an early stage (the second national wave of 2013 data was released in 2015). In addition, CHARLS is comparable with other Health and Retirement Study (HRS) type surveys such as ELSA in the UK and HRS in the US, making it ideal to conduct cross-country studies. There are many directions that future related work could be taken. Here we present 3 possible directions.

We are going to extend the work in the first study to study the regional differences in health measures across China using biomarker data and subjective health measures with anchoring vignettes. As mentioned in the data overview in Chapter 2, a potential problem with subjective measures is differential item functioning (DIF), namely, respondents with a different background or from a different region may interpret the questions differently and hence give different answers even though in some objective sense they have the same health problems (King et al., 2004). Anchoring vignettes are designed to overcome the measurement problems arising from DIF and elicit the thresholds that respondents use when evaluating their health. CHARLS included vignettes in the survey for six health domains (i.e. pain, sleep, mobility, cognition, breathing, affect). With more objective health measures available and a larger sample size, we could potentially explore the adaptation of the elderly to chronic diseases in different dimensions of health. In addition, more objective health measures also allow us to explore the mechanisms driving the differences in many economic decisions among the elderly such as their participation in health insurance programmes, the timing of retirement, intergenerational transfers and asset accumulation in anticipation of potential health and long-term care costs (Banks and Smith, 2012). In addition, this study can be extended to encompass the other HRS survey data to conduct a cross-country analysis to examine the health and retirement behaviour of the elderly across the countries under study.

The elderly often exhibit wide disparities in their sources of income and how they finance their consumption in retirement is of great concern (Poterba, 2014). Family support in old age is especially important in China where public support is weak. Support from family is, however, under threat as the effects of China's one child policy and the changing nature of living arrangements take hold. As highlighted in Chapter 4, physical support from adult children is more important than financial support in terms of helping the households manage financial burden of diseases. We plan to evaluate the effect of a policy programme on the financial capability of the elderly to manage the cost of their retirement. To tackle the prospective pension crisis, 'equity release' (also called 'reverse mortgage') was recently piloted by the Chinese government in two cities in 2014. The aim of this policy is to allow pensioners to take out bank loans against their homes to pay for their living expenses. This can potentially affect the intergenerational transfers from their children because homes are traditionally regarded as inheritance passed on to the next generation. The interaction of housing, public and private transfers involved in this policy initiative provides us with a quasi-experiment to examine the intra-household effect that rolling-out this programme has on the welfare of the elderly and other household members.

Lastly, in light of worsening pension provision, the elderly are increasingly re-entering the labour market (so-called bridge employment). Bridge employment could be considered as an alternative to compulsory increases in the retirement age (Alcover et al., 2014). The few economic studies in this area frame bridge employment theoretically as an individual decision making process and focus mainly on the US, where partial retirement is relatively uncommon (Shultz, 2003). Here the debate often centres over the rise in the pension age, rather than the effect bridge employment has on health and well-being. We could overcome these limitations in a spousal interaction model and examine the drivers, barriers and supporting factors that affect the capacity of older worker to continue employment as they approach retirement as well as its impacts this has on their health and well-being.

APPENDIX A

Appendix for Chapter 2

Self-reported questions in CHARLS 2011 National Wave

DA001. Next, I have some questions about your health. Would you say your health is excellent, very good, good, fair, or poor?
[IWER: Interviewer should read all the following options]

1 Excellent 2 Very good 3 Good 4 Fair 5 Poor

DA002. Next, I have some questions about your health. Would you say your health is very good, good, fair, poor or very poor?
[IWER: Interviewer should read all the following options]

1 Very good 2 Good 3 Fair 4 Poor 5 Very poor

DA079. How would you rate your health status? Would you say your health is very good, good, fair, poor or very poor?
[IWER: Interviewer should read all the following options]

1 Very good 2 Good 3 Fair 4 Poor 5 Very poor

DA080. Next I have some questions about your health. Would you say your health is excellent, very good, good, fair, or poor?
[IWER: Interviewer should read all the following options]

1 Excellent 2 Very good 3 Good 4 Fair 5 Poor

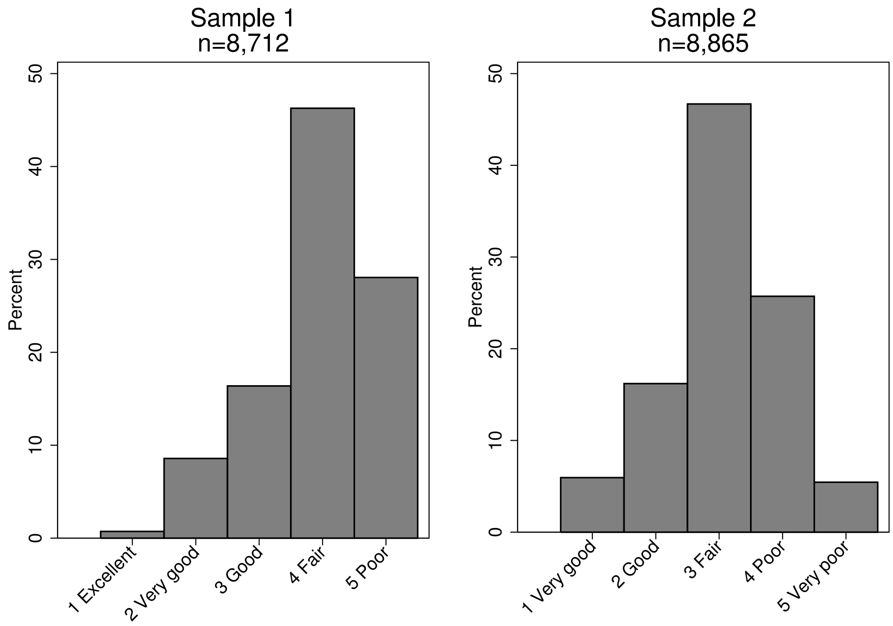


Figure A.1: Histogram Self-rated Health Status Using Two Scales

APPENDIX B

Appendix for Chapter 3

Factor Analysis Technique

Factor analysis finds a few common factors (suppose, q of them) that linearly reconstruct the p original correlated variables ($q < p$).

$$y_1 = f_1 b_{11} + f_2 b_{12} + \cdots + f_q b_{1q} + d_1 u_1$$
$$y_2 = f_1 b_{21} + f_2 b_{22} + \cdots + f_q b_{2q} + d_2 u_2$$
$$\vdots$$
$$y_p = f_p b_{p1} + f_p b_{p2} + \cdots + f_p b_{pq} + d_p u_p$$

where y_j is the value of the jth observed variable ($j = 1, 2, \ldots, p$), f_k is the kth common factor ($k = 1, 2, \ldots, q$), b_{jk} is the set of linear coefficients called factor loadings. u_j is similar to a residual but is known as the jth variable's unique factor, and d_j is the unique factor loading associated with the jth unique factor. Everything except the left-hand-side variable is to be estimated, so the model has an infinite number of solutions without introducing more restrictions. Compactly, the above equations can be written in a matrix form:

$$\mathbf{y} = \mathbf{Bf} + \mathbf{du}$$

The fitting of such a factor model illustrated above is to reproduce the correlation matrix of the original variables. There are several typical assumptions made before fitting the model (estimation of b_{jk} and d_j) to obtain an initial solution. The typical restrictions are imposed below:

$$cov(f_k, f_s) = cov(f_k, u_j) = cov(u_l, u_j) = 0$$
$$\text{where } k, s \in (1, 2, \ldots, q) \text{ but } k \neq s;\ l, j \in \{1, 2, \ldots, p\} \text{ but } l \neq j.$$

which implies that common factors are orthogonal to each other; the common factors are not correlated with the unique factor as appearing in the same equation; the unique factors are not correlated to each other. In the rotation stage in order to obtain simpler and more readily interpretable results, the restriction that common factors are orthogonal to each other can be relaxed and an oblique solution can be obtained.

Maximum Likelihood Estimation

There are several methods in terms of fitting the model, and the one we choose is maximum likelihood method due to the fact that our original health variables are basically normally distributed and we argue that it is reasonable to assume that our data is distributed with a multivariate normal distribution. Using this method we obtain our initial solution, which comprises of 4 factors.

We use the information criteria AIC and BIC (chi-square test) associated with the maximum likelihood method to determine the number of initial factors retained. Table B.4 shows that the AIC and BIC statistics for the models with 1, 2, 3 and 4 factors. The three-factor model is preferred although we need to interpret the results cautiously as the models with 3 and 4 factors are Heywood solutions (i.e. boundary). We also produce the scree plot as an alternative diagnosis in determining the number of factors.[93] However, this scree plot does not suggest a natural break between high and low eigenvalues so provides little guidance in selecting the number of factors (Figure B.1).

Construction of the Factor Scales

After examining the factor structure of the original variables after the rotation step, the last step of constructing factor scale is in fact a reversed process. Remember in a factor model, each variable can be expressed as a weighted sum of common and unique factors:

$$y_j = f_1 b_{j1} + f_2 b_{j2} + \cdots + f_q b_{jq} + d_j u_j.$$

Now we consider replacing each common factor f_k with the predicted f_k and construct q common factors in such a way that the following weighted sum of squares is mini-

[93] The scree test involves plotting the eigenvalues in descending order of their magnitude against their factor numbers and determining where they level off. The break between the steep slope and a levelling off indicates the number of meaningful factors, different from random error (Cattell, 1966).

mized across all observations:

$$\sum_{j=1}^{p}[y_j - (\hat{f}_1 b_{j1} + \hat{f}_2 b_{j2} + \cdots + \hat{f}_q b_{jq})]^2.$$

However, if we want to take the sampling variability into consideration, then we might assume that the variables containing more random errors will naturally have a larger variance attributed to the unique factor and then a less weight should be given to. A Bartlett approach is to use this assumption and minimize the sum of squares given above after weighting each element with the reciprocals of the variance of the corresponding unique factor.

$$\sum_{j=1}^{p}[y_j - (\hat{f}_1 b_{j1} + \hat{f}_2 b_{j2} + \cdots + \hat{f}_q b_{jq})]^2 / d_j^2.$$

Addressing such a minimization objective function will lead us to the formulation of factor scales as a function of all the original variables:

$$\hat{\mathbf{f}} = (\mathbf{B}'\mathbf{U}^{-2}\mathbf{B})\mathbf{B}'\mathbf{U}^{-2}\mathbf{X}.$$

Where $\mathbf{U}^{-2}$ is the diagonal variance-covariance matrix of unique factors.

Table B.1: Definition of Health Outcome Measures

Measures	No. of items	Definition
BADLs	15	Capability in performing a number of fairly normal and routine day to-day activities or tasks. The 15 activities are: walking, running or jogging, getting up from a chair after sitting a long time, climbing stairs, stooping, kneeling, or crouching, reaching or extending arms above shoulder level, carrying weights over 5 kg, picking up a small coin from a table, dressing, bathing and showering, eating, getting in and out of bed, using the toilet and controlling urination and defecation. For each of the 15 items, the response is categorized 0 ('I cannot do it'), 1 ('Yes, I have difficulty and need help'), 2 ('I have difficulty but can still do it'), or 3 ('No, I don't have any difficulty').
IADLs	5	Similar as above, the five activities are household chores, preparing hot meals, shopping for groceries, managing money, and taking medications.
Self-reported health	1	Overall self-evaluation of current health in general, where respondents rate their health as being 'Very poor', 'Poor', 'Fair', 'Good' or 'Very good'.
Survival probability	1	The self-evaluated surviving chance in reaching a certain age given their current age (reported chance='Almost impossible', 'Not very likely', 'Maybe', 'Very likely' or 'Almost certain'). These questions represent the probability of surviving over the same time interval. For example, if the respondent is younger than 65, the respondent is asked to evaluate the chance in reaching the age of 75, however, if the respondent is aged 65-69, he or she is then asked to evaluate the surviving chance in reaching age 80, analogously, those aged 70-74 will be asked to estimate the chance surviving to age 85, so and so on.
Life satisfaction	1	Overall life satisfaction, respondents evaluate their satisfaction with life as a whole as being: 'Not at all', 'Not very', 'Somewhat', 'Very', or 'Completely'.
Intensity of pain	1	Self-reported intensity of body pain, where respondents rate their intensity of a body pain as being 'No pain', 'Mild', 'Moderate' or 'Severe'. Respondents are firstly asked whether or not they were often troubled with any pain in the body and a check-list of 15 parts of body feeling pain is used including head, shoulder, arm, wrist, fingers, chest, stomach, back, waist, buttocks, leg, knees, ankle, toes and neck. For each part of body pain, they are followed up by the question asking the intensity of pain. For respondents experiencing more than one part of pain, they are asked about the most severe one among them.
Episodic memory	2	The average of immediate and delayed recall scores. The respondents heard a list consisting of 10 words and were asked to memorize as many as possible, then the number of recalls were recoded as 'immediate recall scores' after two minutes. After several minutes, the respondents were asked to recall again, and the number of recalls were recorded as 'delayed recall scores'.
Mental status	11	The aggregate score of each respondent's answers to a series of mental status questions including the following items: naming today's date (year, month and day), the day of the week, current season, serial 7 subtraction from 100 (up to five times) and whether the respondent needed any aid such as paper and pencil to complete the number subtraction, and ability to redraw a picture shown to respondents. It is based on some components of the mental status questions of the Telephone Interview of Cognitive Status (TICS) to capture the cognitive functioning of the elderly group.

Table B.2: Definitions of Variables in Chapter 3

Variable Names	**Definition**
Cardiovascular disease	= 1 if respondent has cardiovascular disease, 0 otherwise
Diabetes	= 1 if respondent has disabetes, 0 otherwise
Respiratory disease	= 1 if respondent has respiratory disease, 0 otherwise
Arthritis	= 1 if respondent has arthritis disease, 0 otherwise
Other chronic physical disease	= 1 if respondent has other chronic physical disease mentioned above, 0 otherwise
Has any chronic physical disease	= 1 if respondent has at least one type of chronic physical disease
Depression	= 1 if respondent has a CES-D 10 score lower than 10, 0 otherwise
Demographic characteristics	
Age	Age calculated based on the birth of respondent
Male	= 1 if male, 0 otherwise
Lives with spouse/partner	= 1 if lives with spouse or partner, 0 otherwise
Urban area	= 1 if lives in an urban area, 0 if lives in a rural area
Urban Hukou	= 1 if has an non-rural Hukou, 0 if has a rural Hukou
Disability	= 1 if has one of the following disabilities: physical disabilities, brain damage/mental retardation, vision problem, hearing problem or speech impediment, 0 otherwise
Household size	Number of people living regularly as a member of the household
Living arrangements	
At least one child lives at home	= 1 if respondent lives with his/her child, 0 otherwise
Closest child lives in the same province	= 1 if the closest child lives in the same province from the household, 0 otherwise
Closet child lives in another province/country	= 1 if the closest child lives in another province or country as the household, 0 otherwise
No children	= 1 if respondent has no children, 0 otherwise
Household receives net transfers from at least one child	= 1 if at least one child sent back transfers and the net amount greater than zero, 0 otherwise
Socioeconomic status	
Education (respondent)	
Illiterate	= 1 if receives no formal education, 0 otherwise
Elementary	= 1 if the highest education level is elementary, 0 otherwise
High school	= 1 if the highest education level is high school
Vocational or above	= 1 if the highest education level is vocational or above
Employment status	
Employed or self-employed	= 1 if in employment, 0 otherwise
Subsistence farmer	= 1 if the main job is working in agriculture as farmer, 0 otherwise
Currently not working	= 1 if not working in the past 6 months
Retired	= 1 if retired formally, 0 otherwise
Has insurance	= 1 if has at least one type of health insurance, 0 otherwise
Household expenditure per capita last year (RMB)	The total household expenditure divided by the household size

Table B.3: Prevalence of 14 Disease States

Chronic Condition Status	**Freq.**	**Percent %**	**Cum. %**
No chronic condition	2,801	27.18	27.18
Cardiovascular disease alone	952	9.24	36.41
Diabetes alone	68	0.66	37.07
Respiratory disease alone	166	1.61	38.68
Arthritis alone	615	5.97	44.65
Other chronic physical disease alone	599	5.81	50.46
Depression alone	792	7.68	58.14
Comorbid depression with cardiovascular disease	324	3.14	61.29
Comorbid depression with diabetes	23	0.22	61.51
Comorbid depression with respiratory disease	90	0.87	62.38
Comorbid depression with arthritis	375	3.64	66.02
Comorbid depression with other chronic physical disease	287	2.78	68.81
Two or more chronic physical diseases	1,674	16.24	85.05
Comorbid depression with two or more chronic physical diseases	1,541	14.95	100
Total	10,307	100	

Table B.4: Factor Analysis with Different Numbers of Factors using Maximum Likelihood Estimation

	Log likelihood	**d.f. of model**	**d.f. of residual**	**AIC**	**BIC**
1	-1,272.35	8	20	2,560.70	2,619.48
2	-500.71	15	13	1,031.42	1,141.64
3	-20.46	21	7	82.92	237.23
4	-15.49	26	2	82.97	274.02

Note: The modes with 3 and 4 factors are Heywood cases. Outputs from command -estat factor- in Stata 13.

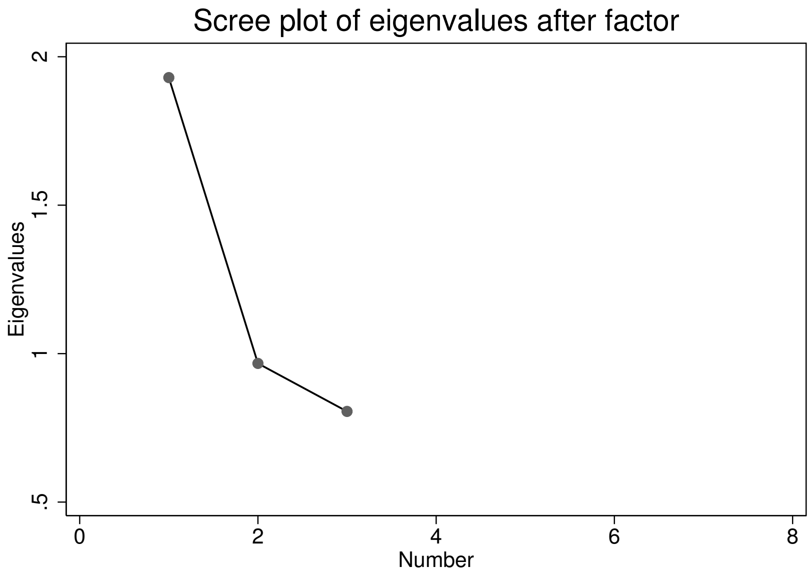


Figure B.1: Scree Plot of Eigenvalues in a Three-factor Model using Maximum Likelihood Estimation

Table B.5: Robustness Test: Comorbid Depression for Sample of Females

Variables	(1) Subjective Health		(1) Physical Health		(1) Cognitive Health		(4) (1) vs (2)	(5) (1) vs (3)	(6) (2) vs (3)
Chronic disease status (Base: No chronic condition)									
Cardiovascular disease alone	-0.295***	(0.048)	-0.170***	(0.036)	-0.040	(0.044)	0.048	0.000	0.017
Diabetes alone	-0.110	(0.155)	-0.440***	(0.151)	0.080	(0.133)	0.167	0.367	0.001
Respiratory disease alone	-0.244**	(0.120)	-0.286***	(0.101)	-0.088	(0.120)	0.799	0.390	0.163
Arthritis alone	-0.265***	(0.057)	-0.361***	(0.051)	-0.047	(0.053)	0.245	0.004	0.000
Other chronic physical disease alone	-0.336***	(0.057)	-0.182***	(0.043)	-0.002	(0.054)	0.033	0.000	0.008
Depression alone	-0.574***	(0.054)	-0.399***	(0.043)	-0.201***	(0.046)	0.013	0.000	0.001
Comorbid depression with cardiovascular disease	-0.766***	(0.074)	-0.742***	(0.082)	-0.240***	(0.066)	0.841	0.000	0.000
Comorbid depression with diabetes	-0.371	(0.349)	-0.933***	(0.359)	-0.006	(0.212)	0.347	0.315	0.019
Comorbid depression with respiratory disease	-1.100***	(0.155)	-0.501***	(0.123)	-0.401***	(0.150)	0.000	0.002	0.629
Comorbid depression with arthritis	-0.709***	(0.066)	-0.821***	(0.069)	-0.253***	(0.061)	0.269	0.000	0.000
Comorbid depression with other chronic physical disease	-0.840***	(0.081)	-0.691***	(0.082)	-0.272***	(0.070)	0.213	0.000	0.000
Two or more chronic physical diseases	-0.587***	(0.041)	-0.528***	(0.036)	-0.005	(0.037)	0.305	0.000	0.000
Comorbid depression with two or more chronic physical diseases	-1.060***	(0.041)	-1.164***	(0.041)	-0.289***	(0.037)	0.104	0.000	0.000
Observations	5,065		5,065		5,065				
Adjusted R^2	0.173		0.315		0.401				
Correlation for residual							-0.137	-0.032	0.096
P-value for BP test							0.000	0.000	0.000

Notes: (1) (1) the dependent variables are factor 1 (subjective health), factor 2 (physical health) and factor (cognitive health), which are standardized with a mean of zero and variance of 1. (2) Additional controls include those included in Table 3.5. (2) Clustered robust errors in parentheses. * p<0.1. ** p<0.05. *** p<0.01.

Table B.6: Robustness Test: Comorbid Depression for Sample of Males

Variables	(1) Subjective Health		(1) Physical Health		(1) Cognitive Health		(4) (1) vs (2)	(5) (1) vs (3)	(6) (2) vs (3)
Chronic disease status (Base: No NCDs/depression)									
Cardiovascular disease alone	-0.320***	(0.046)	-0.184***	(0.036)	0.008	(0.036)	0.026	0.000	0.000
Diabetes alone	-0.468***	(0.132)	-0.163**	(0.078)	-0.079	(0.099)	0.050	0.011	0.538
Respiratory disease alone	-0.444***	(0.083)	-0.244***	(0.069)	-0.046	(0.071)	0.054	0.000	0.036
Arthritis alone	-0.290***	(0.050)	-0.215***	(0.042)	-0.116**	(0.046)	0.276	0.010	0.087
Other NCDs alone	-0.511***	(0.053)	-0.090***	(0.033)	0.015	(0.046)	0.000	0.000	0.049
Depression alone	-0.579***	(0.058)	-0.346***	(0.046)	-0.233***	(0.046)	0.003	0.000	0.064
Depression and cardiovascular disease	-0.773***	(0.081)	-0.691***	(0.094)	-0.192***	(0.072)	0.540	0.000	0.000
Depression and diabetes	-1.119***	(0.227)	-0.987***	(0.214)	-0.063	(0.120)	0.730	0.000	0.001
Depression and lung chronic disease	-0.985***	(0.121)	-0.594***	(0.101)	-0.171*	(0.101)	0.015	0.000	0.004
Depression and Arthritis	-0.819***	(0.089)	-0.673***	(0.085)	-0.379***	(0.069)	0.247	0.000	0.004
Depression and other NCDs	-0.999***	(0.091)	-0.551***	(0.078)	-0.309***	(0.070)	0.000	0.000	0.006
Two or more main chronic conditions	-0.655***	(0.037)	-0.394***	(0.030)	-0.038	(0.031)	0.000	0.000	0.000
Depression and two or more chronic condition	-1.234***	(0.047)	-1.084***	(0.051)	-0.262***	(0.039)	0.046	0.000	0.000
Observations	5,242		5,242		5,242				
Adjusted R^2	0.193		0.289		0.270				
Correlation for residual							-0.115	-0.018	0.112
P-value for BP test							0.000	0.000	0.000

Notes: (1) the dependent variables are factor 1 (subjective health), factor 2 (physical health) and factor (cognitive health), which are standardized with a mean of zero and variance of 1. (2) Additional controls include those included in Table 3.5. (3) Clustered robust errors in parentheses. * p<0.1. ** p<0.05. *** p<0.01.

Table B.7: Robustness Test: Comorbid Depression for Original Eight Outcome variables

Variables	(1) NADL	(2) IADL	(3) Self-reported health	(4) Self-reported Survival Probability	(5) Life Satis-faction	(6) Intensity of pain	(7) Episodic Memory	(8) Mental Status
Chronic disease status (Base: No chronic condition)								
Cardiovascular disease alone	-0.168***	-0.021	-0.386***	-0.204***	0.019	-0.068***	-0.053	-0.017
	(0.024)	(0.016)	(0.032)	(0.035)	(0.036)	(0.022)	(0.035)	(0.027)
Diabetes alone	-0.268***	-0.050	-0.462***	-0.257**	0.147	-0.029	-0.275***	-0.004
	(0.072)	(0.036)	(0.111)	(0.115)	(0.102)	(0.060)	(0.098)	(0.077)
Respiratory disease alone	-0.246***	0.002	-0.503***	-0.332***	-0.011	-0.043	-0.122*	-0.045
	(0.053)	(0.034)	(0.071)	(0.072)	(0.062)	(0.050)	(0.065)	(0.059)
Arthritis alone	-0.263***	-0.042**	-0.287***	-0.214***	-0.099***	-0.317***	-0.089**	-0.073**
	(0.030)	(0.020)	(0.036)	(0.040)	(0.038)	(0.037)	(0.040)	(0.033)
Other chronic physical disease alone	-0.128***	0.013	-0.434***	-0.201***	-0.130***	-0.191***	-0.064	0.011
	(0.025)	(0.012)	(0.037)	(0.040)	(0.036)	(0.033)	(0.041)	(0.032)
Depression alone	-0.345***	-0.116***	-0.517***	-0.426***	-0.544***	-0.418***	-0.235***	-0.190***
	(0.029)	(0.021)	(0.037)	(0.037)	(0.042)	(0.036)	(0.037)	(0.031)
Comorbid depression with cardiovascular disease	-0.666***	-0.223***	-0.869***	-0.523***	-0.487***	-0.553***	-0.335***	-0.189***
	(0.057)	(0.048)	(0.049)	(0.051)	(0.060)	(0.057)	(0.049)	(0.046)
Comorbid depression with diabetes	-0.910***	-0.223	-0.841***	-0.826***	-0.809***	-0.499***	-0.444***	-0.005
	(0.194)	(0.150)	(0.209)	(0.127)	(0.222)	(0.193)	(0.142)	(0.125)
Comorbid depression with respiratory disease	-0.535***	-0.127*	-0.932***	-0.747***	-0.381***	-0.758***	-0.211**	-0.209***
	(0.075)	(0.076)	(0.085)	(0.100)	(0.108)	(0.110)	(0.095)	(0.079)
Comorbid depression with arthritis	-0.701***	-0.142***	-0.757***	-0.527***	-0.638***	-0.811***	-0.285***	-0.275***
	(0.051)	(0.032)	(0.049)	(0.049)	(0.063)	(0.059)	(0.050)	(0.043)
Comorbid depression with other chronic physical disease	-0.581***	-0.252***	-0.821***	-0.640***	-0.586***	-0.789***	-0.286***	-0.256***
	(0.052)	(0.044)	(0.051)	(0.061)	(0.063)	(0.064)	(0.051)	(0.046)

Table B.7 Continued:

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
	NADL	**IADL**	**Self-reported health**	**Self-reported Survival Probability**	**Life Satis-faction**	**Intensity of pain**	**Episodic Memory**	**Mental Status**
Two or more chronic physical diseases	-0.425***	-0.075***	-0.699***	-0.376***	-0.097***	-0.430***	-0.009	-0.029
	(0.021)	(0.014)	(0.026)	(0.028)	(0.028)	(0.025)	(0.028)	(0.022)
Comorbid depression with two or more chronic physical diseases	-1.048***	-0.358***	-1.182***	-0.787***	-0.637***	-1.128***	-0.258***	-0.257***
	(0.030)	(0.024)	(0.028)	(0.031)	(0.034)	(0.031)	(0.028)	(0.025)
Observations	10,307	10,307	10,307	10,307	10,307	10,307	10,307	10,307
Adjusted R^2	0.312	0.136	0.231	0.147	0.0814	0.222	0.198	0.357

Notes: (1) the dependent variables are standardized with a mean of zero and variance of 1. (2) Additional controls include those included in Table 3.5. (3) Clustered robust errors in parentheses. * p<0.1. ** p<0.05. *** p<0.01.

APPENDIX C

Appendix for Chapter 4

Table C.1: Definitions of Variables in Chapter 4

Variable	Definition
Age	Age calculated based on the birth of respondent
Male	= 1 if male, 0 otherwise
Lives with spouse/partner	= 1 if lives with spouse or partner, 0 otherwise
Urban area	= 1 if lives in an urban area, 0 if lives in a rural area
Urban Hukou	= 1 if has an non-rural Hukou, 0 if has a rural Hukou
Household size	Number of people living regularly as a member of the household
Number of children	Number of children of respondent
Household expenditure per capita last year (RMB)	The total household expenditure divided by the household size
Education (respondent)	
Illiterate	= 1 if receives no formal education, 0 otherwise
Elementary	= 1 if the highest education level is elementary, 0 otherwise
High school	= 1 if the highest education level is high school
Vocational or above	= 1 if the highest education level is vocational or above
Main job status (respondent)	
Employed or self-employed	= 1 if in employment, 0 otherwise
Subsistence farmer	= 1 if the main job is working in agriculture as farmer, 0 otherwise
Currently not working	= 1 if not working in the past 6 months
Retired	= 1 if retired formally, 0 otherwise
Type of health insurance (respondent)	
UEBMI	= 1 if in the Urban Employee Basic Medical Insurance scheme, 0 otherwise
URBMI	= 1 if in the Urban Rural Basic Medical Insurance scheme, 0 otherwise
NRCMS	= 1 if in the New Rural Cooperative Medical Scheme, 0 otherwise
Government/private medical insurance	= 1 if in the government or private medical insurance, 0 otherwise
No insurance	= 1 if has no insurance, 0 otherwise
Disease/Disability (respondent/spouse)	
NCD	= 1 if respondent/spouse has at least one type of NCD

Table C.1 continued:

Variable	Definition
Duration of NCD (years)	Duration of the NCD of respondent/spouse who was diagnosed earlier
Specific NCD	
Cardiovascular disease	= 1 if respondent/spouse has cardiovascular disease, 0 otherwise
Cancer	= 1 if respondent/spouse has cancer, 0 otherwise
Diabetes	= 1 if respondent/spouse has diabetes, 0 otherwise
Respiratory disease	= 1 if respondent/spouse has respiratory disease, 0 otherwise
Mental health problems	= 1 if respondent/spouse has mental health problems, 0 otherwise
Other NCDs	= 1 if respondent/spouse has other NCDs, 0 otherwise
Communicable disease	= 1 if respondent/spouse has communicable disease, 0 otherwise
Other diseases	= 1 if respondent/spouse has any other medical disease or condition not previously referred to, 0 otherwise
Disability	= 1 if respondent/spouse has any disabilities, 0 otherwise
Inpatient care (respondent/spouse)	= 1 if received inpatient care last year, 0 otherwise
Outpatient care (respondent/spouse)	= 1 if received outpatient care last month, 0 otherwise
Catastrophic health spending	= 1 if has the medical expenditure exceeding 40% of the household's capacity to pay
Living arrangements	
At least one child lives at home	= 1 if respondent lives with his/her child, 0 otherwise
Closest child lives in the same province	= 1 if the closest child lives in the same province as the household, 0 otherwise
Closet child lives in another province/country	= 1 if the closest child lives in another province or country as the household, 0 otherwise
No children	= 1 if there is no children, 0 otherwise
Household receives net transfers from at least one child	= 1 if at least one child sent back transfers and the net amount greater than zero, 0 otherwise

Table C.2: Mean of Net Transfers from Children to Parents, Disaggregated by Proximity of Children (CNY)

Proximity of children	All	Rural	Urban
Same household (n=5,591)			
Same household, but economically independent (n=435)	572.98	697.62	426.54
Same or adjacent dwelling/courtyard (n=779)	309.36	509.80	-169.09
Another household in the same village (n=4,165)	186.18	217.27	127.83
Another village in the same county/city (n=5,679)	68.67	259.94	-273.32
Another county/city in the same province (n=1,832)	503.02	581.24	346.71
Another province (n=2,504)	1231.60	1586.81	267.15
Abroad (n=47)	6148.81	9950.00	4186.90
No children (n=238)	-	-	-
Total (n=21,270)	385.34	563.53	37.56

Source: Authors' own calculation in CHARLS 2011 national survey. Note: Data pooled at child level.

Table C.3: Maximum Likelihood Estimates of the Probability of Undergoing Catastrophic Health Spending: Mental Health Problems Redefined Using CES-D 10-item Index

Variables	**(1)**	**(2)**	**(3)**
	All	**Rural**	**Urban**
	Mar. Eff.	**Mar. Eff.**	**Mar. Eff.**
Specific NCDs (respondent/spouse)			
Cardiovascular disease	0.044***	0.060***	0.021
	(0.009)	(0.013)	(0.014)
Cancer	0.088**	0.127**	0.046
	(0.037)	(0.054)	(0.052)
Diabetes	0.078***	0.050**	0.100***
	(0.016)	(0.023)	(0.021)
Respiratory disease	0.031***	0.034**	0.027*
	(0.011)	(0.014)	(0.017)
Depression	0.049***	0.049***	0.050***
	(0.009)	(0.012)	(0.013)
Other NCDs	0.045***	0.060***	0.024*
	(0.009)	(0.013)	(0.013)
Number of observations	8,087	4,871	3,216
Pseudo R^2	0.136	0.116	0.166

Notes: Depression is derived from the 10-item version of the Centre for Epidemiologic Studies Depression Scale (CES-D), and equals 1 if the index exceeds a cut-off of 10, 0 otherwise. Additional covariates include all the other variables presented in Table 4.2. Average marginal effects are reported and robust standard errors in parentheses. * p<0.1. ** p<0.05. *** p<0.01.

Table C.4: Robustness Tests: Catastrophic Health Spending Defined at Different Thresholds

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	**25%**	**30%**	**35%**	**40%**	**45%**	**50%**
	Mar. Eff.	**Mar. Eff.**	**Mar. Eff.**	**Mar. Eff.**	**Mar. Eff.**	**Mar. Eff.**
Base: No children						
At least one child lives at home	-0.109***	-0.114***	-0.115***	-0.126***	-0.114***	-0.090***
	(0.030)	(0.029)	(0.029)	(0.028)	(0.028)	(0.026)
Closest child lives in the same province	-0.003	0.000	-0.002	-0.018	-0.017	0.002
	(0.031)	(0.030)	(0.030)	(0.029)	(0.029)	(0.027)
Closest child lives in another province/country	-0.017	-0.001	-0.014	-0.007	-0.033	0.007
	(0.047)	(0.046)	(0.045)	(0.045)	(0.043)	(0.042)
At least one child lives at home × Household receives net transfers from at least one child	-0.013	-0.017	-0.016	-0.017	-0.012	-0.010
	(0.016)	(0.015)	(0.015)	(0.014)	(0.014)	(0.013)
Closest child lives in the same province × Household receives net transfers from at least one child	0.001	0.001	0.005	0.004	0.007	0.001
	(0.015)	(0.014)	(0.014)	(0.013)	(0.012)	(0.011)
Closest child lives in another province/country × Household receives net transfers from at least one child	-0.049	-0.049	-0.057	-0.063*	-0.033	-0.043
	(0.043)	(0.040)	(0.036)	(0.032)	(0.034)	(0.029)
Number of observations	8,087	8,087	8,087	8,087	8,087	8,087
Pseudo R^2	0.143	0.141	0.143	0.144	0.148	0.147

Notes: Additional covariates include all the other variables presented in Table 4.2. Average marginal effects are reported and robust standard errors in parentheses. * p<0.1. ** p<0.05. *** p<0.01.

APPENDIX D

Appendix for Chapter 5

Table D.1: Definitions of Variables in Chapter 5

Variable	Definition
Sample of Parents	
Has migrant child	= 1 if respondent has child who lives in another village, 0 otherwise
Good physical health	= 1 if the ADLs score of respondent is above the average score of the entire sample, 0 otherwise
Good mental health	= 1 if respondent has no clinical signficant depressive symptoms based on CES-D 10 item index
Good life satisfaction	= 1 if respondent is the rating of life satisfaction is 'somewhat satisfied' or above, 0 otherwise
Demographic characteristics	
Age	Age calculated based on the birth of respondent
Lives with spouse/partner	= 1 if lives with spouse/partner, 0 otherwise
Lives with children	= 1 if lives with children, 0 otherwise
Lives with grandchildren	= 1 if lives with grandchildren, 0 otherwise
Household size	Number of people living regularly as a member of the household
Number of children	Number of children of respondent has
Poor	= 1 if the household is below the poverty line, 0 otherwise
Catastrophic health spending	= 1 if has the medical expenditure exceeding 40% of the household's capacity to pay
Has any pension	= 1 if has any pension, 0 otherwise
Has NCDs	= 1 if has at least one type of NCD, 0 otherwise
Has Disability	= 1 if has as any other medical disease or condition not previously referred to, 0 otherwise
Disability	= 1 if has any disabilities, 0 otherwise
Education	
Illiterate	= 1 if receives no formal education, 0 otherwise
Elementary	= 1 if the highest education level is elementary, 0 otherwise
High school	= 1 if the highest education level is high school
Vocational or above	= 1 if the highest education level is vocational or above
Employment	
Employed or self-employed	= 1 if in employment, 0 otherwise

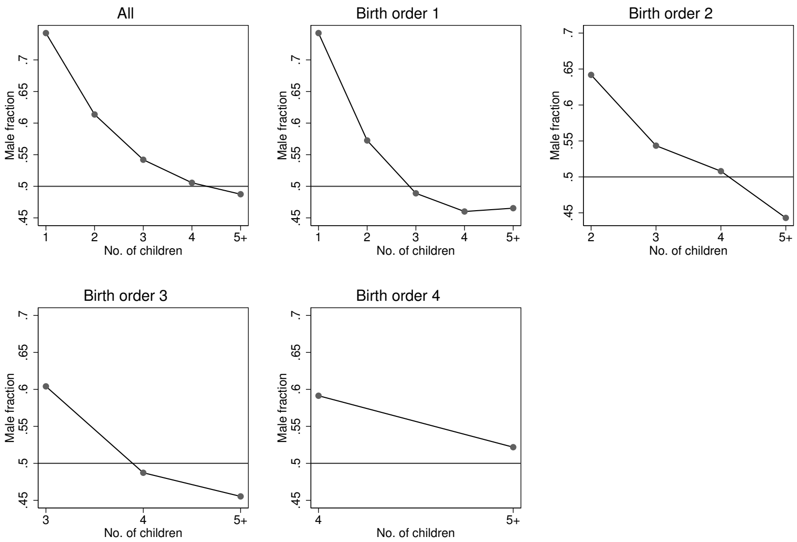
Table D.1 continued:

Variable	Definition
Subsistence farmer	= 1 if the main job is working in agriculture as farmer, 0 otherwise
Currently not working	= 1 if not working in the past 6 months
Retired	= 1 if retired formally, 0 otherwise
Health insurance type	
NRCMS	= 1 if participating in the New Rural Cooperative Medical Scheme, 0 otherwise
Other insurance	= 1 if participating in other insurance type, 0 otherwise
No insurance	= 1 if has no insurance, 0 otherwise
Sample of Children	
Migrant child	= 1 if the child lives in another village, 0 otherwise
Demographic characteristics	
Age	Age calculated based on the birth of the child
Male	= 1 if the child is male, 0 if female
Married	= 1 if the child is married, 0 otherwise
Has job	= 1 if the child is working, 0 otherwise
Sibling size	Number of siblings the child has
Eldest child	= 1 if the child is the eldest or the only child in the household, 0 otherwise
Education	
Elementary	= 1 if the highest education is elementary school, 0 otherwise
High school	= 1 if the highest education is high school, 0 otherwise
Vocational or above	= 1 if the child has an education of vocational or above, 0 otherwise
Child lives with respondent	= 1 if the child has his/her child living with respondent
Lives with respondent	= 1 if the child lives in the household with respondent, 0 otherwise

Table D.2: Number of Children in the Family

Number of children	Freq.	Percent %	Cum. %
1	330	11.04	11.04
2	1,014	33.94	44.98
3	817	27.34	72.32
4	449	15.03	87.35
5	244	8.17	95.52
6	82	2.74	98.26
7	33	1.10	99.36
8	15	0.50	99.87
9	3	0.10	99.97
10	1	0.03	100
Total	2,988	100	

Source: CHARLS 2011 rural sample.
Notes: All children are aged at least 15 in each family.



Note: Households with twins excluded.

Figure D.1: Male Fraction by Number of Children

Table D.3: Effect of Migration on Health and Well-Being of Parents - Endogenous-Binary Treatment with Two-step Consistent Estimator

Variables	Outcome			Treatment
	Physical Health	Mental Health	Life Satisfaction	Has migrant child
Demographic Characteristics				
Age/10	-0.106	-0.168	-0.002	1.750***
	(0.114)	(0.121)	(0.093)	(0.372)
Age/10 (square)	0.000	0.015	0.002	-0.135***
	(0.009)	(0.010)	(0.007)	(0.030)
Male	0.104***	0.092***	-0.003	-0.026
	(0.019)	(0.020)	(0.015)	(0.064)
Live with spouse/partner	-0.011	0.083***	0.025	0.054
	(0.022)	(0.023)	(0.018)	(0.077)
Number of children	0.011	-0.018*	-0.016**	0.411***
	(0.009)	(0.010)	(0.008)	(0.030)
With NCDs	-0.194***	-0.147***	-0.036**	-0.020
	(0.018)	(0.019)	(0.014)	(0.061)
With disability	-0.175***	-0.125***	-0.054***	0.108
	(0.022)	(0.023)	(0.018)	(0.078)
Education attainment (Base: Illiterate)				
Elementary	0.031	-0.002	0.022	0.147**
	(0.021)	(0.022)	(0.017)	(0.073)
High school	0.109***	0.082***	0.045**	0.316***
	(0.027)	(0.028)	(0.022)	(0.091)
Vocational or above	0.281***	0.243***	0.136**	-0.246
	(0.076)	(0.080)	(0.062)	(0.253)
Employment (Base: Employed/Self-employed)				
Subsistence farmer	-0.058**	-0.078***	-0.016	0.068
	(0.024)	(0.025)	(0.019)	(0.079)
Currently not working	-0.207***	-0.105***	-0.029	-0.115
	(0.031)	(0.033)	(0.025)	(0.106)
Retired	-0.059	-0.098	-0.043	-0.225
	(0.076)	(0.081)	(0.062)	(0.270)
Health insurance (Base: NRCMS)				
Other insurance	0.041	-0.018	0.039	0.096
	(0.045)	(0.048)	(0.037)	(0.155)
No insurance	-0.031	-0.063	-0.063**	0.182
	(0.039)	(0.041)	(0.032)	(0.145)
Pensions	0.016	0.006	0.079***	-0.062
	(0.032)	(0.034)	(0.026)	(0.117)
Proportion of sons				-1.016***
				(0.093)
Proportion of getting married				0.891***
				(0.090)
Has migrant child	0.009	0.104*	0.139***	
	(0.055)	(0.059)	(0.045)	
Constant	1.216***	0.898**	0.778***	-6.093***
	(0.346)	(0.366)	(0.282)	(1.132)

Table D.3 Continued:

Variables	**Outcome**			**Treatment**
	Physical Health	**Mental Health**	**Life Satis-faction**	**Has migrant child**
ρ	-0.008	-0.186	-0.279	-0.279
Sample size	2,988	2,988	2,988	2,988

Note: Additional control variables include 27 provincial dummy variables. Robust standard errors in parentheses. * p<0.1. ** p<0.05. *** p<0.01.

Table D.4: Effect of Migration on Two Additional Outcomes - Two-step Estimator

Variables	**(1)**	**(2)**
	Log (food expenditure)	**Log (out-of-pocket health expenditure)**
Has migrant child	0.436**	0.472**
	(0.181)	(0.224)
ρ	-0.206	-0.201
Sample size	2,709	2,988

Notes: Dependent variable: Logarithm of (household total food expenditure); Logarithm of (household out-of-pocket medical expenditure). For additional notes, please refer to Table 5.7. Robust standard errors in parentheses. * p<0.1. ** p<0.05. *** p<0.01.

Table D.5: Robustness Test: Migration Decisions Out of County - OLS

Variables	**(1)** **All**	**(2)** **Female**	**(3)** **Male**
Sibling size	-0.012**	-0.012	-0.012*
	(0.006)	(0.008)	(0.007)
Birth order (Base: First child)			
Second child	0.014	0.022	0.010
	(0.010)	(0.017)	(0.014)
Third child	0.033**	0.033	0.034*
	(0.015)	(0.022)	(0.020)
Fourth child	0.047**	0.062**	0.035
	(0.021)	(0.031)	(0.028)
Fifth child	0.060**	0.093**	0.034
	(0.029)	(0.045)	(0.037)
Sixth + child	0.075*	0.115	0.035
	(0.044)	(0.072)	(0.053)
Child characteristics			
Age	0.002	0.002	0.001
	(0.001)	(0.002)	(0.002)
Male	-0.029***		
	(0.009)		
Education (Base: Below elementary)			
Middle school	0.052***	0.063***	0.037***
	(0.011)	(0.016)	(0.014)
Vocational or above	0.200***	0.172***	0.214***
	(0.018)	(0.028)	(0.023)
Married	0.019	0.018	0.018
	(0.015)	(0.020)	(0.018)
Has job	0.069***	0.048**	0.100***
	(0.015)	(0.019)	(0.021)
Family characteristics			
Age of respondent /10	0.199***	0.205**	0.187**
	(0.065)	(0.095)	(0.074)
Age of respondent /10 square	-0.016***	-0.017**	-0.014**
	(0.005)	(0.007)	(0.006)
Education (Base: Illiterate)			
Elementary	0.027*	0.010	0.044**
	(0.016)	(0.020)	(0.020)
High school	0.019	0.016	0.029
	(0.019)	(0.024)	(0.024)
Vocational or above	-0.056	0.027	-0.118***
	(0.036)	(0.052)	(0.043)
Employment			
Subsistence farmer	0.014	0.005	0.019
	(0.016)	(0.022)	(0.020)
Unemployed	-0.020	-0.048*	0.002
	(0.020)	(0.027)	(0.025)
Retired	-0.031	-0.006	-0.058
	(0.039)	(0.062)	(0.051)

Table D.5 Continued:

Variables	**(1)** **All**	**(2)** **Female**	**(3)** **Male**
Poor household	-0.004	-0.017	0.007
	(0.012)	(0.016)	(0.015)
Has household ownership	-0.099***	-0.071**	-0.112***
	(0.022)	(0.030)	(0.026)
Constant	-0.277	-0.301	-0.287
	(0.203)	(0.294)	(0.234)
Observations	8,625	3,900	4,725
R^2	0.094	0.072	0.130

Notes: Dependent variable: binary variable whether a child lives beyond his/her parent's county. For additional notes, please refer to Table 5.7. Robust standard errors in parentheses. * p<0.1. ** p<0.05. *** p<0.01.

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