PRODUCTIVE ENGAGEMENT OF OLDER ADULTS IN CHINA: A LONGITUDINAL MULTILEVEL ANALYSIS

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FACULTY OF ECONOMICS AND ADMINISTRATION
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PRODUCTIVE ENGAGEMENT OF OLDER ADULTS IN CHINA: A LONGITUDINAL MULTILEVEL ANALYSIS

ABSTRACT

Population ageing poses significant challenges, but it also provides opportunities to harness the human capital of a large pool of experienced and skilled workers. In 2019, there were 164.4 million (11.5%) older persons aged 65 years and older in China, and undoubtedly the effective utilisation of this large pool of human resources is crucial for sustainable development. The present study aimed to investigate the effects of health, personal, behavioural, social, economic, physical environment, and demographic factors on the productive engagement of older adults, considering the provincial differences in economic conditions. This study used data from the 2002, 2005, 2008, and 2011 waves of the Chinese Longitudinal Healthy Longevity Survey (CLHLS). The respondents comprised 3,208 older adults aged 65 and over at wave 2002. The older adults were categorised as actively engaged in paid jobs, actively engaged in unpaid work, and less active. As they aged over nine years, the percentage engaged in a paid job declined from 45.5% to 25.1%, while those engaged in unpaid activities rose from 48.3% to 59.2%. The findings from employing a random intercept multilevel multinomial logit model developed from the mixed-effects models indicated a strong association between physical, cognitive, and functional health with paid and unpaid productive engagement. Also, older adults more likely to be involved in unpaid productive activities have the following characteristics: better self-rated health, greater cognitive health, better functionally independence, drinking and exercising habits, active participation in social activities, living alone, and female. Additionally, those who exercised regularly were more likely to participate more actively in paid and unpaid productive work. Participation in social activities was also positively associated with paid and unpaid productive engagement. Rural older adults not subject to the mandatory retirement age and those

financially inadequate were more likely to continue working. However, having chronic diseases, advanced age, and low education did not deter older adults from participating in unpaid productive engagement. The likelihood of being productively engaged among the older adults was higher in the provinces with lower gross domestic product (GDP) per capita. The person-mean centring models provided more insight than the grand-mean centring models, highlighting the importance of between- and within-person differences in explaining the variation in productive engagement. Health and exercising behaviour participation were particularly significant in explaining changes over time. The recommendations to promote active and productive ageing included enhancing the existing work system for older workers, raising the statutory retirement age, establishing social enterprises and entrepreneurship, accelerating the healthcare reform, promoting prevention-based healthy ageing, promoting regular exercise, and promoting social participation.

Keywords: Productive Engagement, Active Ageing, Ageing in China, paid job, Random Intercept Multilevel Multinomial Logit Model.

PENGLIBATAN PRODUKTIF WARGA TUA DI CHINA:

ANALISIS LONGITUD BERTINGKAT

ABSTRAK

Populasi golongan tua menimbulkan cabaran yang ketara, tetapi ia juga memberi peluang untuk mempunyai sejumlah besar pekerja yang berpengalaman dan berkemahiran. Pada tahun 2019, China mempunyai 164.4 juta (11.5%) warga tua yang berumur 65 tahun dan ke atas, dan tidak boleh dinafikan dengan adanya perancangan dan penggunaan efektif atas sumber daya tenaga yang besar ini adalah penting untuk pembangunan lestari. Kajian ini bertujuan untuk menyiasat kesan kesihatan, peribadi, tingkah laku, sosial, ekonomi, persekitaran fizikal, dan faktor demografi dalam penglibatan produktif warga tua, dengan mengambil-kira perbezaan keadaan ekonomi wilayah. Kajian ini menggunakan data dari gelombang 2002, 2005, 2008, dan 2011 dari Kajian *Chinese Longitudinal Healthy Longevity* (CLHLS). Sebanyak 3,208 warga tua berusia 65 tahun dan ke atas pada gelombang 2002 diterima-pakai sebagai kajian responden. Dalam kajian ini, warga tua dikategorikan sebagai aktif dalam aktiviti produktif bergaji, aktif dalam aktiviti produktif tanpa gaji, dan kurang aktif. Dalam jangka masa sembilan tahun, peratusan yang terlibat dalam aktiviti produktif bergaji turun dari 45.5% menjadi 25.1%, sementara mereka yang melakukan aktiviti produktif tanpa gaji naik dari 48.3% menjadi 59.2%. Kajian ini menggunakan model *random intercept multilevel multinomial logit* yang dikembangkan dari *mixed-effects models* menunjukkan hubungan kukuh antara kesihatan fizikal, kognitif, dan fungsi dengan penglibatan aktiviti produktif bergaji dan tanpa gaji. Warga tua yang terlibat dalam aktiviti produktif tanpa gaji juga menunjukkan ciri-ciri seperti kesihatan anggaran sendiri yang lebih baik, kesihatan kognitif yang lebih besar, menikmati kebebasan-fungsi, tabiat minum dan bersenam yang baik, penyertaan aktif dalam dalam aktiviti sosial, tinggal bersendirian, dan merupakan golongan wanita.

Malahan, mereka yang kerap bersenam didapati lebih aktif untuk kerja produktif bergaji dan tanpa gaji. Penyertaan aktiviti sosial juga berkorelasi positif dengan penglibatan dalam aktiviti produktif bergaji dan tanpa gaji. Warga tua di luar bandar tidak dikenakan persaraan umur mandatori dan mereka yang mempunyai tahap kewangan yang tidak stabil didapati lebih cenderung untuk terus bekerja. Di samping itu, penyakit kronik, usia lanjut, dan latar belakang pendidikan yang rendah tidak menghalang mereka untuk mengambil bahagian dalam penglibatan aktiviti produktif tanpa gaji. Kajian ini menemui tahap kebarangkalian untuk penglibatan produktif di kalangan warga tua adalah lebih tinggi di wilayah yang mempunyai Keluaran Dalam Negara Kasar (KDNK) per kapita yang lebih rendah. Model *person-mean centring* adalah lebih berkesan daripada model *grand-mean centring*, apabila ianya memaparkan ciri-ciri kebolehbezaan tahap antara- dan dalam- individu, sekaligus menerangkan variasi penglibatan produktif dengan lebih berkesan. Selain itu, kesihatan dan tabiat bersenam adalah signifikan dalam membuktikan perbezaan masa ke masa. Saranan untuk mempromosikan penuaan yang aktif dan produktif termasuk meningkatkan mutu sistem daya-kerja yang sedia ada untuk pekerja tua, meningkatkan usia persaraan berkanun/mandatori, menubuhkan perusahaan atau keusahawanan sosial, mempercepatkan reformasi penjagaan kesihatan, mempromosikan konsep penuaan yang sihat berlandaskan pencegahan, senaman yang kerap, dan penglibatan kegiatan sosial.

Kata Kunci: Penglibatan Produktif, Penuaan Aktif, Penuaan di China, kerja bergaji, Model *Random Intercept Multilevel Multinomial Logit*.

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AAI	:	Active Ageing Index
AARP	:	American Association of Retired Persons
ADL	:	Activities of Daily Living
AI	:	Artificial Intelligence
AR	:	Augmented Reality
BKPAI	:	Building Knowledge Base on Population Aging In India
BLS	:	U.S. Bureau of Labor Statistics
CASS	:	Chinese Academy of Social Sciences
CHARLS	:	China Health and Retirement Longitudinal Study
CHCs	:	Chronic Health Conditions
CLHLS	:	Chinese Longitudinal Healthy Longevity Survey
CNY	:	Chinese Yuan
COVID-19	:	Coronavirus Disease 2019
DUST	:	Disability and Use of Time
DYNASIM3	:	Urban Institute's Dynamic Simulation of Income Model
E.U.	:	European Union
EBDDP	:	Evidence-Based Disease and Disability Prevention Program
ELSA	:	English Longitudinal Study of Ageing
GDP	:	Gross Domestic Product
GLMMs	:	Generalised Linear Mixed Models
GM	:	Grand-Mean Centring
HILDA	:	Household, Income and Labour Dynamics in Australia Survey
HRS	:	Health and Retirement Survey
HRS CAMS	:	Health and Retirement Study Consumption and Activities Mail Survey
IADL	:	Instrumental Activities of Daily Living
ICT	:	Information and Communication Technology
LCA	:	Latent Class Analysis
LNPGDP per capita	:	Natural Logarithm of GDP Per Capita
LTC	:	Long-Term Care
MAR	:	Missing at Random
MCAR	:	Missing Completely at Random
MMSE	:	Mini-Mental State Examination
NAC	:	National Alliance for Caregiving

NBS	:	National Bureau of Statistics of China
NLCS	:	Netherlands Cohort Study
NMAR	:	Not Missing at Random
NRCMI	:	New Rural Cooperative Medical Insurance
NSHAP	:	National Social Life, Health, and Aging Project
OECD	:	Organisation for Economic Co-Operation and Development
OR	:	OddsRatio
PM	:	Personal-Mean Centring
SAGE	:	Study on Global Ageing and Adult Health
SHARE	:	Survey of Health, Ageing and Retirement in Europe
SLOSELO	:	Shanghai Longitudinal Survey of Elderly Life and Opinion
SOPT	:	Survey of Older Persons in Thailand
SST	:	Socioemotional Selectivity Theory
U.K.	:	United Kingdom
U.S.	:	United States
U3A	:	University of The Third Age
UN	:	United Nations
UNECE	:	United Nations Economic Commission for Europe
UNFPA	:	United Nations Population Fund
URBMI	:	Urban Residential-Based Medical Insurance
VNAS	:	Vietnam Aging Survey
VR	:	Virtual Reality
WHO	:	World Health Organization

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CHAPTER 1: INTRODUCTION

1.1 Introduction

Longevity, one of mankind's greatest achievements, has caused the world to experience unprecedented changes in its demography. This gift of long life can be attributed to advances in medicine and public health, improved nutrition, better hygiene, improved management of chronic diseases, economic development, declining fertility and mortality rates as well as increased life expectancy (B. Gu, 2016; United Nations, 2019a). However, it also the reason why individuals, families, communities, and societies now face new social and economic challenges. The demographic realities arising from our rapid population ageing also puts pressure on the labour market, non-profit organisations as well as the private and public service sector (Gonzales et al., 2015). Although nations face significant challenges in ensuring the well-being of their older citizens, they have to increase efforts to safeguard the human rights, economic security, and financial security of this vulnerable group by providing them with access to long-term care, healthcare services, formal and informal social support networks, and lifelong learning opportunities.

Furthermore, governments need to adequately plan for population ageing in order to achieve sustainable development goals; such as "no poverty" (1), "good health and well-being" (3), "quality education" (4), "gender equality" (5), "decent work and economic growth" (8), "reduced inequalities" (10), and "peace, justice, and strong institutions" (16) and "partnership for the goals" (17) (United Nations, 2019a). However, most politicians, policymakers, researchers, and the media are inadequately prepared to address the rapid ageing of their populations. As such, there is growing concern that the age-related work, consumption, and saving patterns of the ageing population; the larger demographic; will

weaken labour force growth and result in slower overall economic growth and a decline in living standards. Therefore, some quarters view population ageing as a potential crisis that will overwhelm social services, healthcare systems, and retirement schemes across the globe (The Gerontological Society of America, 2018). However, the primary challenge of a changing demographic may not be population ageing itself but failure to adapt to the current reality and embrace new strategies (Börsch-supan, 2014; Lindland et al., 2015). As the number of working-age adults dwindles, harnessing the skills and experiences of older adults will not only become a desirable option but an economic necessity. After all, the growing pool of older adults is a valuable source of human capital (Morrow-Howell, Gonzales, et al., 2017). As productive ageing or productive engagement calls for building the capacity of and utilising older adults, there have been more calls to promote active and productive ageing to meet the challenges of an ageing population. Older adults can be engaged in productive activities such as housework, gardening, caregiving, providing informal help, and volunteering besides work.

The World Health Organization (WHO) has been promoting the Active Aging Framework. Active ageing is an aim for policy and programme developments and refers to "the process of optimising opportunities for health, participation, and security to enhance the quality of life as people age" (World Health Organization (WHO), 2002, p. 12). Meanwhile, as older adults are an underutilised human capital resource, productive ageing focuses on how they can contribute to their families and communities rather than becoming dependent on their families and communities (Butler & Gleason, 1985; Rowe & Kahn, 1997). In the right circumstances, active and productive engagement are expected have multiple positive impacts; such as minimising the fiscal strain of supporting a larger older population, sustaining the health and economic security of older adults, and ameliorating the strain on families and society (Gonzales et al., 2015). As

such, the Longevity Economy is an important part of the economy and integral to the overall fiscal health at local and national levels (The Gerontological Society of America, 2018). Despite the vast number of older adults engaged in productive activities, there is a dearth of empirical research from the longitudinal and multilevel perspectives. Therefore, this study examined the longitudinal and multilevel aspects of productive engagement among older adults from factors; such as health, personal, behavioural, social, economic, physical environment, demographic, and contextual variables (provinces). The sample of this study was obtained from the Chinese Longitudinal Healthy Longevity Survey (CLHLS).

1.2 Population Ageing

Population ageing is a megatrend as people above the age of 65 are the fastest-growing age group in the world (United Nations, 2019a). Over the next 85 years, the old-age dependency ratio; the ratio of older adults aged 65 and above to those aged between 15 to 64; is expected to double in many countries (Clements et al., 2016). In 2019, persons aged 65 and above accounted for approximately 9%; or 703 million; of the global population. This figure is expected to increase to 16%; or one in six people; by 2050 (United Nations, 2019a). In 2018, for the first time in human history, the number of adults over the age of 65 surpassed the number of children under the age of five (United Nations, 2019a). The number of older adults is also expected to surpass the number of young persons aged 15 to 24 by 2050 (United Nations, 2019a). In 2017, about two-thirds of the world's above 60s lived in developing countries (United Nations, Department of Economic and Social Affairs, Population Division, 2017). While Asia is expected to have the most substantial increase in older adults, China is expected to have the highest older population numbers.

Structural changes; such as globalisation, rapid industrialisation, technological advances, urbanisation, migration, and shrinking family sizes; have profoundly affected the well-being of older adults (Cheng & Heller, 2009; United Nations, 2019a). Population ageing also has significant implications and impacts on economic performance, the quality and size of the labour force, fiscal policy, public expenditure on healthcare, pensions, long-term care, and social protection for older adults (United Nations, 2019a). In developing countries, older adults are usually looked after by informal social support networks, especially family members (Y. Fang et al., 2019; J. Lu & Liu, 2019; Teerawichitchainan et al., 2019; Visaria & Dommaraju, 2019). These informal social support networks are essential in developing countries as formal social protection is underdeveloped.

1.3 Ageing in China

Although China is the most populous developing country, it has undergone a demographic transition as fertility and mortality rates have declined while life expectancy has increased substantially (F. Chen & Liu, 2009; J. Lu & Liu, 2019). Moreover, China has the fastest-growing ageing population in the world (Terada-Hagiwara et al., 2018). In 2000, people aged 65 and above accounted for less than 7% of China's population. However, this figure is expected rise to 14% by 2025 and 25% by 2050 (United Nations, 2019a). In 2050, adults over 65 are expected to number 366 million; which is higher than the population of the United States in 2012 (313.9 million) (B. Gu, 2016; United States Census Bureau, 2013). Of China's[1] population of 1.4 billion in 2019, 11.5% (164.4 million) people were above the age of 65 (United Nations, 2019a) which accounted for more than one-fifth of the world's total ageing population at the time (United Nations, 2019b). As seen in Table 1.1, the population will gradually grow between 2000 and 2030

[1]Excluding the populations of Hong Kong, Macao, and Taiwan.

after which it will begin to decrease. However, the number of young people aged 0 to 14 has been decreasing since 2000. Although the percentage of working adults; aged 15 to 64; stood at 68% in 2000, this figure is projected to decrease beginning in 2020 and stand at 60% by 2050. Therefore, a diminished labour force will be expected to sustain and support an aged population.

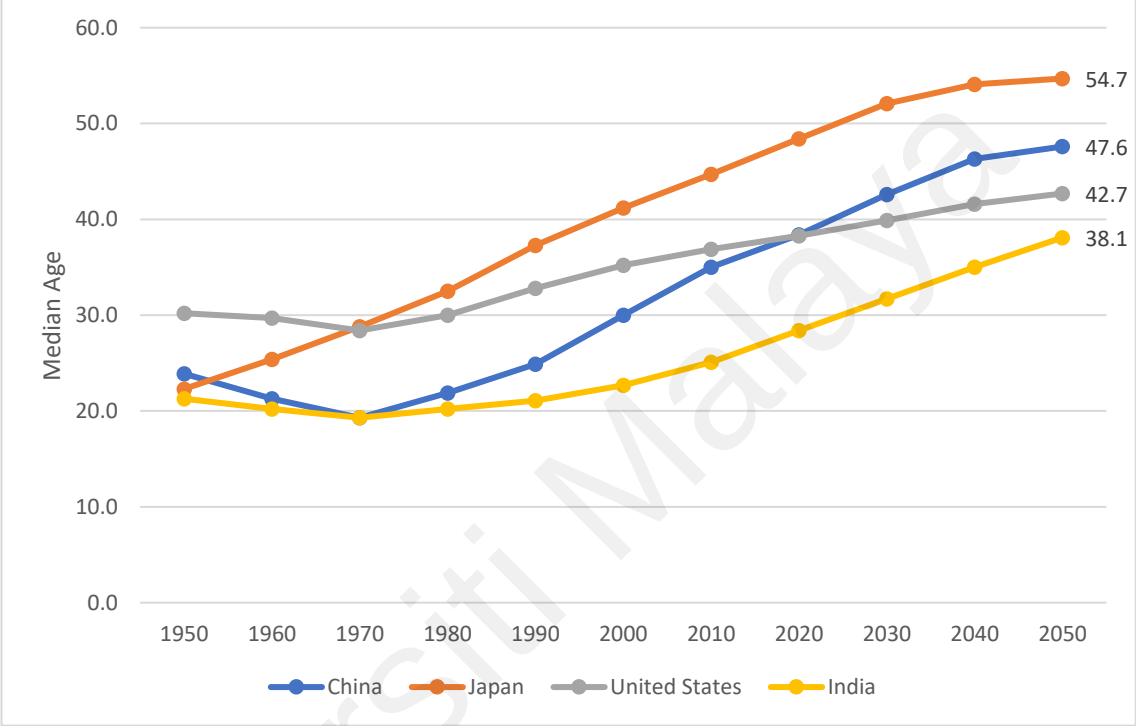
Table 1.1: The Number and Percentage Distribution of the Total Population and Population Aged 65 and over in China between 2000 to 2050

Year	Population (in a million)				Percentage (%)			Population growth rate (%)		
	Total	0-14	15-64	65+	0-14	15-64	65+	0-14	15-64	65+
2000	1,290.60	319.9	882.7	87.9	24.8	68.4	6.8	-	-	-
2005	1,330.80	270.9	960.3	99.6	20.4	72.2	7.5	-15.3	8.8	13.3
2010	1,368.90	255.4	1,002.90	110.5	18.7	73.3	8.1	-5.7	4.4	10.9
2015	1,406.80	254	1,021.60	131.3	18.1	72.6	9.3	-0.5	1.9	18.8
2020	1,439.30	254.9	1,012.10	172.3	17.7	70.3	12	0.4	-0.9	31.2
2025	1,457.90	246.7	1,006.60	204.6	16.9	69	14	-3.2	-0.5	18.7
2030	1,464.30	230.9	986.5	247	15.8	67.4	16.9	-6.4	-2.0	20.7
2035	1,461.10	215.7	943.3	302.1	14.8	64.6	20.7	-6.6	-4.4	22.3
2040	1,449.00	206.8	898.4	343.8	14.3	62	23.7	-4.1	-4.8	13.8
2045	1,429.30	202.4	871	355.9	14.2	60.9	24.9	-2.1	-3.0	3.5
2050	1,402.40	198.4	838.4	365.6	14.1	59.8	26.1	-2.0	-3.7	2.7

Source: United Nations, 2019b; Own calculation.

The median age of China's population was 30.0 years old in 2000 (United Nations, 2019b) and projected to increase to 47.6 years by 2050, surpassing the 42.7 years of the United States. Thus, there is a big challenge for China to be economically sustainable or innovative, with half of the population older than 47.6 years old. China will be one of the countries that most severely affected by population ageing (Attané & Gu, 2014) (refer to Figure 1.1).

Zeng (2001) described the main characteristics of China's ageing population as "two high and three large" with "two high" indicating the high-speed growth of its elderly population and the oldest of its ageing population while "three large" indicates the large size of its elderly population, dependency ratio, and regional differences.



Source: United Nations, 2019b.

Figure 1.1: Median ages in China, India, Japan, and the United States between 1950 to 2050

1.4 Problem Statement

Active and productive ageing means productivity in later life that extends beyond engaging in paid work. This comprises of any paid or unpaid productive engagements that produce goods and services for the benefit of society; such as paid labour, unpaid family labour, household management, caregiving for family members, formal and informal volunteering; which mutually benefits both the elderly and society. Nevertheless, the stereotype that older adults are unproductive, a burden on society, and only participate in self-care and leisure activities still persists (Q. Feng et al., 2019;

Fernández-Ballesteros et al., 2011; Morrow-Howell & Greenfield, 2016; Singh, 2018). However, older adults have always been active and productive in families and communities. What's more, the baby boomer generation is relatively healthier and more educated than their predecessors (Y. Fang et al., 2019). Therefore, the current population of older adults can play a more proactive role in contributing to productive engagement (Moody, 2001). Moreover, many studies have concluded that older adults contribute enormously as workers, producers, entrepreneurs, consumers, volunteers, caregivers, voters etc (AARP & The Economists, 2019; The Gerontological Society of America, 2018; United Nations Population Fund (UNFPA) & International HelpAge, 2012).

As productive engagement may have a positive effect on older adults, its active promotion may provide promising alternatives as it has a positive effect on the mental and physical well-being of older adults, encourages healthy ageing, reduces the likelihood of disability and health risks in later life, delays the ageing process, and benefits others (Y. Hao, 2008; N. R. Hooyman & Kiyak, 2011; Kail & Carr, 2017; Poscia et al., 2015; Svanborg, 2001; F. Tang et al., 2009). Apart from that, continuing to work at an older age reduces the negative correlation between single and multiple chronic conditions and functional limitations. Based on the three waves of the China Health and Retirement Longitudinal Study (CHARLS 2011-2015), productive engagements; such as caring for grandchildren or a spouse, providing informal help, and formally volunteering; play a role in reducing the risk of cognitive decline (Y. Luo et al., 2019).

China has experienced phenomenal development since its implementation of an open-door policy in the late 1970s. Its GDP per capita increased from approximately USD195 in 1980 to around USD4,550 in 2010 and was expected to double to USD9,771 in 2018 (The World Bank, 2019). However, despite its rapid economic development, China is

considered a developing country as its ageing population implies a double burden on its financial and social institutions. This is because ageing societies pose challenges, such as labour shortages in tandem with the need for long-term care, healthcare facilities, and services (Y. Fang et al., 2019). One of the problems faced by China is the statutory retirement age which the government intends to gradually increase from 60-years-old for men and 50-years-old for women to 65-years-old for both men and women by 2045. However, there are still no clear and ultimate regulations to increase the retirement age (China Labour Bulletin, 2019a; Y. Fang et al., 2019).

While China's pension system still faces many problems and challenges in rural areas (Y. Fang et al., 2019), the sustainability of its urban pension fund is a concern in light of the rapidly growing ageing population and declining workforce. The Chinese Academy of Social Sciences (CASS) predicts that the total expenditure of its pension fund reserves might surpass its contributions by 2028 (China Labour Bulletin, 2019b) at which point the pension fund reserves will decrease exponentially and run out by 2035.

At present, China still lacks sound social infrastructure; such as a healthcare programme, long-term care system, and social security system; with which to support and meet the demands of its ageing population. As such, deteriorating health and increasing healthcare costs have become a significant concern among older adults in China (Cao et al., 2016; F. Li & Otani, 2018; R. Sun, 2004). The healthcare system, long-term care systems, and community programmes will also encounter higher demand in the future demand (F. Li & Otani, 2018; B. Lu et al., 2017). Furthermore, China's one-child policy; which was discontinued in 2015; as well as its economic reforms have also weakened social support for older adults and gradually increased the number of empty-nest families (Y. Fang et al., 2019). Therefore, each married couple will, potentially, be responsible for the

financial and social support of two elderly parents and four grandparents (Adamchak, 2001; P. Du & Phillips, 2004). Apart from that, the increase of the older dependency ratio also indicates that a smaller number of working age adults will be available to support the older adults (Ling & Chi, 2008; United Nations, 2019a).

Urban-rural and regional disparities have also been observed in various aspects of the ageing process (P. Du et al., 2016; Y. Wang et al., 2017; H. Zhu et al., 2019). L. Wang et al. (2016) found that the number of older adults and the oldest of the old population in China lived in provinces that had abundant natural resources, higher socio-economic development, and a favourable climate. H. Liu et al. (2017) found that older adults living in the Central, North-Eastern, or Western provinces of China had lower chances of ageing successfully than their counterparts in the east coast provinces. Some studies also concluded that older adults in China's Western region and rural areas were more vulnerable in their old age (P. Du et al., 2016; Q. Feng et al., 2019). Furthermore, older adults in these disadvantaged provinces had less coverage from their pension, social security, and social insurance and, therefore, were less able to afford or access healthcare. These provinces also had less community support in terms of long-term care, psychological well-being programmes, and social participation. Therefore, understanding the urban-rural and provincial variations of ageing and the determinants of productive activities is urgently needed to design policies that support active and productive engagements across the different provinces.

Ageism and age discrimination still prevail in (Boduroglu et al., 2006; Q. Feng et al., 2019). As employers are prejudiced against older job seekers, older workers may not seek new employment after retirement. There is also a lack of training and educational programmes for older workers. College students also harbour negative views of older

workers in China (Boshier, 2009; J. Lu, 2009; B. Luo et al., 2013). A 2006 survey on the perception towards the elderly population among urban and rural Chinese found that 42% of urban respondents and 58% of rural respondents felt that older people were a burden on society while 40% of urban respondents and 62% of respondents felt that older adults were a burden on the family (P. Guo & Chen, 2009). Sadly, a significant portion of older respondents also felt that they were a burden on their families and society.

Although several studies have examined the factors affecting productive engagement among older adults (J. H. Kim, 2019; Ko & Yeung, 2018; Morrow-Howell et al., 2014; Teerawichitchainan et al., 2019; Visaria & Dommaraju, 2019), only a handful of studies have quantitatively analysed the impacts of various determinants; such as health, personal, social, economic, behavioural, and physical environment; and examined their longitudinal and contextual effects on productive engagement. An American study used cross-sectional data from the Health and Retirement Study to examine the effect of factors; such as health, personality, behaviour, social participation, finances, and physical environment; on five activity profiles and found that gender, age, educational background, physical environment, self-rated health, and activities of daily living (ADL) affected working and various activity profiles in old age (Morrow-Howell et al., 2014). However, the correlation between productive engagements and various determinants might differ between Asian or non-Asian societies (Murata et al., 2019; Teerawichitchainan et al., 2019). Furthermore, only a few studies have used longitudinal data to explore the correlation between contextual variables and determinants of productive engagement (Morrow-Howell et al., 2014; Sadana et al., 2016; Watanabe et al., 2019; Zeng, 2012). Thus, this study intends to unveil the active and productive ageing scenario in China using a large-scale longitudinal multilevel study by focussing on three

main aspects; (i) changes over time, (ii) impact of different factors, and (iii) impact of contextual variables to reflect provincial differences.

1.5 Research Questions and Research Objectives

This study contributes to the existing body of literature by addressing the following question: what are the impacts of the health, personal, behavioural, social, economic, physical environment, and demographic factors on the productive engagement over time among older adults in China, and does the provincial differences affected productive engagement?

In order to fill gaps in the literature and to study the active and productive engagement framework, the research questions and objectives of this study were:

1. Does productive engagement of older adults change over time?
2. What are the impacts of the health, personal, behavioural, social, economic, physical environment, and demographic factors on the productive engagement of older adults?
3. Does the provincial contextual variable affect productive engagement?

The objectives of this study are to:

1. To examine the changes in the productive engagement of older adults over time.
2. To investigate the impacts of health, personal, behavioural, social, economic, physical environment, and demographic factors on the productive engagement of older adults.
3. To analyse the provincial effects on productive engagement.

1.6 Significance of the Study

As the population ages rapidly, the segment of older adults who are capable and willing to continue working is growing. Moreover, the experiences, knowledge, consumption, and wealth of older adults can contribute to society and the economy. Most studies reveal that older adults maintain reasonably good physical, cognitive, and functional health well into old age. Therefore, many older adults can still actively participate in the labour force and unpaid productive engagements (AARP & The Economists, 2019; Kim, 2019; The Gerontological Society of America, 2018). Apart from that, productive engagement has several positive effects on older adults; such as promoting healthy ageing as well as reducing mortality, disability, and health risks in later life (Chipperfield, 2008; Hu & Das, 2019; Lam & Bolano, 2019; McDonnall, 2011; Morrow-Howell et al., 2014; Poscia et al., 2015).

Therefore, the findings of this study could serve as a guide for policymakers as they attempt to cope with the rapid population ageing globally, especially in East Asia and developing countries, as understanding, acknowledging, and adapting to rapid population ageing is essential for governments to formulate adequate policies and programmes. After all, population ageing does not necessarily spell macroeconomic decline if the right policies are developed (United Nations, 2019a). As the age of China's ageing population remains relatively young, its dependency ratio is still comparatively low as it still has an adequate supply of labour (H. Zhu et al., 2019). This provides China with a window of opportunity to develop an active and proper response to tap into the potential of its large pool of older human capital. As such, promoting active and productive ageing will provide an alternative that maximises benefits and manages problems associated with population ageing. However, the benefits of an ageing society and the demographic dividend are conditional upon the implementation of adequate policies and investments

that utilise and integrate the potential of older adults (Fried, 2016; Olshansky et al., 2007; United Nations, 2019a).

1.7 Structure of the Study

This study is spread across seven chapters. Chapter one provides an overview of the ageing population and ageing in China. The research problems of this study were established by identifying gaps in the existing body of literature. The research objectives and research questions are stated followed by the significance of this study. Chapter two provides definitions, concepts, and theories on active and productive engagement. It also discusses the determinants and contextual variables related to active and productive engagement and presents gaps in existing research. Chapter three describes the research design, research framework, sources of data, quality of data, and measurement of the variables. It goes on to elaborate the statistical analyses, multilevel modelling, generalised linear mixed models (GLMMs), and the six models of random-intercept multilevel multinomial logit models for longitudinal data.

Chapter four provides a background of the study based on univariate and bivariate analysis. As a two-level model was utilised in this study, chapter five provides an analysis and discusses the results of Models One to Three which examined the impact of the different factors on productive engagement. Chapter six examines and discusses the results of Models Four to Six from three multilevel model perspectives that take provincial effects into consideration. Finally, chapter seven summarises the findings and outlines the study's implications, limitations, and suggestions for future research.

CHAPTER 2: LITERATURE REVIEW

2.1 The Definition of Old Age

Old age is an ambiguous term, with no clear-cut rule or threshold age in deciding the age at which an individual is considered an older adult. However, for pragmatic reasons, a threshold age of 60 or 65 is often cited (Mullan, 2002; Roebuck, 1979; Stuart-Hamilton, 2011). The threshold age of 60 years of age has been accepted by mainstream literature for close to 200 years since Adolphe Quetelet introduced it in his book, *Treatise on Man,* in 1836 (Stuart-Hamilton, 2011). The United Nations (UN) also applies the threshold age of 60 years and above to refer to the older population. Conversely, most developed countries have employed the chronological age of 65 years as a threshold for older adults in which the pension and retirement policy includes both the ages of 60 and 65 (Erber, 2019). As working persons reach 60 or 65 years of age or the mandatory retirement age, they are eligible to receive a pension. Therefore, the pensionable age and retirement age of 60 or 65 has become indicators for entering older adulthood (Erber, 2019).

Nevertheless, longer life expectancy implies that chronological age may not be a helpful indicator of old age (S. Liu et al., 2019). Some older adults perceive or define the old-age threshold over and above 60 or 65 years at present. For example, in the 2000 American Perceptions of Ageing study, men and women are perceived as "old" at 70 and 75 years, respectively (The National Council on the Aging, 2002). A study conducted in China suggests that the self-perception of old age is 70 years (S. Liu et al., 2019).

Scherbov and Sanderson (2016) introduced a novel approach based on the "prospective age," a forward-looking age, to study and supplement the concept and measurement of age and ageing. They mentioned that most population ageing studies employed the

backwards-looking concept, such as chronological age and median age (Sanderson & Scherbov, 2006; Scherbov & Sanderson, 2016). The new measures of prospective age use various characteristics, such as remaining life expectancy, health, average public pension age, and hand-grip strength, to measure population ageing. For example, using 1990 as the reference year, if a 59-year-old Chinese person in 1990 had a remaining life expectancy of 10 years and a 66-year-old Chinese person in 2015 also had a remaining life expectancy of 10 years, then the 66-year-old in 2015 would have a prospective age of 59. The older adults with the same "prospective age" would also have the same remaining life expectancy.

Hooyman and Kiyak (2011), in their study, propose adopting a neutral terminology to address older persons by referring to them as "older adults, older people, or people as they age" (p.7). The rationalising of choices are "(i). There is no comparable phrase for the elderly among younger populations, while older adults or older people are similar to the concept of young people (ii). Many older adults dislike the terminology seniors or elderly" (Hooyman & Kiyak, 2011, p. 7). The term "elders" may link to respect, though some comment that the phrase is quite similar to "elderly" (Burling, 2017).

In general, older adults are categorised into three life-stage subgroups: the young-old (approximately 65–74), the middle-old (ages 75–84), and the old-old (85 and over) (Erber, 2019; Hooyman et al., 2015).

2.2 Longevity Economy

Older adults drive and contribute significantly to the world's economic activities. In this sense, the "longevity economy" is the untapped opportunity for economic growth. Older adults drive the longevity economy in three ways: producers, consumers, and wealth

redistribution (The Gerontological Society of America, 2018). In 2018, the economic contribution of Americans aged 50 and older was worth USD 8.3 trillion (third-largest economies in the world, behind the United States (US) and China). Further, by 2050, it is expected that this contribution will more than triple to USD 28.2 trillion (AARP & The Economists, 2019). By 2032, longevity economy projects are anticipated to account for 52% of the country's GDP in the US, and consumer spending by Americans aged 50 and older will increase by 58% to USD 4.6 trillion (AARP & The Economists, 2016).

Furthermore, economists estimate that increasing the number of older workers, combined with productivity-enhancing investments, could boost the GDP in the US by USD 442 billion in 2020 (Erfurt et al., 2012). Many older adults continue to work in chosen lifelong careers in the US, have started consulting or contracting their businesses, or have taken up new positions or even new jobs. As a consumer, the American 50-plus population in 2018 spent about USD 7.6 trillion (or 56 cents in every dollar spent) on goods and services. By 2050, this figure is expected to rise to 61 cents in every dollar (AARP & The Economists, 2019). The Boston Consulting Group predicts that the 55-plus population in the US, Japan, and Germany will have accounted for 50%, 67%, and 86% of domestic consumer spending growth, respectively, by 2030 (Shibata, 2019; The Boston Consulting Group, 2011). Based on an online consumer survey of 51 countries in 2017, KPMG reported that baby boomers spent the most on online shopping, USD 203 on average per transaction compared to USD 190 by generation X and USD 173 among 'tech-savvy' Millennials (KPMG, 2017). In 2015, 66% of China's older population had reported using products specifically for older adults (Y. Fang et al., 2019). As living standards in China improve, the domestic market for Chinese older adults is expected to experience tremendous growth potential for both products and services.

Besides, the societal contribution of the Americans aged 50 years and older through unpaid productive activities, like caregiving, volunteering, support charities, and others, in 2018 was reported to be worth USD 745 billion (AARP & The Economists, 2019). Moreover, USD 78 billion per year or 3.3 billion hours of community service was contributed by more than 21 million Americans aged 55 and above (Corporation for National and Community Service, 2017). Thus, older adults are not merely seen as a group of people that need services from the "silver economy", but they are importantly the untapped potential of the "longevity economy" that can continue to contribute and participate in the economy.

2.3 Selected Ageing Issues in China

China's population is ageing more rapidly than in most developed countries, such as the US and Europe, where it took between 45 and 115 years for the ageing population to grow from 7% to 14% (OECD, 2018; Terada-Hagiwara et al., 2018). In contrast, doubling the ageing population in China only took 23 years, compared to 115 years in France, 69 years in the US, and 25 years in Japan to transition from ageing to ageing (Table 2.1). China is experiencing a more challenging demographic transition since the county's population is ageing at an earlier stage of development than many other developed countries. For example, at the time when the ageing population in the United Kingdom (UK), the US and Japan achieved 7%, their GDP per capita (at 1990 international prices) was about USD 5,541 (1930), USD 9,561 (1960), and USD 9,714 (1970), respectively (Bolt et al., 2014). However, in 2000, it was USD 3,421 for China at the same stage of population ageing. This situation implies that China needs to better cope with rapid population ageing with a limited wealth accumulation (Terada-Hagiwara et al., 2018). Thus, China is confronting the issue of "growing grey before growing rich."

Table 2.1: The Speed of Population Ageing (percentage of people aged 65 or over) by Selected Countries

No	Countries (from 7% to 21%)	From 7% to 14% (Years)	From 14% to 21% (Years)	From 7% to 21% (Years)
1.	France (1865-2022)	115	42	157
2.	Sweden (1890 - 2015)	85	40	125
3.	United Kingdom (1930 - 2030)	45	55	100
4.	Australia (1938 - 2037)	73	26	99
5.	United States (1944 - 2033)	69	20	89
6.	Spain (1947 - 2028)	45	36	81
7.	Brazil (2012 - 2050)	21	17	38
8.	Japan (1970 - 2007)	25	12	37
9.	Thailand (2003 - 2038)	21	14	35
10.	China (2001 - 2035)	23	11	34
11.	Singapore (2000 – 2028)	19	9	28
12.	South Korea (2000 - 2027)	18	9	27

Sources: OECD, 2018; Terada-Hagiwara et al., 2018.

The old-age dependency ratio in China is growing rapidly (Terada-Hagiwara et al., 2018) (refer to Table 2.2). In China, the old-age dependency ratio is expected to reach 25% in 2030, possibly exceeding the US. Thus, four (4) workers, on average, will need to support one (1) older adult. Meanwhile, in China, the sharp fall in the fertility rate in 2015 has led to fewer working-age adults entering the labour market and reducing the working-age population (United Nations, 2019b).

The age and gender distribution of the elderly population showed that most older adults were the 'young-old in 2020, 69.1% of older adults aged between 65 and 74 years, with females outnumbering males (61.148 million compared to 57.952 million, respectively) (United Nations, 2020). Furthermore, the sex ratio diminishes with the advancement of age (United Nations, 2020). Interestingly, with the betterment of life expectancy, the gender gap in China continues to widen (Table 2.3). Between 1960 and 2017, the life

expectancy in China has risen rapidly and nearly doubling from 44 to 77 years (The World Bank, 2018). The life expectancy of older females has also increased by more than ten years from 68.3 in 1980 to 78.8 in 2017 while increasing by nearly ten for males. However, in 2017, the gender gap in life expectancy expanded from 2.9 in 1980 to 4.5 years. This trend indicated that Chinese females, on average, are more likely to live 4.5 years longer than males.

Table 2.2: The Dependency Ratio of China from 2000 to 2050

Year	Child dependency ratio[@]	Old-age dependency ratio[#]	Total dependency ratio[+]
2000	36.2	10.0	46.2
2005	28.2	10.4	38.6
2010	25.5	11.0	36.5
2015	24.9	12.9	37.7
2020	25.2	17.0	42.2
2025	24.5	20.3	44.8
2030	23.4	25.0	48.4
2040	23.0	38.3	61.3
2050	23.7	43.6	67.3

Note:[@] Ratio of population aged 0-14 per 100 population 15-64; [#]ratio of population aged 65+ per 100 population 15-64); [+]ratio of population aged 0-14 and 65+ per 100 population 15-64. Sources: United Nations, 2019b and own calculation.

Table 2.3: Changes in Life Expectancy by Gender in China from 1960 to 2017

Year	Total (years)	Female (years)	Male (years)	Difference
1960	43.7	45.2	42.4	2.8
1970	59.1	60.9	57.3	3.6
1980	66.8	68.3	65.4	2.9
1990	69.1	71.0	67.4	3.6
2000	71.4	73.4	69.6	3.8
2010	74.4	76.6	72.5	4.1
2015	75.9	78.3	73.8	4.5
2016	76.2	78.6	74.1	4.5
2017	76.5	78.8	74.3	4.5

Source: The World Bank, 2018.

In 2020, more than half of Chinese older adults (56.1%) lived in rural areas (B. Gu, 2016). The percentage of the urban population aged 65 years and above rose from 4.7 % in 1982 to 6.7 % in 2000 and 7.7 % in 2010 (see Table 2.4). Moreover, the corresponding figures in rural areas were 5.0%, 1982 to 7.5 % in 2000 and 10.0% in 2010. The slower increase in the older population in the urban areas could be attributed to the rural-urban influx, which has exacerbated ageing in rural areas despite the slower fertility decline observed in rural China (F. Chen & Liu, 2009; Y. Fang et al., 2019; B. Gu, 2016). In another study, Wang and Mason (2007) highlighted that ageing in rural China would occur much faster. The Fourth National Survey on Elderly People in Urban and Rural China in 2015 reported that the average per capita income for older adults in cities and towns (CNY23,930 per year2) was about three times higher than in rural areas (CNY7,621 per year) (Y. Fang et al., 2019). Further, rural areas recorded a higher old-age dependency ratio and child dependency ratio (Y. Fang et al., 2019). Also, older adults in rural areas were less educated than their urban counterparts. In 2010, it was reported that between 18% and 45% of older males and females in rural areas were illiterate compared to only 8% and 27% of urban males and females (United Nations Statistics Division, 2012).

In 2015, China had attained nearly universal medical insurance coverage for urban and rural areas, and most of the elderly also enjoying free medical examinations (Y. Fang et al., 2019). Nevertheless, most older adults in rural areas still have limited access to social security services, limited coverage of medical insurance plans, and social insurance (Y. Fang et al., 2019; H. Zhu et al., 2019). Despite these limited resources, older adults in rural China have low expectations and are generally satisfied with life (Y. Fang et al., 2019; M. Han & Hou, 2009).

2 CNY = Chinese Yuen

Table 2.4: Population Aged 65 and Above by Residence in China: 1982–2010

Unit	1982	1990	2000	2010
City				
65+ population (million)	6.8	11.4	19.5	31.0
65+ as % of the total population	4.7	5.4	6.7	7.7
Town				
65+ population (million)	2.5	3.8	9.6	21.2
65+ as % of the total population	4.0	4.4	6.0	8.0
Rural				
65+ population (million)	39.9	47.9	58.8	66.7
65+ as % of the total population	5.0	5.7	7.5	10.0

Source: (B. Gu, 2016)

The execution of the one-child policy in China has effectively lessened the population growth rate (Kaneda, 2006). This policy has distorted the population structure resulting in fewer young people and women with a growing population of older adults (Beech, 2013, Nov 21). Also, this scenario is moving from "too many children to support" to "too few children to support a rapidly ageing population" (Kaneda, 2006). In the coming decades, parents of single-child families will be approaching old age, creating a "four-two-one phenomenon," in which one (1) child might need to perform his or her filial responsibility for two (2) parents and four (4) grandparents (L. Wang, 2018; Zaidi et al., 2019).

The fatal causes of death in urban and rural China have evolved from infectious diseases to chronic non-communicable diseases like hypertension, heart disease, stroke, and cancer (WHO, 2014; M. Zhou et al., 2019). Thus, the future pressure on healthcare and the long-term care system for older adults are not infectious diseases but chronic diseases. The endeavours to enhance and improve chronic disease management and professional care are slowly progressing (H. Zhu et al., 2019).

Filial piety (*xiao*) is a primary virtue in Chinese culture where children need to be obedient and respectful to their parents to be filial (Fei, 1992). Having sons makes one's old age secure (*Yang Er Fang Lao*) is a Chinese proverb and Chinese cultural ideal. The government upholds the virtue of filial piety stressing that the children must support and assist their parents. Moreover, the government has reaffirmed the constitution of 1982, the obligation of adult children to respect and care for their aged parents (Palmer, 1995). If an adult child fails or refuses to take care of an aged parent, the adult child may face criminal charges.

Nevertheless, some researchers have highlighted that industrialisation and urbanisation influence the performance of filial piety (F. Chen & Liu, 2009). Indeed, Chinese family demographics have undergone significant changes over many years, such as the average household size in 1982 declined from 4.41 to 3.10 in 2010 (National Bureau of Statistics of China, 2019; A. Xu & Xia, 2014). Moreover, Zeng et al.'s (2008) projection for 2000 revealed that the average household size would fall from 3.46 persons per household, and this average household size would further decline to 2.96 in 2020 and 2.67 in 2050. Older adults' living arrangements have also shifted from traditional multi-generational families to old couple families and older adults living alone. The Fourth National Survey on Elderly People in Urban and Rural China in 2015 reported that the empty-nest of older adults either living alone or living with a spouse in urban and rural accounted for between 50.9% to 51.7% of the total elderly population (Q. Feng et al., 2019). Moreover, older adults living alone accounted for 12.0% in urban and 14.3% in rural areas. Urbanisation, population mobility, and older adults' preferences to living separately with their children are the main reasons for the empty-nest phenomena (Y. Fang et al., 2019). Whyte (2003) also mentions that the traditional familial support system could be further weakened in the future, given the decline in fertility, current economic development, and cultural

influence. In rural areas, several studies reported the weakening of filial practice and the rise in vulnerable older adults, such as growing incidences of failure to support parents, increasing numbers of elderly adults living alone, and raising grievances from older adults (Y. Fang et al., 2019; D. Wang, 2004; Yang & Chandler, 1992; H. Zhang, 2004). Moreover, the large-scale rural-to-urban migration of the young generation has created a geographic separation of adult children from their parents, thus restricting the fulfilment of the filial duties of children (Joseph & Phillips, 1999).

Having said that, population ageing in China has profound effects on political, economic, social, cultural, health, scientific, and technological development. Thus, China needs to develop active, adequate, and long-term responses to rapid population ageing.

2.3.1 Selected Policies in China

This section briefly discusses the selected policies in China, such as the retirement age, the public pension system, population policies, the Hukou system, and the health system. The normal retirement age in China is 50 years for female blue-collar workers, 55 years for female white-collar workers, and 60 years for males. Thus, there is a need to increase the retirement age in China since the retirement age is relatively early compared to countries like Australia (65), Canada (65), Germany (66), Italy (67), Japan (65), New Zealand (65), South Korea (62), the US (66), and the UK (65) (Trading Economics, 2021). Furthermore, several studies indicated that raising the retirement age had no adverse effect on youth employment (Kalwij et al., 2009), such as impeding the promotion opportunities of the younger population (C. A. Chan & Liang, 2013) and increased youth unemployment rate (Cai, 2009). Instead, raising the retirement age would lessen the labour shortage (Q. Feng et al., 2019). Chan and Liang (2013) suggested that younger workers prefer working with experienced older adults who can help minimise mistakes.

China's public pension system is multi-layered and aims to achieve universal coverage and provide basic social security to support all citizens and residents as they age, including the unemployed (H. Fang & Feng, 2018; OECD, 2019; Y. Xu & Zhang, 2012). The first layer of the public pension system consists of mandatory schemes, such as Basic Old-Age Insurance (BOAI) (consists of Basic Old-Age Insurance (BOAI) and Public Employee Pension (PEP)) and voluntary schemes, Resident Pension (consists of Urban Resident Pension (URP) and New Rural Resident Pension (NRP)). The government has provided substantial direct fiscal subsidies for this layer of the public pension system (H. Fang & Feng, 2018; D. R. Phillips & Feng, 2015). In 2017, the public pension scheme covered about 65.8% of the total population (H. Fang & Feng, 2018).

Basic Old-Age Insurance (BOAI) was established in 1951, covering employed workers in private firms, while the Public Employee Pension (PEP) scheme was established in 1953 that included government servants and employees. This pension scheme had merged into Basic Old-Age Insurance (BOAI) in 2015 (H. Fang & Feng, 2018). The first pillar of BOAI is a mandatory scheme with defined contribution and defined benefit features. Under this scheme, employers contribute up to 20% of their payroll (pay-as-you-go system), and employees contribute 8% of individual wages. The contribution of employers varies based on provinces (H. Fang & Feng, 2018; D. R. Phillips & Feng, 2015). PEP is the most generous scheme. Furthermore, there is no contribution required for public employees as the expenditure is borne by central and local governments (H. Fang & Feng, 2018; D. R. Phillips & Feng, 2015). The retirement eligibility age is 50 for blue-collar females, 55 for white-collar females and female public employees, and 60 for males. Under the BOAI, private and public employees with a minimum of 15 years of contribution are entitled to pension benefits. China has one of the highest statutory pension contribution rates globally, at 28%, even higher than the rates seen in Japan

(18.3%), South Korea (9.0%), Australia (AU) (9.5%), Germany (18.6%), and the US (12.4%) (OECD, 2019; Pallares-Miralles et al., 2012).

New Rural Resident Pension (NRP) and Urban Resident Pension (URP) schemes were established in 2009 and 2011, respectively (H. Fang & Feng, 2018). NRP and URP were targeted for unemployed rural and urban residents aged 16 years and older, respectively. Both Pension schemes unified in 2014 in becoming the Resident Pension scheme (H. Fang & Feng, 2018). This scheme is voluntary contributed by individuals and subsidies from the local government. As the subsidies are contributed by local government and depend on the local economics performance, there is a distinct variation across provinces and uneven distribution between rural and urban areas (D. R. Phillips & Feng, 2015; L. Wu, 2013). Participants with a minimum contribution of 15 years are entitled to receive a basic pension upon reaching 60. The retirement eligibility age is 50 for Females and 60 for males.

The second layer of China's public pension system is voluntary schemes from employers and supplements to the current system. This system consists of an employer-sponsored pension system (Enterprise Annuity) introduced in 1991 (H. Fang & Feng, 2018). However, involvement in this layer is much underdeveloped and limited. Finally, the third layer is household savings-based annuity insurance policies, though they are at an early stage (H. Fang & Feng, 2018).

China is facing challenges in the current public pension system, such as financial sustainability and fiscal risks, regional disparity and inequality, participation incentives (Social insurance contribution evasion), and the relative adequacy of resident pension benefits (H. Fang & Feng, 2018; J. Feng & Chen, 2016; J. H. Wang et al., 2016; Y. Xu &

Zhang, 2012). However, the public pension system still needs to reform to achieve universal and widespread coverage and provide basic social security to all residents, especially to close, if not narrow, the gap between rural and urban areas. Compared to urban counterparts, rural older adults are much less likely to have a pension or pension with adequate income security to sustain life at old age (Y. Han & Wei, 2012; Norstrand & Xu, 2012; D. R. Phillips & Feng, 2015).

In the early 1950s, the debate on population restrictions and birth control began, though little action was undertaken, as Mao's view was that "every mouth comes with two hands attached" (Cook & Halsall, 2012). The policy of "wan, xi, shao" ("later, longer, fewer") began during the 1970s in China in response to the increase in population (Cook & Halsall, 2012; D. R. Phillips & Feng, 2015). The policy later encouraged marriage (wan); there should be longer intervals between births (xi), and there should be fewer births than before (Shao) (Cook & Halsall, 2012; D. R. Phillips & Feng, 2015). However, this policy was less effective in controlling the rising population. Thus, in 1979, the Single Child Family Programme (SCFP) or the one-child policy was implemented (Zeng & Hesketh, 2016). The policy controls population restrictions or birth control through incentives to only have one (1) child and disincentives to have more than one (1) child, except in rural areas, if the first child is female or minority (Cook & Halsall, 2012; Z. Guo & Gu, 2014). The comments concerning the one-child policy vary. Some researchers view the policy as being essential in family planning and reducing population growth. For example, in 1992, Li, a prominent Chinese demographer and statistician, commented that the one-child policy was an outstanding achievement in population control and contributed to world population control. Without this policy, China's population would not merely be one billion, but 1.1 billion (C. Li, 1992). A slower population growth provided a demographic dividend that stimulated economic growth (Potts, 2006). Some researchers

would comment that the policy could lead to a rapid ageing and declining dependency ratio (Cook & Halsall, 2012; McIntosh & Zhang, 2012), and doubt in the ability of adult children, especially "Little Emperors" or "Little Empresses," to support a large number of the elderly population (Cook & Halsall, 2012).

Given the negative effect of the one-child policy, such as increasing population ageing, skewed sex ratio, reduction in the working-age population, and possibly affecting economic growth, the universal two-child policy replaced the one-child policy in 2015 (Zeng & Hesketh, 2016). This new policy allowed Chinese couples to have two (2) children. Some researchers are optimistic about the positive impacts of the policy in addressing the challenge of population ageing, contributing to economic growth, reducing the sex ratio at birth, and being beneficial for all sectors of Chinese society (Zeng & Hesketh, 2016). Nevertheless, some scholars have commented that the decline in fertility rate is a consequence of government policy and a response to modernisation, urbanisation, and social and economic development; for example, the high cost of rearing children in cities (F. Chen & Liu, 2009; Zeng & Hesketh, 2016). A more recent development by the government in China allows couples to have three (3) children (BBC, 2021).

China's government in 1996, legislated a national law, the 'Law of the People's Republic of China on the Protection of Rights and Interests of the Aged' and was updated in 2012 to implement the essential role of family support for older adults (D. R. Phillips & Feng, 2015). Under this new legislation, adult children are required to meet their older parents' financial and emotional needs, with frequent visitations. In addition, employers must also approve home leave for their employees to visit their older parents (FlorCruz, 2013). However, the impact of this law to revert the practices of filial piety remain unclear (FlorCruz, 2013; D. R. Phillips & Feng, 2015).

The Hukou (household registration) system was established in 1958, that registers the residence of all Chinese citizens and classifies (or divides) citizens as 'non-agricultural (urban) hukou' or 'agricultural (rural) hukou' based on their place of birth and lineage (D. R. Phillips & Feng, 2015; Q. Song & Smith, 2019). The system targets restricting population movement, especially workers from rural to urban areas (D. R. Phillips & Feng, 2015). However, the system has been criticised for widening the disparities or gaps between urban and rural areas (D. R. Phillips & Feng, 2015; Q. Song & Smith, 2019). In addition, the system differentiates the opportunity and welfare structures for all Chinese citizens by favouring urban hukou holders in accessing certain levels and types of services and benefits, such as education, healthcare (D. R. Phillips & Feng, 2015), housing, employment opportunities (X. Wu & Treiman, 2007), health insurance (Z. Liu, 2005), pensions pensions (D. R. Phillips & Feng, 2015) and other social services and provisions (Q. Song & Smith, 2019). Thus, those with different hukou registration (new migrants and rural hukou holders) usually face pressures to provide financial support to their older parents and relatives (D. R. Phillips & Feng, 2015).

Between 1950 to 1970, the health system in China was comparable to other developing countries and received global recognition in developing its primary health care system (X. Li et al., 2020). China has a three-tiered system for healthcare delivery. The healthcare organisations and providers operate at the municipal, district, and community levels in urban areas and county, township, and village levels in rural areas (Meng et al., 2019). The three-tiered health care delivery system was well-operated in both rural and urban areas (X. Li et al., 2020; Yip & Hsiao, 2015).

Then between the 1980s to early 2000s, the central government reduced its healthcare financing and insurance organisation role (X. Li et al., 2020). Due to market-oriented reform, the integrated three-tiered health care delivery system deteriorated in rural and urban areas (X. Li et al., 2020; Yip & Hsiao, 2015). Health providers at the village level became privatised, and at the township level, county-level health centres or hospitals became self-financing and relied on user fees. Hence, the profitable curative care slowly replaced preventive care (X. Li et al., 2020; Yip & Hsiao, 2015). Under the cooperative medical scheme, insurance coverage rates reduced from 95% in 1976 to 5% in 1985 (X. Li et al., 2020). The Urban Employee Basic Medical Insurance scheme (UEBMI), however, only covered formal sector employees, leaving the majority of urban residents (for example, dependents, workers in the informal sectors, retirees, and the unemployed) uninsured (Yip & Hsiao, 2015). Thus, some national and international academic and health care organisations criticised China's inability to provide primary health care coverage to all (X. Li et al., 2020). The Development Research Centre (DRC) also reported that China's health care policies since the 1980s were, in general, a failure (Yip & Hsiao, 2015).

From the early 2000s to the present, the government started to reform primary healthcare, a National Essential Medicines System, basic public health services, and universal health insurance coverage (X. Li et al., 2020). China has three primary health insurance schemes. First, the urban Employee Basic Medical Insurance (UEBMI) scheme established in 1998 is a compulsory scheme for urban residents working in the formal sector (Su et al., 2018). Employers and employees contribute between 6% and 2% of their payroll, respectively, to UEBMI (Yip et al., 2012). In 2013, the scheme covered 37.50% of the total urban residents (Su et al., 2018). Second, the Urban Resident Basic Medical Insurance (URBMI) scheme established in 2007 is a voluntary scheme covering the remaining urban

residents without formal jobs or unemployed, such as children, students, older adults, and the young unemployed (Su et al., 2018). In 2013, this scheme covered 40.9% of the urban residents (Su et al., 2018). Third, the new Cooperative Medical Scheme (NCMS) is a rural health insurance scheme established in 2003 (Yip et al., 2012), targeting rural residents of China, receiving essential health care services, thus reducing the medical burden and achieving social fairness or equity (You & Kobayashi, 2009). In 2013, it covered more than 800 million rural Chinese citizens, accounting for about 98.7% of the total rural population (Lai et al., 2018). In 2016, the Healthy China 2030 plan was issued, which envisions the primary health care system to address the emerging burden of chronic non-communicable diseases, increasing health expenditures, and ageing population (P. Chen et al., 2019; L. Li & Fu, 2017).

China is performing well in investing and has introduced favourable policies for reforming its primary health care system, preventing and managing chronic diseases and emerging infectious diseases, such as the Coronavirus disease (COVID-19) (P. Chen et al., 2019; X. Li et al., 2020). Nevertheless, the current health care system fails to address the changing needs of the ageing population (Y. Han et al., 2020; X. Li et al., 2020; Y. Zhou et al., 2020). Furthermore, some challenges remain that need to be tackled, such as "lack of professional training for primary healthcare practitioners, inadequate preventative services in providing preventive care, and paucity of geriatric care and support system" (P. Chen et al., 2019; Y. Han et al., 2020; X. Li et al., 2020).

As the Chinese population ages, policies are required to address the growing disparities between geographical areas (urban and rural, and provinces) and between gender (males and females) (D. R. Phillips & Feng, 2015). The policy is vital to ensure that all older adults can access similar environments, resources, and infrastructure for productive

engagement. Consequently, the government urgently needs to increase the retirement age and introduce age-friendly employment policies and practices to promote and encourage the participation of older adults in the labour force. Policymakers also required to reform and improve the current pension system, especially the coverage of rural and low-income urban residents. The practicalities of the Hukou system may also require further reform and even abandoning the system. The provision of healthcare still needs further reform while aiming to reduce health disparities among older persons. The focus and strategies of health policies need to shift from treatment to prevention and prevention-oriented. The Heathy China 2030 plan emphasises that promoting public health and disease prevention should be implemented in China as early as possible. The policies to increase the retirement age, age-friendly employment policies and practices, and reform and improve the current pension system and the Hukou system are vital to providing financial security in promoting productive engagement. Furthermore, promoting public health and disease prevention is also essential to sustain productive engagement.

2.4 The Concept of Active Ageing and Productive Ageing

From 1949 onwards, the psychosocial theories of ageing and the Kansas City Study of Adult Life have started positive and affirmative disclosure of ageing in shifting the views of old age as a "dependent" to instead highlighting the potential resource of older persons (Cavan et al., 1949; Quadagno, 2018; Zaidi & Um, 2019). The new paradigm, terms, and conceptualisations that described these changes were referred to as "productive ageing" (Butler & Gleason, 1985), "successful ageing" (Rowe & Kahn, 1987), "active ageing" (Walker, 2002; World Health Organization (WHO), 2002), and "healthy ageing" (Bousquet et al., 2015; WHO, 1990).

The World Health Organisation (WHO) proposed the concept of active ageing in 1996. The term "active" refers to "continuing participation in social, economic, cultural, spiritual and civic affairs, not just the ability to be physically active or to participate in the labour force" (WHO, 2002, p. 12). The active ageing approach builds upon recognising the human rights of older adults and the "United Nations Principles of independence, participation, dignity, care, and self-fulfilment" (WHO, 2002, p. 13). Active ageing recognised the older adults as immense and valuable social resources, and their active participation in the community and society contributes towards their well-being, communities, and societies. WHO encourages nations to utilise and customise the framework to fulfil their ageing population's needs within their social-cultural context and values. WHO has also provided minimal practical guidance regarding the definition or measurement of each domain, determinant, and framework pillar (Buys & Miller, 2012).

There is limited consensus on the operational definitions and the range of activities counted as productive. From the economic perspective, productivity activities link to paid work and are generally defined as "the production of the goods and services in the market and ultimately contribute to the gross domestic product (GDP)" (Fernández-Ballesteros et al., 2011, p. 206). Nonetheless, not all the products and services are included and computed in the GDP since these works or services may be unpaid. A large number of older adults are productive but participate in unpaid work, services, and activities. Indeed, older adults have always been recognised as central and vital productive players in families, communities, and societies (Achenbaum, 2008).

Note: This framework is produced by the World Health Organization in 2002, summarising the determinants of the Active Ageing, From "The determinants of Active ageing" by the World Health Organization, 2002, *Active ageing: a policy framework*, p. 19 (https://www.who.int/ageing/publications/ active_ ageing/en/). Copyright 2002 by the World Health Organization.

Figure 2.1: The Determinants of WHO Active Ageing Framework

In 1982, Robert Butler introduced the term 'productive ageing', employing it to alter 'older adults' negative image and perception (Butler & Gleason, 1985). Morgan (1986) illustrates productivity as "anything that produces goods and services" (p. 7). Butler and Schechter (1985) define "the capacity of an individual or population to serve in the paid workforce, to serve in volunteer activities, to assist in the family, and to maintain himself or herself as independently as possible" (p. 763). In a separate study, Bass and Caro (2001) broaden the productivity activities to include activities "need to be done by others, but not those done simply or personal gain or self-enhancement" (p. 40). In a more recent development, productive engagement is defined as any paid or unpaid activity, such as household chores, domestic activity, volunteering, and caregiving, that produces goods and services that carry benefits and values and the older adults, community, and society

(Hooyman & Kiyak, 2011; J. H. Kim, 2019; Moody, 2001; Morrow-Howell & Greenfield, 2016; Morrow-Howell & Wang, 2013).

In socio-cultural contexts, changes in family institutions and structures, living arrangements, and the differences in experience in old age may explain older adults' ways of performing and interpreting productive activities (Ko & Yeung, 2019b; Morrow-Howell & Wang, 2013; Torres, 1999). Studies on productive ageing from the Western world emphasise an individual's contribution to economic productivity and adding value. In contrast, Asian countries hold on to collectivism originating from traditional Confucian ethics (J. H. Kim, 2019; M. Luo & Chui, 2016). Chinese older adults may prefer to contribute indirectly and avoid becoming a burden to others (M. Luo & Chui, 2016). Besides, support networks of older adults and their resources are embedded within the family (Silverstein et al., 2006). Furthermore, families supporting ageing parents and co-residing with them are standard practices among Asia countries (Croll, 2006; Yamada & Teerawichitchainan, 2015).

Having said that, some researchers define productive ageing more broadly that include capacity building and self-development activities. From a narrow perspective, productive engagement includes self-employment, full-time and part-time jobs (see Table 2.5). Unpaid labour is involved in the work or the family business without pay in agriculture, forestry, or fisheries for self-consumption (J. H. Kim, 2019). Here, older people can carry out work, such as food preparation, cleaning, laundry, purchasing household items, and other household work. Indeed, someone else would have to do these activities at a cost if older people did not (Baxter et al., 2009; Morrow-Howell & Wang, 2013; Spitze, 1999).

Table 2.5: Various Types of Productive Engagement

Classification of behavioural domains	Activities	Sources
Activities with economic value		
Paid labour	Employed work (full-time and part-time) and self-employment work	(L. T. Giang et al., 2018; Hu & Das, 2019; J. H. Kim, 2019; Y. Luo et al., 2019; Morrow-Howell et al., 2014; Morrow-Howell & Wang, 2013; Peng & Fei, 2013; Teerawichitchainan et al., 2019; Visaria & Dommaraju, 2019)
Unpaid labour: Unpaid family labour	Unpaid family business in agricultural, forestry, or fisheries for self-consumption	(Ironmonger, 2001; J. H. Kim, 2019; Y. Luo et al., 2019; Morrow-Howell et al., 2014)
Unpaid labour: Household management	Food preparation, cleaning laundry, cleaning and arrangement, cleaning and tidying, purchasing household items, and other household works	(Hu & Das, 2019; J. H. Kim, 2019; Morrow-Howell et al., 2014; Morrow-Howell & Wang, 2013; Peng & Fei, 2013; Teerawichitchainan et al., 2019)
Caregiving for Family Members	Caring for children, grandchildren, spouse, elderly parents, grandparents, and other family members	(L. T. Giang et al., 2018; Hu & Das, 2019; J. H. Kim, 2019; Y. Luo et al., 2019; Morrow-Howell et al., 2014; Morrow-Howell & Wang, 2013; Peng & Fei, 2013; Teerawichitchainan et al., 2019; Visaria & Dommaraju, 2019)
Volunteering	Formal and informal volunteer activities, and informal helping like community volunteer services, helping neighbours, friends, or others	(Hu & Das, 2019; J. H. Kim, 2019; Y. Luo et al., 2019; Morrow-Howell & Wang, 2013; Peng & Fei, 2013; Putnam et al., 2014)
Capacity-building activities		
Educational activities	Attending and participating in regular educational and lifelong learning activities	(J. H. Kim, 2019; Morrow-Howell et al., 2014; Morrow-Howell & Wang, 2013; Peng & Fei, 2013)
Self-development activities		
Social activities	Attending and participating in social activities	(J. H. Kim, 2019; Morrow-Howell et al., 2014; Morrow-Howell & Wang, 2013; Visaria & Dommaraju, 2019)
Religious activities	Attending and participating in religious activities	(J. H. Kim, 2019; Morrow-Howell et al., 2014; Visaria & Dommaraju, 2019)
Leisure activities	Attending and involving in cultural events, hobbies, sports, indoor and outdoor leisure activities, but excluding activities such as karaoke, dancing, drinking, smoking, and doing nothing	(J. H. Kim, 2019; Morrow-Howell et al., 2014; Morrow-Howell & Wang, 2013; Visaria & Dommaraju, 2019)

Unpaid labour and household management are less common in Western studies though relatively common in Asia societies. Caregiving includes helping those who require assistance due to illness or disability. Formal volunteering involves voluntary or charity work supported by a formal organisation, whereas informal volunteering or informal helping cover neighbouring, community volunteer services, mutual aid, and helping others. Unpaid labour, caregiving, and volunteering have economic value but fail to be remunerated.

Educational and training activities enhance the productive engagement of older adults (Bass & Caro, 2001). Some researchers also suggest including social, leisure, and religious activities mainly for recreational, spiritual, and self-development purposes in productive engagement definition. The reasons are that these activities are valuable to the individual and maintain the ability of an older adult to live independently (Bass & Caro, 1996; Butler & Schechter, 1985; Morrow-Howell & Wang, 2013). However, some researchers opined that these activities should not be included in productive engagement. These activities do not benefit others and are less important and relevant in contributing to social integration and harmonious social development (Peng & Fei, 2013).

Extensive definitions of productive engagement may promote personal and societal value based on relevant activities under a particular cultural context. Nevertheless, Morrow-Howell and Wang (2013) suggested adopting the narrowest definitions to facilitate more efficient study and advance a coherent body of work and knowledge. The present study defines productive engagement as paid and unpaid activities that produce goods and services that include paid productive engagement (full-time and part-time work) and unpaid labour (unpaid family labour, housework management, and garden work) as the core components of productive engagement. The unpaid labourers perform personal

outdoor activities (grow vegetables and do other fieldwork), raise domestic animals, garden work, and perform household chores. However, there is a limitation of this study that does not include volunteering, caregiving, and informal helping, given that this question is not covered in the Chinese Longitudinal Healthy Longevity Survey (CLHLS). Although this range could be restrictive to some degree, the rationale for studying productive engagement still contributes to policy and programme intervention.

2.5 Controversies in Defining the Term

Scholars have criticised the productive ageing model from varying perspectives, such as critical theories, political economy, social constructionist, and feminist gerontology (Hooyman & Kiyak, 2011; Morrow-Howell & Greenfield, 2016). The notion of productivity as a higher value in one's later life had devalued "unproductive" people and thus created a social stigma that continues to marginalise "unproductive" older adults. The situation exacerbated gender, ethnicity, class, and functional inability biases, preventing an older adult from pursuing and participating in productive activities. Further, the term "productive ageing" insinuated the presence of "unproductive ageing." This term subsequently led to an expectation that an older adult should have economic sense, holding on to a job or some volunteer hours despite their relatively frail condition (Estes & Mahakian, 2001; Hooyman & Kiyak, 2011; Moody, 2001). Otherwise, they would be perceived as unproductive and of less value. Productive engagement is not unilaterally a "free choice" " (Morrow-Howell & Greenfield, 2016) as these individuals need to undertake work, not of their desire (e.g., providing care to family members and grandchildren) (Y. Luo et al., 2012). This perception ignored some older adults who may have a better choice to choose their productive engagements than others.

Productive ageing emphasises work and formal volunteering more so than activities that are less visible and rewarded at the public level (e.g., caregiving). These activities are

often taken up by those less advantaged or fortunate groups, such as women, older adults, or ethnic minority groups (Martinson & Minkler, 2006). The other controversy is the value and monetary assessment of various types of productivity activities, viewed differently (Greenfield, 2010; Morrow-Howell & Greenfield, 2016). For example, some people may support the volunteer activity, and others may oppose such activity.

Nevertheless, given the heterogeneity of the older population, to combat against the age-drain narrative and ageism, and to take advantage of the valuable human capital, the term "productive engagement" is worthwhile for fostering a broader area of research, policy, and programme development to promote older adults' contributions to families, communities, and society (Morrow-Howell & Gonzales, 2020; Morrow-Howell & Greenfield, 2016; Richert-Kaźmierska, 2019).

2.6 Theoretical Concepts in Explaining the Active and Productive Ageing

Role theory, activity theory, continuity theory, socio-emotional selectivity theory, social and human capital, and the life course perspective are often used to explain productive activities (H. Y. Liu & Lou, 2016; Matz-Costa et al., 2014; Morrow-Howell, 2010; Morrow-Howell & Greenfield, 2016). Role theory can be described as "a theory based on the belief that roles define us and our self-concept and shape our behaviour" (Hooyman & Kiyak, 2011, p. 334). The theory explains that productive activities will be undertaken or carried out differently (H. Y. Liu & Lou, 2016). For example, the role substitution hypothesis examines the changes in the status of older adults (for example, retirement replaces unpaid activities) from their daily experiences (Lum & Lightfoot, 2005). Based on the role strain perspective, there is a negative association between caregiving for parents and grandchildren with labour force participation among women, but not men (Y. Lee & Tang, 2015).

Activity theory builds on the hypothesis that there is a positive association between the level of activity of a person and life satisfaction, and the self-concept of an older adult verified across involvement in role characteristics associated with middle age (Diggs, 2008a; Havighurst, 1957, 1961; Hooyman & Kiyak, 2011). This theory indicates that for older adults to be satisfied, they must remain active and replace lost roles (widowhood, retirement, or loss of ability to participate in past activities) with new roles to sustain their position in the community (Hooyman & Kiyak, 2011). Based on this theory, the more active and involved in productive roles an older adult is, the happier or more age successful he or she will be (Havighurst, 1961; Havighurst et al., 1968). Productive roles may include paid and unpaid productive activities.

Continue theory states that older adults are inclined to preserve and maintain the same and existing habits, personalities, lifestyle, and social patterns they developed in earlier years by applying well-acquainted knowledge, skills, and strategies (Atchley, 1971, 1989; Diggs, 2008b; J. Phillips et al., 2010). This theory explains that the older adults select particular choices to sustain consistency in internal (self-perception, goals, belief system, past experiences, ideas, skills, personal preferences, and temperament) and external continuity (especially relationships), in remaining active and participate throughout their old age (Diggs, 2008b; Hooyman & Kiyak, 2011). The extent of an individual's life satisfaction is associated with the compatibility between current lifestyles or activities with one's self-perception and past experiences (Diggs, 2008b; Neugarten et al., 1968).

Socio-emotional selectivity theory (SST) has been applied widely to productive behaviours research related to individual and intrapsychic characteristics (Hendricks & Cutler, 2004; Okun & Schultz, 2003). SST perceives time as being limited (as in old age)

rather than endless. People value emotionally meaningful goals, activities, and relationships in the pursuit and selection of social goals (Carstensen et al., 1999; Neubauer et al., 2017). Thus, if older adults perceive productive engagements as personal, emotionally, and meaningful activities, they are more likely to participate in them. For example, a study in the US showed that older people might reduce their overall volunteering time in all organisations but will still maintain their constant time of volunteering in their main organisation (Hendricks & Cutler, 2004).

Social and Human capital has been used to investigate the antecedents of productive engagement (S. Kim, 2020; V. Loh & Kendig, 2013; McNamara & Gonzales, 2011). Social capital examines the social relationships among people, groups, and organisations that have benefited the members (Coleman, 1998). Social capital can be classified into bonding capital (intimate bonds, including marital and family relationships) and bridging capital (looser relationships among friends and neighbours) (S. Kim, 2020). Some studies have shown that bonding relationships are exemplary for providing support, whereas bridging linkages include resources for employment and volunteering opportunities (Keating & Dosman, 2009; S. Kim, 2020; Wilson & Musick, 1997). Human Capital discusses the resources rooted within individuals, like skills, knowledge, education, health, and functional ability (Becker et al., 1990; Coleman, 2009). S. Kim (2020), for example, used two-wave panel NSHAP data and found that human capital (higher education) was associated with employment and volunteering cross-sectionally. In contrast, social capital (greater neighbourhood socialisation) correlated with volunteering both cross-sectionally and longitudinally.

The life course perspective focuses on the age-graded, socially-rooted sequence of roles within key life domains, such as family, work, and leisure, that connect the phases of life

(Elder, 1998; Morrow-Howell & Greenfield, 2016; Mortimer & Shanahan, 2004). The concept focuses on ageing rather than old age, linking the micro and macro considerations of ageing (J. Phillips et al., 2010). The life course perspective discusses the five paradigmatic principles, time and timing, the intersection of history and biography, social-location contexts or place, linked lives, and human agency (George, 2019). The literature has applied some concepts from the life course perspective in examining determinants that potentially associate with the productive engagement of older adults. The examples of concepts include time and timing (for example, how the timing of one's retirement influences volunteer activity), social-location contexts (for example, how age, gender, marital status, social class, and health affect (the productive engagement at old age), and linked lives (for example, how a younger family member's need for financial assistance leads to older adults continuing to work) (Moen & Flood, 2013; Morrow-Howell & Greenfield, 2016).

On the other hand, the theory related to human development ecological perspective, ecological systems theory is also used to examine the physical environment and contextual variables of productive engagement (Bronfenbrenner, 1993; Morrow-Howell & Greenfield, 2016). The theory states that the individual level consists of "one level within a broader person-environment system, which comprises nested layers of environmental contexts" (Morrow-Howell & Greenfield, 2016, p. 299). Further, the environment can be defined as both proximal or distal to an individual. From this theory perspective, besides the individual-level determinants, there are also community and societal levels determinants. For example, individual characteristics relate to an individual's socioeconomic resources and their specific conditions. In contrast, community characteristics refer to the unique context of a geographic area, such as the social and physical environment. Societal characteristics address circumstances shared

across broader geographic areas and exceed any subset of communities, such as social policy, societal norms, and expectations (Morrow-Howell & Greenfield, 2016). An ecological approach highlights that as the older adults' competence (individual resources) and their communities achieve the balance, older adults are more likely to become involved in activities (Lawton, 1982; Rowles & Bernard, 2013). The community is a space for older adults to live, in which space also influences their activity engagement (Ko & Yeung, 2018).

Besides the aforementioned theories, the "affluence or leisure preference" hypothesis is employed to investigate the relatively low participation of older adults in paid jobs (Bass & Caro, 2001). Moreover, there are prevailing social norms stating that older adults are relieved from their obligations to encourage economic productivity and pursue leisure activities at old age (Bass & Caro, 2001). Thus, older adults who continue to work is mainly attributed to economic reasons, as they need money to support themselves and their families. Lastly, there is also an urging need to integrate or include gender, age, and ethnicity "as power relations that structure social life" in the research (McMullin, 2000, p. 21).

Role theory, activity theory, continuity theory, and SST are the theoretical frameworks commonly employed to examine the transition from paid productive engagement to unpaid productive activities (Grünwald et al., 2021). The determinants selected under the life course perspective, such as health, marital status, and education, overlap with human and social capital. Accordingly, this study intends to examine the determinates of various productive engagements. Thus, social and human capital, ecological systems theory, "affluence or leisure preference" hypothesis, social-location contexts under life course

perspective, and active ageing framework are applied to examine the association between the determinants and productive engagement.

2.7 Productivity Engagement and Ageing Well-beings

Several studies suggest that productive engagement leads to positive outcomes for older adults (Chipperfield, 2008; Hu & Das, 2019; S. Liu et al., 2019; McDonnall, 2011). Promoting productive engagement may be one of the promising alternatives in promoting healthy ageing (Lam & Bolano, 2019) and reduce disability and health risks later in life (Poscia et al., 2015). Furthermore, one study has shown that re-employment is correlated with better health outcomes (Gallo et al., 2000). Some scholars found positive influences associated with paid work among older adults, such as reduced mortality risk, less functional disability, lessened negative emotional mood, and better-perceived health (Calvo, 2006; Luoh & Herzog, 2002). From the biomedical perspective, the most significant dividend of productive engagement would no doubt delay the ageing process (Svanborg, 2001). Besides, continuing to work at an old age reduces one or multiple chronic conditions and subsequently attenuates older adults' functional limitations (E. Choi et al., 2016; Kail & Carr, 2017). Several researchers have reported that continuing to work at old age has a positive impact on physical and psychological well-being, including life satisfaction (Aquino et al., 1996; Calvo, 2006; S. Liu et al., 2019). Using the 2008-2010 World Health Organisation (WHO) Study on Global Ageing and Adult Health (SAGE) survey, Hu and Das (2019) revealed that paid work has a positive effect on the quality of life in Urban China.

In a study by Murata et al. (2019), they reported the positive effect of community engagement for women to lessen the incidence of dementia through a 10-year longitudinal study in Japan. Based on the three waves of the China Health and Retirement Longitudinal

Study (CHARLS 2011-2015), Luo et al. (2019) showed that productive engagement like caring for spouse and grandchildren, informal helping, and formal volunteering contributes towards reducing the risk of cognitive decline. The study further indicates that informal helping benefits urban men the most, whereas paid employment benefits rural men (Y. Luo et al., 2019). Cho et al. (2002) noted that older women who provide caregiving to their children or grandchildren have more meaningful lives (Cho et al., 2002). Meanwhile, household management involvement also contributes to lower mortality in older adults (Glass et al., 1999).. Involvement in gardening activities can also help to promote psychological well-being, enhance physical benefits, build social support and social capital among older adults (Scott et al., 2020).

Nevertheless, some activities, such as employment, caregiving, or grandparenting under certain conditions, have been correlated with adverse outcomes (Adams et al., 2008; Son et al., 2007). In Korea, the older adults who participated in caregiving activities and housework reported lower life satisfaction (J. H. Kim, 2013). Furthermore, older caregivers with moderate level engagement were found to have better psychological well-being than non-caregivers. In contrast, those caregivers having low and high engagement reported worsened psychological well-being (Carmack, 1997; Matz-Costa et al., 2014). In some studies, grandparenting was cited as stressful, leading to anxiety, depression and even cause hypertension and cardiovascular diseases (X. Ling et al., 2017). Thus, whether caregiving may have adverse or positive effects on life satisfaction relies on the context of the heaviness of such commitment.

2.8 Patterns of Productive Engagements in Later Life

Recent evidence, particularly from many Western countries, shows that older adults delay retirement and work beyond the traditional retirement age (Czaja, 2020; Dosman et al.,

2006; Komp et al., 2010; Toossi & Torpey, 2017). Consequently, this trend changes the demographic profile of the workforce and the tendency for "early retirement". For example, the US Bureau of Labour Statistics (BLS) indicated that the annual growth rate of the labour force participation rate for older adults between 65 and 74 and 75 and older is the fastest. The older population and the labour force between 2014 and 2024 are expected to grow by 4.5% and 6.4%, respectively (Toossi & Torpey, 2017). BLS data reveals that about 27% of workers aged 55 and older and up to 40% of workers aged 65 and older in 2016 worked part-time (Toossi & Torpey, 2017). Nevertheless, working at an old age to support and ensure economic security and sufficiency has become necessary for many Chinese retirees (Ling & Chi, 2008). Rural older workers, particularly those involved in the agricultural sector, may need to work when reaching old age until they are no longer physically capable and able to do so (G. Chen & Gao, 2013; Giles et al., 2011; F. Tang et al., 2018). The reason to continue working at old age varies due to the lack of financial security, death of a spouse (especially for older women), healthcare benefits, a sense of self-identity, as a hobby, and to remain socially and productively engaged (Button, 2020; Cohen, 2004; Czaja, 2020; Erikson et al., 1986; Jones & Kolomer, 2019; J. Kim et al., 2018; Ling & Chi, 2008; Toossi & Torpey, 2017).

Having said that, there is no consensus and "cut-off" definition for "older workers" (Czaja et al., 2020), since the range of "older workers" is broad, ranging between 40 and 65 years. For example, the cut-off definition of an older worker of the United States Department of Labour, the National Research Council, and under the Age Discrimination in the Employment Act is 55, 45, and 40, respectively (Czaja, 2020; National Research Council and Institute of Medicine, 2004; Ventrell-Monsees, 2020). Policymakers, businesses, industry, and researchers all have different standards and ways to define the

meaning of “older workers” since definitions vary according to context and occupation (Czaja et al., 2020).

Several studies have examined the participation of older adults in paid jobs and economic activities, which included different measures and age groups. Table 2.6 below displays a rough estimate of older adults participating in paid jobs. China (63.9% to 8.4%) has one of the highest participation rates in economic activities, possibly due to the high percentage of agricultural activities. For instance, older Chinese people tend to have much higher rates and intensity to work than in the US due to farming (Y. Chen, Wang, et al., 2018).

For example, Indonesia (66.4%) is another country having the highest involvement rate of older adults in economic activities due to the high percentage of agricultural activities in rural areas (Utomo et al., 2019). The participation rates in economic activities of Korea (38.6%), Thailand (38.4%), Vietnam (37.3%), and India (37.2%) are comparative to the US (about 40.0%), France (34.6%), and the UK (32.9%) (Burr et al., 2007; Di Gessa & Grundy, 2017; Toossi & Torpey, 2017). However, the prevalence in urban areas, such as in urban South Korea (14.2%), Hong Kong (10.9%), and China (10.6%) are lower than in Spain (13.5%) and Italy (13.1%) (Komp et al., 2010; H. Liu & Lou, 2017). Nevertheless, the participation rates in economic activities may fail to include those involved in part-time paid jobs. Limited studies have explored the involvement of older adults in unpaid family labour. Kim (2019) recorded that about 1.1% of urban Koreans participated in unpaid family labour.

Table 2.6: Prevalence of Productive Engagement in Later Life

No	Studies (Source)	Age	Sample Size	Paid Labour (%)	Unpaid Productive Activities (%)	Remark
1.	Australia (Lam & Bolano, 2019)	65+	10,653	16.8	Caregiving: 12.8	Fifteen waves of couple-level data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey from 2001 to 2015.
2.	Australia (V. Loh & Kendig, 2013)	65-74	1,326	11.9	Housework: 58.6 Grandparenting: 6.6 Formal volunteering: 31.9	Household, Income and Labour Dynamics in Australia (HILDA) Survey (Wave 10 or 2010)
3.	China (Ko & Yeung, 2019a)	55+	5,818	63.9	Caregiving: 28.2 Formal volunteering, informal helping & self-development activities: 11.6	The 2013 China Health and Retirement Longitudinal Studies (CHARLS). Note: Paid Labour included agricultural work, waged work, self-employment, or work in a family business
4.	China (Ko & Yeung, 2018)	50+	6,290	8.4	Participated in agricultural activities: 49.2 Grandparenting: 22.0 Self-development activities: 22.6	The 2011 China Health and Retirement Longitudinal Studies (CHARLS) Note: 50 and above with at least one grandchild.
5.	China (H. Y. Liu & Lou, 2016)	60+	3,019	27.7	Grandparenting: 10.6 Caregiving for spouse: 4.6 Caregiving for parent: 2.3 Formal volunteering: 1.1 Informal helping: 4.5	The 2011 baseline survey of the China Health and Retirement Longitudinal Study (CHARLS). Note: Urban Respondents only.

Table 2.6, continued

No	Studies (Source)	Age	Sample Size	Paid Labour (%)	Unpaid Productive Activities (%)	Remark
6.	China (Ling & Chi, 2008)	60+	7,381	12.5	-	The 2000 National Survey of the Aged Population in China. Note: Urban Respondents only.
7.	Hong Kong (Tong et al., 2019)	65+	57,061	10.9	-	Seven waves of 5% Hong Kong population censuses and by-censuses from 1986 to 2016 (with 1% for 1986)
8.	India (Visaria & Dommaraju, 2019)	60+	8,329	37.2	Grandparenting: 56.2 Contribution to household financial matters: 42.4 Self-development activities: 18.9 - 31.6	(Visaria & Dommaraju, 2018 The 2011 Building Knowledge Base on Population Aging in India (BKPAI)
9.	South Korea (J. H. Kim, 2019)	65+	3,766	14.2	Housework: 84.8 Unpaid labor: 1.1 Caregiving: 12.2 Formal volunteering & informal helping: 3.4 Self-development activities: 17.2- 69.7	Urban Respondents only
10.	Indonesia) (Utomo et al., 2019)	60+	2,750	65.0	Housework: 12.8 Grandparenting: 16.5	The 2015/2016 Aging in Rural Indonesia Study Note: Rural Respondents only

Table 2.6, continued

No	Studies (Source)	Age	Sample Size	Paid Labour (%)	Unpaid Productive Activities (%)	Remark
11.	Myanmar (Teerawichitchainan et al., 2019)	60+	4,080	23.0	Grandparenting: 33.0	The 2012 Myanmar Aging Survey (MAS)
12.	Thailand (Teerawichitchainan et al., 2019)	60+	34,173	38.4	Grandparenting: 28.0	The 2011 Survey of Older Persons in Thailand (SOPT)
13.	Vietnam (Teerawichitchainan et al., 2019)	60+	2,789	37.3	Grandparenting: 34.0	The 2011 Vietnam Aging Survey (VNAS)
14.	USA (Morrow-Howell et al., 2014)	55+	5,324	31.0	Housework: 21.0 – 84.0 Formal volunteering: 31.0 Informal helping: 58.0 Garden work: 52% Self-development activities: 31.0 – 55.0	The 2008 and 2010 the RAND HRS and the 2009 Health and Retirement Study Consumption and Activities Mail Survey (HRS CAMS)
15.	USA (S. Kim, 2020)	65+	3,005	30.0	Caregiving (general): 17.0 Formal volunteering: 63.0	The National Social Life, Health, and Aging Project (NSHAP) (Wave 1 or 2005-06 and Wave 2 or 2010-11)
16.	USA (Toossi & Torpey, 2017)	55+	-	40.0	-	US Bureau of Labor Statistics (BLS) data in 2014

Table 2.6, continued

No	Studies (Source)	Age	Sample Size	Paid Labour (%)	Unpaid Productive Activities (%)	Remark
17.	Denmark (Di Gessa & Grundy, 2017)	50+	866	54.1	Informal helping & grandparenting: 40.3 Formal volunteering & self-development activities: 37.3	Survey of Health, Aging, and Retirement in Europe (2004, 2006)
18.	France (Di Gessa & Grundy, 2017)	50+	1,369	43.5	Informal helping & grandparenting:39.5 Formal volunteering & self-development activities: 26.1	Survey of Health, Aging, and Retirement in Europe (2004, 2006)
19.	Italy (Di Gessa & Grundy, 2017)	50+	1,291	25.4	Informal helping & grandparenting: 40.8 Formal volunteering & self-development activities: 12.7	Survey of Health, Aging, and Retirement in Europe (2004, 2006)
20.	England (Di Gessa & Grundy, 2017)	50+	6,049	46.9	Informal helping & grandparenting: 23.5 Formal volunteering & self-development activities: 17.1	English Longitudinal Study of Aging (2002, 2004)

Note: Age: 65+ denotes the sample of older adults aged 65 or over; Caregiving refers to grandparenting, caregiving for a spouse, caregiving for parent or caregiving for others; self-development activities refer to social, political, religious, or leisure activities.

There is no consensus on the definition of unpaid productive engagement, with the studies on productive engagement somewhat sporadic. Furthermore, the prevalence of various unproductive engagements involving older adults is also affected by the targeted respondents' aggregated productive activities and criteria, such as age and physical environment (urban and rural) (Table 2.6). Hence, it is pretty challenging to compare the participation of various unproductive engagements among various countries. The most common reported unproductive engagement relates to grandparenting and caregiving (including caregiving for spouse and others people). The prevalence of grandparenting ranged from 11% to 56% in Asia countries compared between 7% and 41% in Australia and western countries. Formal volunteering is commonly reported in western countries but not Asia countries.

In contrast, household management is prevalent among Asia-related studies than Western-related studies. The involvement in housework ranged between 21% and 84% in the US. While self-development activities, such as social, religious, or leisure activities were reported, the type of studies was quite scattered and different from one to the next.

Chinese culture, as mentioned earlier, is family-oriented (Y. Luo et al., 2019). Older Chinese adults are obligated to provide caregiving to family members, typically a parent, parent-in-law, spouse, and grandchild (Mjelde-Mossey et al., 2009; Penning & Wu, 2016; Silverstein et al., 2006; J. Sun, 2013). Grandparenting is an everyday productive activity among Asian countries (F. Chen et al., 2011; Knodel et al., 2015). Many studies have found that most older adults, especially older women, provided a certain level of caregiving to family members, relatives, or friends (Doty et al., 1998), while older men are more likely to assist in coordinating care for others (Johnson & Lo Sasso, 2000).

Household management or performing household chores is considered an unpaid productive engagement linked to productive ageing and successful ageing (Liffiton et al., 2012; Menec, 2003). It is quite common to consider the involvement of older adults in performing household chores as non-economic contributions. However, they help working household members focus on their economic activities and lessen the monetary costs of hiring a maid or paid domestic helper (Teerawichitchainan et al., 2019). Nevertheless, relatively few studies examine the participation of housework work among older adults following retirement (Geist & Tabler, 2018; Leopold & Schulz, 2020).

Regarding older adults, housework is part of their daily activities and lives. Herzog et al. (1989) reported that older men and women tend to be involved to a certain level in performing housework. Based on the Health and Retirement Survey (HRS) data, Morrow-Howell and colleagues reported that up to 85% of older adults aged 60 and above in the US were involved in household management (Morrow-Howell et al., 2014). The gender construction theories highlight that housework comprises various gendered housework or domestic tasks (Leopold & Schulz, 2020). Both men and women take on different tasks involving housework (Shelton & John, 1996). Routine housework or low-schedule-control tasks, like meal preparation, laundry, and cleaning, are essential and cannot be postponed to incorporate into women's work (Barnett & Shen, 1997). Women already perform and carry most of the burden of housework historically compared to men (Bianchi et al., 2012).

On the other hand, non-routine activities outside of the house or “high schedule-control tasks,” such as repair work, caring for the car, yard maintenance, and garden work, are typically attended by men. Some studies suggested that housework patterns are “gender-based", mostly unrelated to age, economics, and time restrictions/limitations (West &

Zimmerman, 1987). Solomon, Acock, and Walker (2004) stated that retirement did not significantly change the way couples assign housework. However, the “continuity hypothesis" indicates that the distribution of housework is more equitable among couples following retirement (Leopold & Skopek, 2015). Notwithstanding, older males may increase their weekly household chores or housework, while older females still performed more tasks than men (Langner & Furstenberg, 2020).

Involvement in gardening improves life quality, contributing to psychological, physical, and social benefits (Scott et al., 2020). Gardening correlates with increased mental well-being, mental stimulation, self-esteem, and creativity (Lampinen et al., 2006). One study in the UK found that activities, such as gardening correlated with the reduced risk of morbidity and mortality rates among a sample of older participants with coronary heart disease (Wannamethee et al., 2000). Moreover, restorative benefits from gardening can be gained through potted plants and disregarding garden size (Chiang et al., 2017; Scott et al., 2020). Based on a cross-sectional study of 331 older Australian gardeners aged 60 years and above, “doing” gardening or simply “being” in the garden was crucial for achieving positive therapeutic benefits (Scott et al., 2020). There are a few studies that have investigated the involvement of older adult garden work. Morrow-Howell and colleagues (2014) reported that about 52% of older adults in the US were involved in yard or garden work.

There are other patterns of productive engagement in later life, such as formal volunteering, caregiving, and informal helping. Including formal volunteering as productive engagement is common among Western literature (Hooyman & Kiyak, 2011; Matz-Costa et al., 2014; Morrow-Howell et al., 2014; Morrow-Howell & Greenfield, 2016). Also, given different socio-cultural contexts in China, the involvement of older

adults in volunteer activities is much lower than in Western civilisations (Y. Luo et al., 2019). Based on 13,596 older respondents aged 50 and above based on three waves of the CHARLS, the involvement in volunteering ranged between 1.8% to 2.7%.

Furthermore, volunteering was not perceived nor recognised as a part of the activities associated with old age, especially in rural areas of China (H. Y. Liu & Lou, 2017). Most volunteering activities are government-led volunteer programmes that mainly target retired professionals (Y. Chen, Putnam, et al., 2018; Y. Luo et al., 2019; Mui, 2010). Nonetheless, older adults involved in volunteering activities or programmes tend to report better physical and mental health health (Y. Li et al., 2014; H. Y. Liu & Lou, 2017).

Informal helping refers to "older adults providing help to others living outside the household, including neighbours, friends, and relatives" (H. Y. Liu & Lou, 2017, p. 13). Most studies indicate a positive relationship between informal helping and well-being (Avlund et al., 2004; S. L. Brown et al., 2003; Y. Luo et al., 2019). Brown and colleagues (2003) reveal that providing instrumental help or support to others (e.g., providing help in transportation, shopping, running errands, housework, childcare, and others tasks to people other than family members) has substantially lowered mortality rates in older adults (Brown et al., 2003). Similarly, Krause et al. (1992) indicated that providing informal help to others promoted feelings of personal control in old age and lowered the depressive symptoms (1992). Given that mutual assistance is a cultural phenomenon among Chinese, informal helping is an everyday productive activity among Chinese older adults (H. Li et al., 2010; Y. Luo et al., 2019). Luo et al. (2019) reported that around 6% to 12% of older Chinese adults aged 50 and above were involved in informal helping.

Furthermore, there is a growing trend toward examining multiple productive activities. Based on a study of 1,896 older people aged 55 and above in the American Changing Lives survey, Burr et al. (2007) combined several productive activities, such as paid work, volunteering, housework, informal helping, and caregiving to examine the structure of productive activities among older adults. The results suggested that many productivity activities are clustered or grouped with particular patterns, inclined to complement rather than compete with one another (Burr et al., 2007). The work of Morrow-Howell et al. (2014) considered 36 activity items simultaneously to identify profiles of activity among older adults. This study profiled 36 activity items of older people into five main activity profiles: "Low Activity, Moderate Activity, High Activity, Physically Active, and Working" to capture the concept. Using data from the 2011 CHARLS and a national representative sample of adults aged 60 years and over (n = 3,019), H.Y. Liu and Lou (2017) utilised working, parental care, spousal care, grandchildren care, formal volunteering, and informal helping to capture the clusters of productive engagement among older urban Chinese people.

2.9 Determinants and Factors Affecting Productive Engagement

In the following sections, the discussion centres on the determinants, factors, and variables of the research framework of this study. These include health and personal determinants (physical health, chronic diseases, cognitive health, and functional health), behavioural determinants (smoking, drinking, and exercising), social determinants (social participation, living arrangement, and marital status), economic determinant, physical environment, demographic factors (gender, age, education, and pre-retirement occupation), and contextual variables. In general, most of the determinants and factors related to the WHO Active Ageing framework (WHO, 2002) and productivity in the later life framework by Morrow-Howell and Wang (Morrow-Howell & Wang, 2013).

2.10 Health and Personal Determinants

2.10.1 Physical Health

In general, those people with better health are more likely to participate in all forms of productive activities (Gimenez-Nadal & Molina, 2015; Jang et al., 2009; J. H. Kim, 2019; Lennartsson & Silverstein, 2001; Morrow-Howell et al., 2014). Health is one of the significant determinants of old age employment (Ozawa & Lum, 2005; Smyer & Pitt-Catsouphes, 2007). Indeed, older people with better health conditions and fewer physical functioning limitations or constraints are more likely to participate in full-time and part-time employment. Moreover, health also is a critical factor in unpaid productive engagement, such as volunteering and informal helping (S. Y. Kim & Hong, 1998; F. Tang, 2008; Wilson & Musick, 1997). Using two-wave panel data of older adults from the NSHAP, the finding indicates a positive relationship between employment and volunteering with self-rated health (S. Kim, 2020).

Wilson and Musick (1997) postulated that physical health is more significant than education or income to associate with informal helping positively. Based on the 23 waves of the German Socio-Economic Panel Study for the period between 1992 and 2015 and with observing 3,889 retired couples aged between 60 and 85 years, the performance of household chores among retired couples reduced with deteriorated health status, and were even higher for those who had severe health problems (Leopold & Schulz, 2020). Based on data collected from the 2009 and 2013 Disability and Use of Time (DUST) survey, Geist and Tabler (2018) investigated the relationship between health and housework activities of older couples aged 60 or older in the US. Their findings indicate that poorer health is associated with less housework for older couples, with the association more evident for women than men. Housework tasks, such as laundry, cleaning, and preparing

dinner, remain stronger for gendered couples, typically female partners (Geist & Tabler, 2018; Langner & Furstenberg, 2020).

2.10.2 Chronic Diseases

"Multimorbidity" refers to having two or more chronic diseases or conditions (Fabbri et al., 2015; Kadijk et al., 2019; Ubalde-lopez et al., 2017; van Zon et al., 2020). The risk of multimorbidity increases with age (Hernández et al., 2019; Jung, 2016), and it is estimated that a substantial percentage of older adults aged 65 years and above have more than one chronic health condition (CHCs) (Barnett et al., 2012; Czaja, 2020). Compared to developed countries, older adults living in developing countries have relatively higher levels of age-related morbidity because of inadequate health infrastructure and poverty (Hu & Das, 2019). Notably, multimorbidity is the consequence of age-related impairments to multiple systems and organs (Fabbri et al., 2015). There is a strong relationship of rising multimorbidity with changes in multiple ageing phenotypes and high risk for physical and cognitive decline, disability, and mortality (Fabbri et al., 2015; Hernández et al., 2019; McKee & Nolte, 2004). Furthermore, multimorbidities lower the activities of daily living and quality of life of patients (Bayliss et al., 2008; Fortin et al., 2006; Jung, 2016).

More workers have multimorbidity with an ageing workforce, mainly suffering from physical and mental health problems that often co-occur (van Zon et al., 2020). Older employees with multimorbidity have reduced workability, especially when mental health problems prevail. Ubalde-Lopez and colleagues (2017) found that multimorbidity negatively impacts work functioning, particularly for those who recover from sick leave due to common mental disorders. Based on an analysis of data from the HRS, van Zon et al. (2020) concluded that full-time workers aged between 50 and 64 years with

multimorbidity and higher mortality risks were more likely than those without or only one disease to leave full-time paid employment.

Furthermore, previous studies have indicated that multimorbidity increases the limitation in performing specific work demands and the risk of physical and psychosocial work limitations (Kadijk et al., 2019; Lerner et al., 2000). Nevertheless, it is notable that chronic diseases may not hinder older adults from remaining physically active (Hudon et al., 2008; S. Kim, 2020). Based on the data from the Quebec Health Survey 1998 of 16,782 respondents aged between 18 and 69 years, Hudon and colleagues (2008) revealed that multimorbidity was not associated with physical activity levels in both males and females after considering a range of control factors, such as age, education, income, and employment. A cross-sectional study from the Building Knowledge Base on Population Ageing in India (BKPAI) 2011, by Visariaa and Dommaraju (2019), showed that chronic health conditions do not affect older adults caring for grandchildren. Using a cross-sectional study and multilevel model, J. Kim et al. (2020) also observed that the presence of chronic disease might not impact active ageing. Nevertheless, the extent to which multimorbidity affects older adults' participation in unpaid productive engagement remains uncertain.

2.10.3 Cognitive Health

Cognitive health plays a significant role in active ageing and should be an integral part of long-term care (WHO, 2002). Ageing is normally associated with declining cognitive ability, and cognitive status is associated with mortality (Anstey et al., 2001; Czaja, 2020; Liang et al., 2000; Parker et al., 1992). The study of Zimmer (2008) reported that cognitive disorder could lead to a functional limitation. Based on the 2011-2012 Chinese

Longitudinal Healthy Longevity Survey (CLHLS) data, S.T. Ng et al. (2017) documented that cognitive ability is positively correlated with life satisfaction.

In general, engagement activities are related to better cognitive performance (Morrow-Howell et al., 2014). Cognitive abilities are also one of the resources for successful ageing at work (Zacher, 2015). Research using the "use-it-or-lose-it" hypothesis indicated that active older people are more likely to score higher marks on cognitive tests (Hultsch et al., 1993). Furthermore, people involved more in active social or leisure lives have a lower risk of dementia (Crowe et al., 2003; Fratiglioni et al., 2000; Kuiper et al., 2015; Murata et al., 2019). Participation in unpaid productive engagement, such as housework, volunteering, and involvement in social activities, has been shown to significantly improve the 6-year cognitive change in speed, incidental recall, and picture naming (Newson & Kemps, 2005).

2.10.4 Functional Health

Poor functional health, self-care limitations, and independent living activities are often used in evaluating disability prevalence and trends (K. S. Chan et al., 2012; Freedman et al., 2002). Functional decline and disability can impact health cost expenditure, poorer subjective well-being, and rising mortality rates (Q. Feng et al., 2013; Ferrucci et al., 1997; George, 2010; Leveille et al., 1999; Machón et al., 2016; Moran et al., 2008; Zeng & Vaupel, 2002). Since ageing does not imply dependence, WHO (2017) notes that functional health is more crucial than chronological age. Physiologic changes due to ageing, such as weak muscular strength, limited flexibility, and decreased bone mass, may invariably cause loss of physical function, dependence in undertaking daily activities, and disability (Beswick et al., 2008; Guralnik & Simonsick, 1993). Two common measures for functional health and impairment are the activities of daily living

(ADL) and instrumental activities of daily living (IADL) (Katz et al., 1970). ADLs evaluate more basic daily life tasks, such as the independent ability to eat, dress, bathe, toilet, and transfer from bed to chair. IADLs examine instrumental activities' performance, like the ability of older adults to prepare meals, use the telephone, walk long distances, go shopping, and manage finances (Moran et al., 2008).

A study using the data from five waves (2000–2008) of the HRS concluded that older adults with better functional health are more likely to be actively engaged in full-time work and part-time jobs, in addition to volunteering (E. Choi et al., 2016). Geist and Tabler's finding suggests that functional limit is linked with less housework for older men and women, with the relationship more evident for women than for men (Geist & Tabler, 2018).

Data from the China population census in 2010 and a 1% population sample survey conducted in 2015 by W. Zhang and Wang (2019) reported that improvements in social development, medical care services, and age-friendly living conditions improved older adults' functional health. Based on the Shanghai Longitudinal Survey of Elderly Life and Opinion (SLOSELO), older adults from Shanghai experienced substantial improvements in functional health, particularly IADL disability prevalence, between 1998 to 2008 (Q. Feng et al., 2013). It also found that physical function declines with age (Salem et al., 2000; Skelton et al., 1994; Unhjem et al., 2019). As long as older adults continue to sustain a high muscle force-generating capacity through strength training, they can benefit from functional performance (Unhjem et al., 2019).

2.11 Behavioural Determinants

2.11.1 Smoking

Healthy eating, not smoking, moderate drinking, and involvement in physical activity in late adulthood can prevent functional decline and disease, prolong longevity and promote one's quality of life (Dai et al., 2015; Jernigan et al., 2000; U.S Preventive Services Task Force, 1996; WHO, 2002). A non-smoker and a lower consumption rate of smoking were associated with healthy ageing (Haveman-Nies et al., 2003; Vaillant & Mukamal, 2001). In some studies, being a non-smoker and light smoker (smoking less than 30 or 40 packets per year) was one of the predictive factors of healthy ageing (Goren et al., 2015; Newman et al., 2003; Peel et al., 2005; Vaillant & Mukamal, 2001). However, some studies indicated scant evidence on the relationship between successful ageing and smoking status in China and Korea (Q. Feng et al., 2015). The association between the prevalence of tobacco use and labour force participation was also not revealed in 24 high-income OECD countries (Johnson et al., 2015). Nevertheless, smoking cessation could reverse some adverse health-related impacts of smoking to a certain degree (X. Li et al., 2017).

2.11.2 Alcohol Drinking

Even though several studies have investigated the impact of alcohol-drinking behaviour of older adults on socio-cultural rituals and successful ageing (Q. Feng et al., 2010, 2015, 2019; D. Gu et al., 2008), it remains controversial. Some studies claimed that drinking brings a negative impact on health (Wood et al., 2018), while other studies uphold the benefits of drinking (Blow et al., 2007; Pruchno & Wilson-Genderson, 2015; Vancampfort, Smith, et al., 2018). Based on 83 long-term prospective studies in 19 high-income countries, drinkers had the most significant risk for mortality causes (Wood et al., 2018). Vaillant and Mukamal's (2001) found that the absence of alcohol abuse under 50 years of age of an urban cohort was a vital protective factor. On the other hand, moderate

drinking compared with abstention was beneficial for healthy ageing (Guralnik & Kaplan, 1989).

In some studies, light-to-moderate consumption of alcohol improved the self-reported health and lowered the risk of heart disease (W. Hao et al., 2004; W. Hsu et al., 2017; J. Li et al., 2017; Murray et al., 2002; National Institute on Alcohol Abuse and Alcoholism, 1999). Moreover, light-to-moderate alcohol consumption was shown to improve self-esteem and promote relaxation through social interaction and, to a certain extent, temporarily reducing stress (Blow et al., 2007; Vancampfort, Smith, et al., 2018). Based on the Netherlands Cohort Study (NLCS), van Den Brant and Brants (2020) reported that there is a positive association between light-to-moderate alcohol intake (drinking 5 to 15 g alcohol/day) and longevity among men and women (probability of reaching 90 years). In both China and the UK, older adults who consume alcohol are more likely to mention having a moderately active social lifestyle and social network (Q. Feng et al., 2015; Hajat et al., 2004). In China, it is quite common to drink at social events, such as festivals, weddings, and business interactions (J. Li et al., 2017). Furthermore, the Chinses also believe that medicinal or herb wine is good for one's health and treating illnesses (W. Hao et al., 2004; J. Li et al., 2017).

2.11.3 Physical Exercise

Some literature points out that physical inactivity in China is a high-risk factor for major non-communicable diseases (Arem et al., 2015; Johnsen et al., 2013; I. M. Lee et al., 2012) and raising healthcare-related costs (J. Zhang & Chaaban, 2013). Besides, sedentary behaviour has been recognised as a risk factor for developing non-communicable diseases, (i.e. overweight or obesity, cardiovascular disease, diabetes)

(Buman et al., 2014; Dempsey et al., 2014), and cognitive impairment (W. Zhu et al., 2015).

Many studies have shown that regular exercise is associated with healthy (Ford et al., 2000; Haveman-Nies et al., 2003; Leveille et al., 1999; Strawbridge et al., 1996; Vogelsang, 2018). Moderate-to-vigorous physical activity (about 27 minutes/day) moderates the association between sedentary time and frailty status (Mañas et al., 2019). In China, participating in exercise is also correlated with the slow deterioration of health among older adults (W. Han & Shibusawa, 2015).

A systematic review of physical activity in older people by F. Sun et al. (2013) revealed that the percentage of older Chinese people studied who met the physical activities guideline (at least 30 min/day for five days or more per week, or an equal amount) ranged from one-quarter to nearly half. In Western studies, the percentage of older adults who met the physical activity recommendation ranged between 2.4% (Troiano et al., 2008) to 83.0% (Bird et al., 2009) or between 20% and 60% (F. Sun et al., 2013). There are also substantial physical activity differences between rural (52.7% to 60.9%) and urban populations in China (9.8% to 82.6%) (H. Du et al., 2013; F. Sun et al., 2013).

2.12 Social Determinants

2.12.1 Social Participation

Based on activity and continuity theories, older adults attempt to sustain and maintain their social life during youth and middle age, continuing into their old age through participation in social activities. Social participation has been shown to correlate with lower mortality levels in older adults (Croezen et al., 2015; Ding et al., 2015; Lennartsson & Silverstein, 2001; J. Lu et al., 2017). The same relationship has been observed in China

as well (J. Wu & Li, 2018). Social participation maintains social norms, strengthens social solidarity, promotes a non-sedentary lifestyle, such as exercise (Uchino, 2006), and impedes deviant behaviours, such as suicide (Kawachi & Kennedy, 1997; J. Wu & Li, 2018). Previous studies report that social participation plays a significant role in preventing cognitive decline (Ertel et al., 2008; Kuiper et al., 2015) and cognitive impairment in older people (W. Zhu et al., 2017).

However, there is little consistency and no widespread agreement on the term and concept of social engagement or social participation per se (Levasseur et al., 2010; Mendes de Leon, 2005), such as social activity (Bath & Deeg, 2005; Mars et al., 2008), social engagement (Mendes de Leon, 2005), social participation (Levasseur et al., 2010), social integration (Lennartsson & Silverstein, 2001), social connectedness (H. J. Kim et al., 2015; Lancee & Radl, 2012), social support (Lyyra & Heikkinen, 2006), social networks (Hanson et al., 1997), social involvement (Badley, 2008), social interaction (Croezen et al., 2015), social ties (Berkman & Syme, 1979), and social cohesion (Latham & Clarke, 2018). In this study, social participation is defined as "a person's involvement in activities that provide interaction with others in society or the community" (Levasseur et al., 2010, pp. 11–12).

Older adults with more considerable social capital are generally more productive (S. Kim, 2020). The likelihood of older adults, especially men having more social resources in unpaid productive activities is higher than in women (Morrow-Howell & Greenfield, 2016). Numerous studies have examined social participation links with paid work (O'Rand, 2006). Rife and Belcher (1993) indicating that better social network ties also help the re-employment of older adults who have lost their jobs. In contrast, older adults with weak family and friend ties may be less inclined to withdrawal from the labour force

(Lancee & Radl, 2012; Szinovacz et al., 2001). Regarding the 'role' theory, more active older adults in social participation are more likely to leave employment earlier as they have found it to be a viable substitution for paid work and in countering role loss (Quick & Moen, 1998).

Based on the SST, older persons are more likely to spend their limited time in informal social participation (frequent contact and social gatherings with family and friends) (Lancee & Radl, 2012). Thus, their active involvement in informal social participation is associated negatively with the likelihood of older adults' withdrawal from work and seeking early retirement.

2.12.2 Living Arrangement

Co-residence with adult children is preferred in Chinese cultures and is considered mutually beneficial between older adults and their children. Older adults receive daily care, financial and emotional support from their adult children while participating in household chores and caring for their grandchildren (J. Sun, 2013; Tienda & Glass, 1985; Tong et al., 2019). In Korea, older urban adults staying with children are also more likely to be involved in a paid job and helping in household chores than inactive older urban adults (J. H. Kim, 2019). The decision of older adults to participate in the labour force is not merely an individual preference but rather to consider the family's financial needs, especially the co-resident child or children (Ellis, 1993). In adhering to Chinese traditional values, older adults living with married adult children are generally linked with a lower likelihood of being involved in a paid job (Tong et al., 2019). However, living with unmarried sons rather than with daughters may increase the economic pressure for older parents and raise the likelihood of older adults being actively involved in the labour force (Cherlin, 2010; Tong et al., 2019). Moreover, the likelihood of older adults

participating in caregiving and volunteering is higher since they live with their adult children (Utomo et al., 2019).

Some studies indicate that involvement in paid and unpaid productivity improves one's ability to cope with spousal loss (Cohen, 2004; Erikson et al., 1986; R. W. Johnson, 2009; Utz et al., 2002). Thus, the likelihood of older adults living alone and becoming involved in paid and unpaid productive activities is higher (Utz et al., 2002). A recent study of Chinese older adults aged 55 years and above living alone reported a relatively lower retirement rate than other types of living arrangements to maintain their financial security at old age (J. Liu et al., 2019). However, Choi's (2003) study estimates that those living alone are more likely to have a low level of engagement outside the home. Nevertheless, the impact of living arrangements on productive activities could be gendered and needs further investigation (Visaria & Dommaraju, 2019).

2.12.3 Marital Status

Marital status is a helpful indicator of life-long personal resources and available kinship networks (Kendig et al., 2007; Kjellsson, 2013; V. Loh & Kendig, 2013). Marital status may positively correlate with productive engagement as older adults can extend the benefits gained to their spouse (Glass et al., 1995; Hesketh et al., 2011; S. Kim, 2020). Through marriage, older adults can expand their kinship network and increase the likelihood of providing care for children and grandchildren (Kendig et al., 2007). Married men may delay retirement given they have to support dependent children and spouses (Henretta et al., 1993; Honig, 1996; Pienta, 2003; Talaga & Beehr, 1995; Yorgason et al., 2020).

Based on the fourth wave of the CHARLS in 2015, Henry, Fraga, and Yu (2018) reported that having a working spouse is positively associated with working hours per week. With

support from a spouse, those married are more likely to be involved in a paid job (Teerawichitchainan et al., 2019). Ling and Chi's (2008) study also revealed that marital status was an essential factor in determining older women's work status. However, Morrow-Howell and colleagues (2014) found that those older adults not married were more likely to be involved in paid jobs than those currently married. Besides, some studies in Indian showed limited support regarding the impact of marital status on paid jobs (Visaria & Dommaraju, 2019).

The likelihood of married older adults and their involvement in unpaid productive engagement, such as informal helpers, caregivers, and managing household financial matters, is relatively high (H. C. Hsu et al., 2019; Jegermalm & Grassman, 2009; S. Kim, 2020; Visaria & Dommaraju, 2019). Based on 15 waves of couple-level data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey, participating in social activities is a protective factor against deterioration in health for older adults and their partners (Lam & Bolano, 2019). Marriage and having children are also linked with a higher likelihood of volunteering (Wilson & Musick, 1997). Using two-wave panel data (2015-2016) of older adults from the NSHAP, the finding indicates that married older adults are more likely to be caregivers, possibly due to their ill spouses (S. Kim, 2020). Notwithstanding, the impact of marital status on productive activities, like living arrangements, could be gendered, though further research is needed (M. A. Chen, 1997; Visaria & Dommaraju, 2019).

2.13 Economic Determinants

Poverty correlates to low income, lack of pension benefits, malnutrition, poor health, low literacy, and the well-being of older adults (UNFPA & International HelpAge, 2012). Based on a 7-year longitudinal Komo-Ise Cohort study of 11,565 working and retired Japanese adults, the findings show that relative poverty may be associated with a higher death rate among retired men (Tanaka et al., 2018). Many older adults, especially females, tend to live alone or in rural areas without consistent or sufficient income (WHO, 2002).

Carr and colleagues (2020) examined the longitudinal data from the 2004 to 2014 waves of the HRS to investigate the changes in life satisfaction of retirement versus post-retirement of 1,304 older adults aged between 51 and 87. Their findings indicated that older adults who were financially stable were most likely to experience improved life satisfaction. The reason may be attributed to individuals utilising their time with the support of financial resources to participate in activities to enhance their life satisfaction. Financially vulnerable older workers may have little control over their lives and are less likely to adjust their retirement living and improve their life satisfaction (Froidevaux et al., 2016).

Some older adults need to continue to work since they do not have a pension or adequate pension and retirement savings to meet their economic needs (Hu & Das, 2019; J. Kim et al., 2018; O. E. Lee & Lee, 2014). Older adults may also face decreased income, lower self-esteem, and a sense of loneliness if they have a financial problem or are excluded from income-generating activities (J. Kim et al., 2018). Furthermore, the healthy financial status of older adults is vital for older adults to maintain good health. Some studies have indicated that experiencing the burden of economic hardship was correlated with worsening physical capability, poor cognitive function, and higher inflammatory levels

(Al Hazzouri et al., 2017; Foverskov et al., 2020; Leone & Hessel, 2016). Morrow-Howell and colleagues (2014) noted that lower asset possession was more likely to be associated with lower activity than in more active engagement groups. Ultimately, families, communities, and society may be over-burdened to care for those in poverty and experiencing economic hardship. Economic recession, the loss of income in retirement, and increased cost of living may also give rise to financial distress (Dew & Yorgason, 2010; McDaniel et al., 2013). In most cases, economic hardship requires older adults, especially older males, to continue working (Yorgason et al., 2020).

However, there is inconsistent evidence on the relationship between income to employment, volunteering, and informal helping. The financial resources and net worth of older adults are positively linked to paid and unpaid productive engagement (S. Y. Kim & Hong, 1998; Ozawa & Lum, 2005; Pienta & Hayward, 2002). Older adults with higher pensions tend to retire early (Pienta & Hayward, 2002), while those with homeownership and higher household income are more likely to involve themselves in volunteering (S. Y. Kim & Hong, 1998). Wilson and Musick (1997) indicated that income is associated with informal helping. However, Gallagher's study (1994) states that income level is not a determinant of informal helping (helping family members or friends) among older adults.

2.14 Physical Environment

Physical environment factors include urban-rural contexts (Morrow-Howell & Wang, 2013). The lives of older adults in urban and rural areas present a substantial difference, though fewer discussions are evident on rural and urban differences found in Western literature (Henry et al., 2018; J. H. Kim, 2019; Warburton & Stirling, 2007). Usually,

older rural adults allocate most of their time to engage in farming work and activities; thus, their involvement in productive activities is ordinarily high (J. H. Kim, 2019).

Conversely, older urban adults may participate in different productive activities. Using the time spent by urban older Koreans on productive engagement in 2014, J.H. Kim (2019) used a cluster of adults in classifying urban older Koreans into four groups: self-development type (24.9%), household management type (27.6%), work maintaining type (9.3%), and the inactive type (38.2%). H.Y. Liu and Lou (2016) included several productive activities, like paid working, formal volunteering, family caregiving, and informal helping, to study the patterns of productivity engagement among older urban adults in China. Based on the baseline survey of the CHARLS (2011-2012) and latent class analysis (LCA), H.Y. Liu and Lou (2016) categorised urban Chinese adults into spouse carer (51.2%), working grandparents (21.7%), multifaceted contributor (16.6%), and light-engaged volunteer (10.5%). Based on the baseline data (2011–2012) of the CHARLS and the framework of the Age-Friendly Community (AFC) initiative, urban communities are more age-friendly than in rural villages in China (Y. Wang et al., 2017).

Ageing in rural areas in developing countries, including China, is challenging given the scarcity of resources, minimal and limited income sources and the vast geographic distribution of the population (Y. Fang et al., 2019; Morrow-Howell & Wang, 2013; Norstrand & Xu, 2012). Older rural adults, especially women, tend to be more vulnerable than men. The youths tend to move away from rural areas to urban areas to pursue higher education and employment in cities (Burnett et al., 2012; W. Chen, 2006). Thus, older rural adults have to become involves in productive activities, such as farm work and childcare for those children left behind (Y. Wang et al., 2017). Rural older adults, including women, may view pastoral work as necessary rather than a choice and need to

continue working until they are no longer physically capable or able (G. Chen & Gao, 2013; Giles et al., 2011; Henry et al., 2018; Utomo et al., 2019). They need to work through farm work or extended family arrangements (Benjamin et al., 2003). Nevertheless, rural older adults still achieve higher life satisfaction than their urban peers expecting little from life (M. Han & Hou, 2009; Henry et al., 2018).

Based on the Aging in Rural Indonesia Study conducted in 10 selected villages, Utomo and colleagues (2019) reported that older rural adults' motivation to work at an old age is based on the need for income security. Participating in unpaid productive engagement is correlated with the social atmosphere of the neighbourhood of older adults (Ko & Yeung, 2018).

2.15 Demographic Factors

Gender differences and gender inequality in the labour market and participation in later life are most observed and prominent in many Asian societies than in the West (Y. Hao, 2008; J. E. Hinterlong et al., 2007; Ko & Yeung, 2019b; Y. Lee & Yeung, 2019; J. Liu et al., 2019; Y. Luo et al., 2019; Luoh & Herzog, 2002; Raymo et al., 2015). Generally, men have a higher likelihood to be involved in paid jobs while women are more likely to engage in unpaid productive activities, such as caregiving and housework housework (L. T. Giang et al., 2018; Henry et al., 2018; J. H. Kim, 2019; H. Y. Liu & Lou, 2017; Visaria & Dommaraju, 2019). Burr and Mutchler (2007) found that older adult women are more likely to work less than older men. Childrearing and poor health conditions may be some factors for women to have a more inconsistent employment history (Hsueh & Tienda, 1996). Older Korean women still maintain the traditional gender division of labour involved in family care, while older Korean men are involved in paid activities (J. H. Kim, 2019). Visaria and Dommaraju (2018) also found consistent gender patterns in Indians. Here, Indian women engage in caregiving and grandparenting, while older Indian

men engage in activities outside the household. Similarly, Giang et al. (2018) mentioned that older Vietnamese men tend to involved in economic activities, while older Vietnamese women are engaged more in caregiving.

Housework tasks are strongly gendered, in which women undertake more housework than men (Bianchi et al., 2012; Geist & Tabler, 2018). Women are primarily responsible for routine domestic housework and "low-schedule-control tasks," such as meal preparation, cleaning, and laundry (Barnett & Shen, 1997). On the other hand, men tend to be involved in non-routine activities outside the house or "high schedule-control tasks," such as repair work, caring for the car, yard maintenance, and garden work (Leopold & Skopek, 2018). Older females continue to carry out weekly household chores, even as their spouse increases their engagement in performing housework (Langner & Furstenberg, 2020).

Given the traditional socialisation of women in caregiving and nurturing roles, Wilson and Musick (1997) reported that the likelihood of women involved in informal helping is higher than men. Likewise, Herzog and colleagues (1989) also stated that women spend more time helping others than men across different age groups.

Generally, most studies state the negative association between age and paid jobs among older adults (Henry et al., 2018; J. H. Kim, 2019; H. Y. Liu & Lou, 2017; Morrow-Howell et al., 2014; Teerawichitchainan et al., 2019). A study by Flippen and Tienda (2000) based on a nationally representative sample of adults aged between 51 and 61 shows that the age of an older worker is positively linked with retirement and leaving the labour force. Age is also an adverse factor for re-employment and re-entry into the labour force for older workers. Herzog and colleagues (1989) document that the proportion of informal

help significantly declines as people age, but age-related change is less evident in the number of hours spent helping others.

Schmitz (2011) stated that there are more barriers for older adults, especially those lacking human capital and education (Becker et al., 1990; S. Kim, 2020). Education is a significant contributor to employment at old age (O'Rand, 2006). Some studies indicate that higher education is a prerequisite for older adults to participate in productive activities, such as paid jobs (S. Kim, 2020; Ling & Chi, 2008; H. Y. Liu & Lou, 2017; Morrow-Howell et al., 2014). Using a sample of males aged 70 years or older from the Assets and Health Dynamics of the Oldest Old data, Ozawa and Lum (2005) found that the likelihood of employment is significantly higher for those having a college education compared to high school completion. Morrow-Howell et al. (2014) show that older adults with lower educational attainment are more likely to be in a low-activity group than other groups. Older Indians with no formal education are more likely to be hired than older adults with a higher level of education. However, they are less likely to be employed than those with some formal education (primary school) (Visaria & Dommaraju, 2019). Similar patterns can also be observed in Myanmar, Vietnam, and Thailand (Teerawichitchainan et al., 2019).

On the other hand, the findings related to the association between education and paid job are inconsistent, for example, in China. H.Y. Liu and Lou (2016) revealed that higher educated Chinese older adults were more likely to be working grandparents. Nevertheless, Ling and Chi (2008) found limited support for education in predicting work decisions among older Chinese living in urban areas. Similarly, Henry et al. (2018) and S. Kim (2020) reported that education had little effect on finding work for older adults.

Wilson and Musick (1997) found that education may not relate to the participation of older adults in informal helping compared to formal volunteering, given the obligatory nature of informal helping. Regardless of the educational background of older people, they may assist family members or friends.

Occupation is also a helpful indicator of life-long personal resources, providing a further human capital link to productivity engagement (Kendig et al., 2007; Kjellsson, 2013). Like managerial and professional jobs, some occupations may improve their chances to develop and equip themselves with work-related skills. However, some physical or manual related jobs may require less training, exposing individuals to more impoverished health conditions and lower wages (Kjellsson, 2013). In general, many older adults in rural areas in Asian countries are involved in agricultural activities, though the research in Western contexts is limited (Ko & Yeung, 2018, 2019b). As mentioned earlier, agricultural activities are more prevalent among older Chinese people (Y. Chen, Wang, et al., 2018; H. Li et al., 2013). Besides, much of the agricultural work and activities are likely necessities rather than choices (Henry et al., 2018). However, there is limited research to examine the association between a pre-retirement job on productive activities.

2.16 Contextual Variables

There is growing interest to investigate contextually related factors like community, provinces, and other factors that affect older adults' involvement in active and productive engagement (J. Kim et al., 2020). Some studies have shown the association of environmental factors (at the county or city level) with elderly health and mortality (Zeng et al., 2010). On the other hand, multilevel models offer causal inferences by grasping social problems' longitudinal and contextual aspects. Thus, Zeng (2012) encourages to employ a multilevel design and data analysis.

Based on a cross-sectional survey employing a sample of 380 older adults aged 65 living in a senior citizens' centre from 35 neighbourhoods in Seoul, Kim and colleagues highlight two community-capacity factors (cooperative unions and senior leisure welfare facilities) that are significantly correlated with active ageing (J. Kim et al., 2020). However, the study results could not be generalised to other centres or regions since the respondents were older adults involved in a particular senior citizen centre in the community, and the sample size was relatively small. Based on the multilevel analysis, Utomo et al. (2019) highlight the association of productive engagement with village variations in social engagement by older Indonesians.

Analysis using random-intercept multilevel logistic models, Ko and Yeung (2018), suggest that the residential community environment, especially the economic environment, is crucial for older Chinese adults to sustain and enhance their participation in paid work and grandparental childcare. The results reveal that better economic development and the establishment of suitable infrastructure may offer more employment opportunities for older Chinese people. However, the impacts decrease after covering the institutional and socio-demographic environmental indicators. The finding shows that urban communities have more resources and services for older adults (Z. Feng et al., 2011).

2.17 Active and Productive Ageing in China

Historically, the literature on the productive engagement of older adults was documented more than 2,500 years ago in China (Lum, 2013; Y. Song et al., 2010) but only limited to elite families or government staff. Many retired professionals and knowledge workers in China include scientists, professors, technological personals, and experts in various fields

(J. Y. S. Cheng et al., 2007; R. Sun & Liu, 2008). The majority are young-old (less than 70 years), in good health, still capable of working, and willing to continue working (J. Y. S. Cheng et al., 2007; Wei & Li, 2001). However, many older adults no longer use or utilise their talents (J. Y. S. Cheng et al., 2007; G. Q. Sun, 2005). Therefore, a proactive strategy to utilise older Chinese adults resources, assets, and skills is critical (J. Y. S. Cheng et al., 2007; Mui, 2010).

Morrow-Howell and Wang (2013) propose a productivity framework for research studies related to later life by synergising the WHO Active Ageing framework (World Health Organisation (WHO, 2002) and productivity in the Later Life (J. Hinterlong et al., 2001). Using the nationally representative data from the US, China, and South Korea, Y. Chen, Wang et al. (2018) found that productive activities vary by country. These differences may cause variations in the socio-cultural context and discrepancies in operationalisation and measurement.

Based on a sample of 10,016 urban Chinese adults aged 60 years or older, Y. Li et al. (2014) discovered that older people with a paid job, volunteering, or providing family assistance disclosed significantly better self-rated and functional health and lower levels of depression than those without those activities. Hu and Das (2019) promote productive engagement and improve basic public provisions to improve the effects on the quality of life of Chinese older adults. Using the World Health Organisation's (WHO) Study on Global Ageing and Adult Health (SAGE) Wave 1 data, F. Tang et al. (2018). examined the positive relationship between employment and specific work characteristics with life satisfaction in both older adults and older males. In the three waves of the CHARLS and Generalised Estimation Equations, the study shows that the beneficial impacts of productive activities on older adults' cognition vary (Y. Luo et al., 2019). For example,

volunteering and grandparenting are most helpful for urban women, while informal helping is most favourable for urban men, with the paid job cited as most advantageous for rural men.

H.Y. Liu and Lou (2016) aimed to capture multiple productive activities of older urban adults through latent class analysis (LCA) using working, formal volunteering of grandchildren, parental care, spousal care, and informal helping. In another study, Ling and Chi (2008) examined the determinants of work among urban Chinese adults aged 60 and above. The results showed that gender, age, ethnicity, earning a high income, and self-perceived health status are essential variables affecting the work status of urban Chinese adults. Conversely, determinants, such as savings, public pension, health insurance, and material assets, were adversely associated with continuing to work (Ling & Chi, 2008). Ko and Yeung (2018) examined the association of childhood conditions with the productive engagement of older adults finding that better childhood health, childhood hukou status, parents' education, and childhood neighbourhood cohesion with altruistic or pro-social values affect older adults' productive engagement.

Um, Zaidi and Choi (2019) found that the Active Ageing Index (AAI) results in China (ranked number 3) demonstrate that the employment domain performs well compared with 28 European Union (EU) countries but is ranked behind Korea (as number one). Another study compared the prevalence of successful ageing in China (18.6%) and Korea (25.2%) (Q. Feng et al., 2015). The study demonstrates that successful ageing, especially good financial conditions, is similar between China and Korea, except for gender and health behaviours (Q. Feng et al., 2015). In another study, the prevalence of successful ageing is low among Chinese older adults (13.2%) and is influenced by education, Hukou, and geographic regions (H. Y. Liu & Lou, 2017).

2.18 Within and Between Changes

Ageing involves significant inter-individual and intra-individual variability among older adults (Czaja, 2020). Longitudinal studies examine both between-person and within-person relationships in the same variables concurrently. In fact, several scholars have conducted studies on within-person variation and between-person variation (Hoffman, 2015; Mroczek et al., 2003; Murayama et al., 2017; Voelkle et al., 2014; Zacher, 2015). However, Voelkle et al. (2014) comment on "the mechanisms specified by psychological theories generally operate within, rather than across, individuals. This disconnect between research practice applied demands, and psychological theories constitute a major threat to the conceptual integrity of the field" (p.193).

Nevertheless, researchers should be aware of the distinction between the within and between-person since it is an important theoretical problem in ageing and development (Mroczek et al., 2003). Nevertheless, between and within-person variation studies have enriched new findings, especially in behavioural science research. T.W.H. Ng and Feldman (2013) address five significant within-person changes of job performance (cognitive capacity, personality, goal orientation, social-emotional experience, and health) related to ageing, in which the cumulative evidence reveals that older workers are still productive workers(T. W. H. Ng & Feldman, 2013). Based on a combined inter-individual and intra-individual analysis, Goetz et al. (2016) found a significant association between students' achievement goals and their emotions. Interestingly, some researchers urge more longitudinal research to examine the assumptions on intra-individual age-related changes over time to resolve the effects of different birth cohorts and "healthy worker" selection effects in successful ageing at work (Hofer & Piccinin, 2010b; Zacher, 2015).

2.19 Conclusion on the Gaps of the Studies

Most of the literature examined in this chapter explore the impact of productive ageing on older people's well-being, life satisfaction, or physical health. Further, they investigate productivity activities from a cross-sectional perspective. While many studies have been undertaken by considering Western societies and developed countries, limited research has considered developing countries or research from an Asian perspective. Furthermore, there is a scarcity of research on housework, growing vegetables, garden work, and raising domestic animals as a form of productivity engagement in developed and developing countries. The mentioned unpaid productive activities are more common in socio-cultural conditions in Asia.

Furthermore, some senior researchers are encouraging academics and other scholars in this field to investigate and analyse the active and productive ageing framework through longitudinal data. There is limited research that analyses and examines the determinants of health, personal, behavioural, economics, physical environment, social, personal, and social-demographic factors simultaneously by including the longitudinal and contextual effect on productive engagement. Furthermore, fewer studies examine the relationship of the contextual variable in combination with various determinants on productive engagement through longitudinal data.

China's current and future situation provides a unique opportunity to study active and productive ageing. Its extensive geographical coverage has led to significant provincial differences, especially concerning economic development and the expected effect on the lives of people and living arrangements of the older population. Having said that, there are three notable gaps in the research. First, this study fills the gap in the literature by employing a longitudinal and multilevel analysis that allows changes over time and

different provincial effects to be considered. Second, the study notes the limited research on productive engagement in Asia, where socio-cultural conditions are different from the West. Third, past studies have examined the factors sporadically and not within a unified active ageing framework as adopted in this study.

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CHAPTER 3: METHODOLOGY

3.1 Introduction

Longitudinal studies are essential for understanding ageing-related changes as they enable the estimation and evaluation of within-person variation over time and individual differences (Hofer & Piccinin, 2010a). Most scholars agree that longitudinal holds significant potential to advance research in gerontology (Ferraro & Kelley-Moore, 2003). This chapter discusses the design and methodologies that were used in this study.

3.2 Research Design

Panel studies measure the characteristics of the same individuals or persons on two or more occasions over a period of time (Hofer & Piccinin, 2010b) and study the specific change and variation (Hofer & Piccinin, 2010a; Kalaian & Kasim, 2008; Taris, 2000). Menard (2004) states that longitudinal research should include three characteristics: "(a) data are collected for each item or variable for two or more distinct periods; (b) the subjects or cases analysed are the same or at least comparable from one period to the next, and (c) the analysis involves some comparison of data between or among periods" (p.1).

In a longitudinal study, the respondents provide information at some different points in time (also called waves or phases) (Menard, 2002). In behavioural and social science research, the number of times may be small and often involve just two or three waves. Therefore, depending on the purpose of a study, the duration between the waves can range from several weeks (or even days, minutes, or seconds) to several decades. Finally, the sample size may vary considerably from 200 respondents to more than tens of thousands of respondents (Taris, 2000). The primary purposes of a longitudinal study is to collect and analyse quantitative and qualitative data related to growth, change, and development over a period of time (Kalaian & Kasim, 2008; Menard, 2002). Some terms that are often

used to describe longitudinal studies include longitudinal research designs, within-subjects designs, repeated measures designs, time-series models, and individual change models growth modelling, and multilevel growth modelling (Kalaian & Kasim, 2008).

Longitudinal research designs, especially panel studies, have some advantages over cross-sectional research designs. Longitudinal research designs estimate change and growth in a dependent or outcome variable, predict the long-term effects of growth or change on a particular dependent or outcome variable, and address longitudinal issues related to research questions (Kalaian & Kasim, 2008; Menard, 2002). However, longitudinal research studies are not without methodological and analytical challenges and shortcomings (Kalaian & Kasim, 2008; Menard, 2002); such as data attrition, mortality and the unavailability of some respondents at data collection time points.

Menard (2004) has documented four different types of longitudinal designs: total population design, repeated cross-sectional design, revolving panel design, and longitudinal panel design. A total population design collects data from an entire population at different times while a repeated cross-sectional design collects data from different new samples at different time points. In a revolving panel design, data is either retrospectively or prospectively collected from the sample before some subjects are dropped or replaced with new subjects. In a longitudinal panel design, the same respondents, participants, or set of cases are followed up in each wave or period. Of these four longitudinal designs, the present study adopted the longitudinal panel design.

3.3 Research Framework and the Hypotheses of the Study

Longitudinal analyses provide rigorous evidence and arguments for the cause and effect of activity patterns among older adults (Morrow-Howell et al., 2014). It also ensures that

longer-term outcomes and changes in cohorts and socioeconomic circumstances are accounted for when analysing the corelation between determinants and productive engagement (Morrow-Howell & Wang, 2013). This study adopted a longitudinal panel design with a three-level multilevel model (Figure 3.1). In Level 1, repeated observations were nested within individuals, including time-varying variables (e.g., changes in self-rated health and instrumental activities of daily living (IADL) status). In Level 2, the variables described differences between the individuals (e.g., demographic variables) before they were nested in the contextual variables in Level 3.

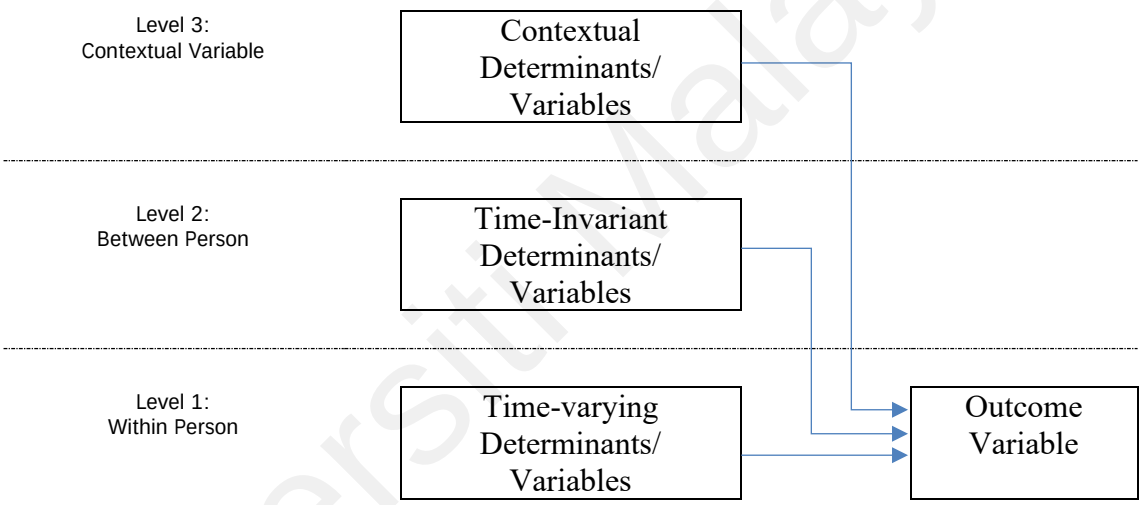


Figure 3.1: Example of a three-level multilevel model

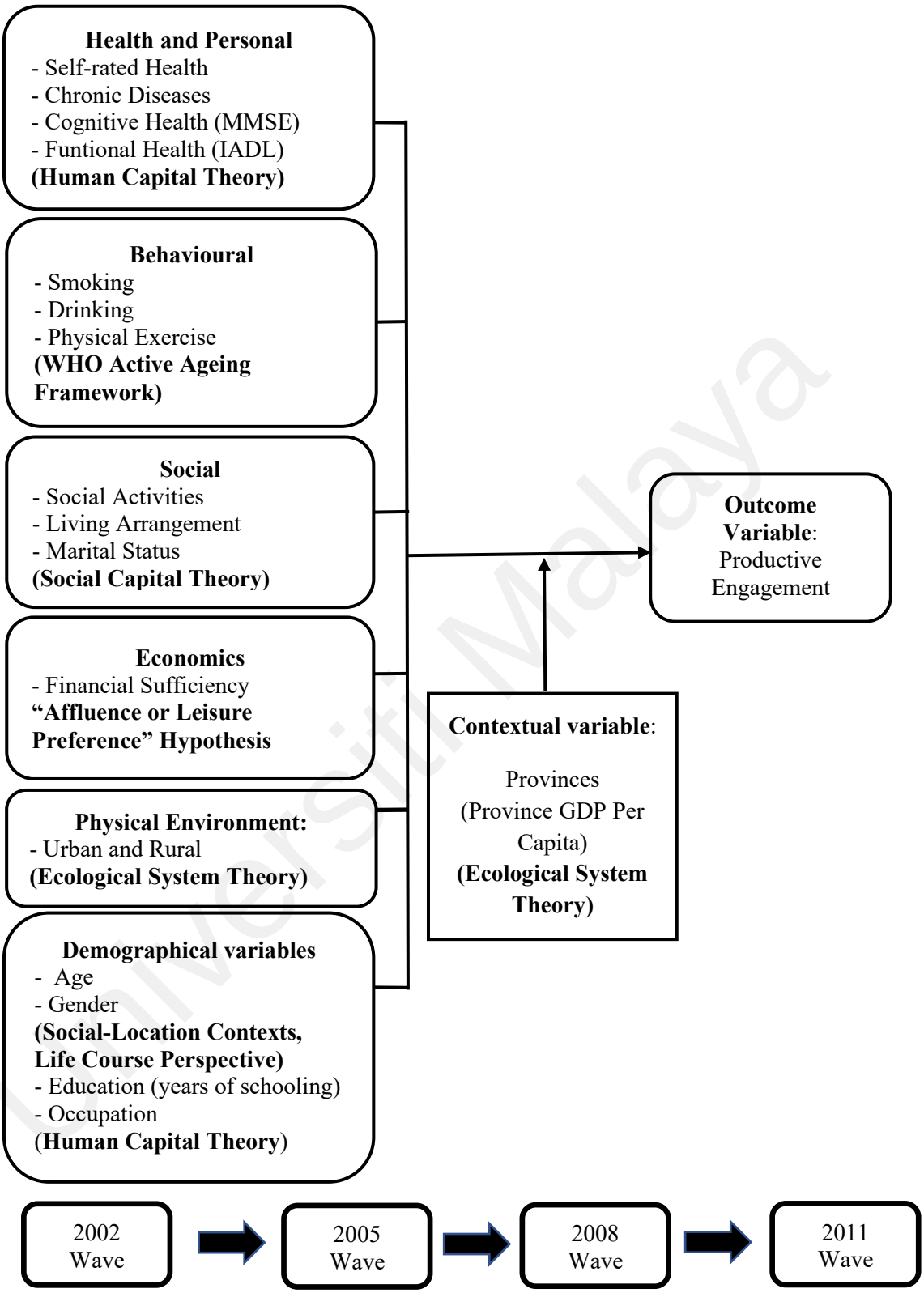
The conceptual framework was designed based on the WHO's Active Ageing Framework (WHO, 2002) and the productive engagement concept (Morrow-Howell & Wang, 2013). The basic conceptualisation of productive engagement was determined by health, personal, behavioural, social, economic, physical environment, and contextual factors. A narrow definition of productive engagement; only activities with economic value; was adopted to lay out criteria with which to define productive engagements. As such, productive engagement was defined in this study as any paid or unpaid activities that produced goods and services. The involvement of older adults in paid productive

engagement was measured as either full-time, part-time, or income received from work. Older adults who participated in any of the following activities; housework, personal outdoor activities (such as growing vegetables or performing other fieldwork), gardening, and rearing domestic animals; almost daily were categorised as involved in unpaid productive engagement. Figure 3.2. shows the research framework.

Based on the WHO's Active Ageing Framework and the determinants outlined in the previous chapter, the current study used human and social capital, the "affluence or leisure preference" hypothesis, the social context of the life course theory (LCT), and ecological systems theory to predict various types of productive engagements; namely paid and unpaid productive engagements (Figure 3.2).

Empirical studies indicate that individuals with better health-related human capital; such as with better physical, cognitive, and functional health, as well as without chronic diseases or multimorbidity; were generally more likely to be involved in productive engagements (Q. Feng et al., 2013; Geist & Tabler, 2018; J. H. Kim, 2019; S. Kim, 2020; Morrow-Howell et al., 2014; Newson & Kemps, 2005; Ubalde-lopez et al., 2017; Visaria & Dommaraju, 2019). The study also examined the various effects of health-related human capital on productive engagement by including provincial effects over time. The concept of within- and between- changes was embedded in physical and cognitive health. Therefore, the first hypothesis of this study was as follow:

Hypothesis 1 Individuals with better health-related human capital (physical, cognitive, and functional health, and without chronic diseases) are more likely to involve in productive engagement a) over time and b) by including provincial effects over time.



Note: MMSE: Mini-Mental State Examination; IADL: Instrumental Activities of Daily Living. Adapted from the WHO Active Ageing Framework (WHO, 2002) and Productive Engagement Concept (Morrow-Howell & Wang, 2013)

Figure 3.2: Research framework of this study

According to the WHO's Active Ageing Framework, research on behavioural determinants of ill health focus mainly on risk factors; such as smoking, alcohol misuse, and physical inactivity. Smoking and less exercise were generally more likely to be associated with less participation in productive engagement (Goren et al., 2015; Peel et al., 2005; World Health Organization (WHO), 2002). However, there are still inconsistency in productive engagement literature on drinking (van den Brandt & Brandts, 2020; Wood et al., 2018). Hence, this study also investigated the effects of behavioural determinants; such as smoking, drinking, and exercise; on productive engagement by including provincial effects over time. Therefore, the second hypothesis of this study was as follow:

Hypothesis 2 Individuals with smoking, drinking, or exercising behaviour are associated with the participation in productive engagement a) over time and b) by including provincial effects over time.

The literature suggests that social factors; such as social activities, marital status, and living arrangements; may impact the likelihood of older adults continuing to engage in productive activities (Henry et al., 2018; S. Kim, 2020; Morrow-Howell & Greenfield, 2016; Tong et al., 2019; Visaria & Dommaraju, 2019). Multiple studies on social participation found positive correlation with paid productive engagement (S. Kim, 2020; Morrow-Howell & Greenfield, 2016). However, some older adults received daily care as well as financial and emotional support from their adult children while participating in household chores and grandparenting (Tong et al., 2019). Therefore, this study also examined the various effects of social capital (social activities, marital status, and living arrangement) on productive engagement by including provincial effects over time. The

concept of within- and between- changes was included for social participation. Therefore, the third hypothesis of this study was as follow:

Hypothesis 3 Various social capitals (social activities, marital status, and living arrangement) are associated with the participation in productive engagement a) over time and b) by including provincial effects over time.

The "affluence or leisure preference" hypothesis posits that older adults mainly work for economic reasons (Bass & Caro, 2001). Thus, the financial sufficiency of older adults may affect productive engagement in old age (Hu & Das, 2019; J. Kim et al., 2018). As such, this study also investigated the effects of financial sufficiency on productive engagement by including provincial effects over time. Therefore, the fourth hypothesis of this study were as follow:

Hypothesis 4 Financial Sufficiency is associated with participation in productive engagement a) over time and b) by including provincial effects over time.

Based on the ecological system theory, urban and rural environments may influence the opportunities for older adults to engage in productive activities (Ko & Yeung, 2018) as urban areas may receive more governmental investment, have better economic prospects, and better infrastructure and services in both the public and private sectors whereas rural areas are less developed and lack basic infrastructure (Ko & Yeung, 2018; Yeatts et al., 2014). As such, this study also investigated the effects of the rural-urban environment on productive engagement by including provincial effects over time. Therefore, the fifth hypothesis of this study were as follow:

Hypothesis 5 The rural-urban environment is associated with participation in productive engagement a) over time and b) by including provincial effects over time.

Age and gender are markers of life course inequality (O'Rand & Henretta, 1999) and relate to the social-location context of the life course perspective (Moen & Flood, 2013). While age has been consistently linked to engagement and withdrawal from the labour force, it is a less salient factor where unpaid productive engagement is concerned (Henry et al., 2018; J. H. Kim, 2019; H. Y. Liu & Lou, 2017; Moen & Flood, 2013; Morrow-Howell et al., 2014; Teerawichitchainan et al., 2019). In terms of traditional gender roles, men are expected to engage in paid work while women are expected to maintain the household by performing housework and caring for the family (Geist & Tabler, 2018; J. H. Kim, 2019; Penning & Wu, 2016).

The literature also suggests that human capital; such as pre-retirement occupation and education background; may impact the likelihood of older adults continuing to engage in a range of productive activities. However, the effects of pre-retirement occupation and educational background on productive engagement among older adults are inconsistent, especially in Asia (Henry et al., 2018; Kendig et al., 2007; S. Kim, 2020; Kjellsson, 2013). While some studies found that older adults with higher levels of education were more likely to engage in productive activities, such as paid jobs (S. Kim, 2020; Ling & Chi, 2008; H. Y. Liu & Lou, 2017; Morrow-Howell et al., 2014), other similar studies had inconsistent findings (Henry et al., 2018; S. Kim, 2020; Ling & Chi, 2008). As such, this study also examined the effects of demographic variables; such as age, gender, pre-retirement occupation, and educational background; on productive engagement by

including provincial effects over time. Therefore, the sixth hypothesis of this study was as follow:

Hypothesis 6 Demographic factors (age, gender, pre-retirement occupation, and education status) are associated with participation in productive engagement a) over time and b) by including provincial effects over time.

Based on the ecological framework, the economic development of the different provinces in China effects the likelihood of participation in productive engagement among older adults (Ko & Yeung, 2019b; H. Li et al., 2013). (Ko & Yeung, 2019b; H. Li et al., 2013). Ko & Yeung (2018) indicate that, on a contextual level, while economic development is a vital factor affecting the participation of older adults in paid work, it does not affect their participation in unpaid productive engagement; such as grandparenting. As such, this study included the concept of within- and between- changes when examining the GDP per capita of each province. Therefore, the seventh hypothesis of this study was as follow:

Hypothesis 7 Provincial Gross Domestic Product (GDP) per Capita is associated with participation in productive engagement over time.

3.4 Sources of Data

The data that was utilised in this study was obtained from a longitudinal survey of the oldest old population in China; the Chinese Longitudinal Healthy Longevity Survey (CLHLS) which was conducted under the auspices of the National Institute on Aging (NIA), Duke University, and Peking University in 1998, 2000, 2002, 2005, 2008 to 2009, and 2011 to 2012 (Zeng, 2012).

The primary purpose of the CLHLS was to collect data for scientific studies and policy analysis related to healthy ageing in China (Zeng, 2012). The CLHLS was carried out in a randomly selected half of the counties and cities in 22 of China's 31 provinces (Zeng, 2012). The coverage of the surveyed provinces was Heilongjiang, Jilin, Liaoning, Beijing, Tianjin, Hebei, Shanxi, Shanghai, Jiangsu, Zhejiang, Anhui, Jiangxi, Fujian, Shandong, Henan, Hubei, Hunan, Guangdong, Guangxi, Chongqing, Sichuan, and Shaanxi (Figure 3.3). The population in the survey areas covered about 85% of the total population in China in 1998. The initially targeted sample of this study was those aged 80 and above. In wave 2002 onwards, they also included those aged 65 and above. This study interviewed about three nearby older adults aged 65 to 74 of predetermined age and sex in conjunction with every two centenarians in the sampled counties and cities. 'Nearby' refers to older adults who lived in the same village, street, town, county, or city district (Zeng, 2012).

3.4.1 Quality Assessment of CLHLS Data

In China, age reporting is of relatively high quality as the population, particularly the Han people, firmly believe in astrology. This to the extent that the Chinese use their date of birth to determine the dates of momentous life events; such as marriage, moving to a new house etc (Zeng, 2012; Zeng & Gu, 2008). Furthermore, the accuracy of the age reporting of this survey was confirmed by many international and Chinese researchers (Booth & Zhao, 2008; Poston & Luo, 2004; Zeng, 2012; Zeng & Gu, 2008). Participation in the CLHLS was also very high, with only about 2% refusing to be interviewed (Zeng, 2012). This was because the majority of older adults stayed at home, had plenty of leisure time, and liked to communicate with people.

The average percentage of missing values for each respondent in the CLHLS was less than 10%, which is much lower than similar studies (Wallace et al., 1992). Similar to the findings of comparable surveys in Western countries, participants who were female, older, minorities, single, urbanites, and in poor health were more likely to have missing values (Francis & Busch, 1975; D. Gu, 2008; Herzog & Rodgers, 1981). Furthermore, the quality of the data collected by every wave of the CLHLS was evaluated and found to be satisfactory in comparison to other major ageing studies (H. Chen, 2010; Goodkind, 2009; D. Gu & Zeng, 2004; Shen, 2010; Zeng, 2012; Zeng & Gu, 2008). The inconsistent responses and incomplete data rates were low; ranging from 1% to 3% only; while the morbidity data was slightly better than that of the National Health Service Survey (D. Gu, 2008).

3.4.2 Comparison between the Chinese Longitudinal Healthy Longevity Survey (CLHLS) and the China Health and Retirement Longitudinal Study (CHARLS)

The China Health and Retirement Longitudinal Study (CHARLS) is a national survey of residents aged 45 and older (X. Chen et al., 2017; Y. Zhao et al., 2014). The design of the survey was based on the format of the United States' Health and Retirement Study (HRS), Europe's Study of Health, Ageing, and Retirement in Europe (SHARE), and England's English Longitudinal Study of Ageing (ELSA) (X. Chen et al., 2017; Y. Zhao et al., 2014). A biennial survey that covers 28 provinces in China, the first wave of CHARLS was conducted in 2011 and 2012 with a sample size of 18,648, of which 39.8% were above the age of 60 (X. Chen et al., 2017; Y. Zhao et al., 2014). To date, it has completed four waves. Table 3.1 shows a comparison of the CLHLS and the CHARLS.

Table 3:1: Comparison between the CLHLS and the CHARLS

	CLHLS	CHARLS
Sponsoring and supporting organizations	Peking University, Duke University, National Institute on Aging, United Nations Fund for Population Activities (UNFPA), China National Foundation for Social Sciences, China National Natural Science Foundation, Hong Kong Research Grant Council, and Max Planck Institute for Demographic Research.	Peking University, the National Natural Science Foundation of China, the Behavioral and Social Research Division of the National Institute on Aging and the World Bank.
Wave	Wave 1 (1998), Wave 2 (2000), Wave 3(2002), Wave 4 (2005), Wave 5 (2008/9), Wave 6 (2011/12), Wave 7 (2014), Wave 8 (2018)	Wave 1 (2011); Wave 2 (2013), Wave 3 (2015); Wave 4 (2018)
Targeted Respondents	80 years and above and from 2002 wave onwards, the CLHLS extended its sample to include older adults aged 65–79	The residents of China aged 45 and older and their spouses.
Coverage	22 provinces	28 provinces
Sampling	The baseline survey was carried out in 631 randomly selected counties and cities in 22 of China's provinces. In the 1998 baseline survey, the survey attempted to interview all centenarians in the sampled counties and cities. Since the 2002 wave, the survey interviewed approximately three nearby elders aged 65 to 79 of predefined age and sex in conjunction with every two centenarians.	The baseline survey was conducted in 150 counties or urban districts were selected with probability proportional to population size. For each county-level unit, three primary sampling units (villages and urban neighbourhoods) are randomly chosen with probability proportional to population
Data Collection	Face-to-face home-based interviews with a structured questionnaire	Face-to-face computer-assisted personal interview (CAPI)
Productivity Engagement	Working Full-time and Part-time	Working Full-time and Part-time
	Housework	Not direct question on involvement in Housework
	Taking care of young children (Included in housework)	Caring for grandchildren, parents/parents-in-law, and Spouse
	Personal outdoor activities (grow vegetables & do other fieldwork), garden work, and raise domestic animals	Formal Volunteering and Informal Helping

Source: (X. Chen et al., 2017; Zeng, 2008, 2012; Y. Zhao et al., 2014)

The CLHLS and the CHARLS are both national surveys of older adults conducted by Peking University with the sponsorship and support of other Chinese and international institutions; such as the National Institute on Aging. While the CLHLS compares centenarians, nonagenarians, and octogenarians with a comparative group of younger older adults, the CHARLS targets persons who are 45 or older and their spouses. Therefore, data from both surveys are good sources with which to study the productive engagement of older adults aged 65 to 74 years old.

When measuring unpaid productive engagement, the CHARLS includes various types of caregiving activities, formal volunteering, and informal helping. However, it does not directly measure the involvement of older adults in housework. The CLHLS measures unpaid productive engagement by listing productive activities common to Asian countries; such as housework, grandparenting (embedded in housework), personal outdoor activities (such as growing vegetables or performing other fieldwork), gardening, and rearing domestic animals.

As China was an emerging ageing country in 2000, there is a need to study productive engagement in its early stages. However, only the CLHLS has data dating back to 2002 while the first wave of the CHARLS was only conducted in 2011. As such, the data from the CLHLS was chosen for this study. Moreover, as the CLHLS consists of unpaid productive engagements that better reflect the socio-cultural practices prevalent in East Asia and other developing countries, it will provide more comprehensive insight into unpaid productive engagement among older adults.

3.5 Targeted Sample and Sample Size

The targeted respondents in this study were those aged 65 to 74 years old in wave 2002, and the data were collected from 22 provinces in mainland China (refer to Figure 3.3). Data on the same respondents were traced and collected from the CLHLS survey conducted in 2005, 2008/09, and 2011/12 to form the longitudinal database used in this study. Data from the 1998 and 2000 waves was excluded because it was collected only from those aged 80 and above. Although 3,222 respondents were found to be eligible for this study, 14 respondents were excluded from participation as they were unable to answers key determinants; such as years of schooling, self-rated health, drinking, financial sufficiency. As such, the sample size of this study was 3,208. This study defined productive engagement as paid (full-time and part-time) and unpaid activities that produce goods and services.

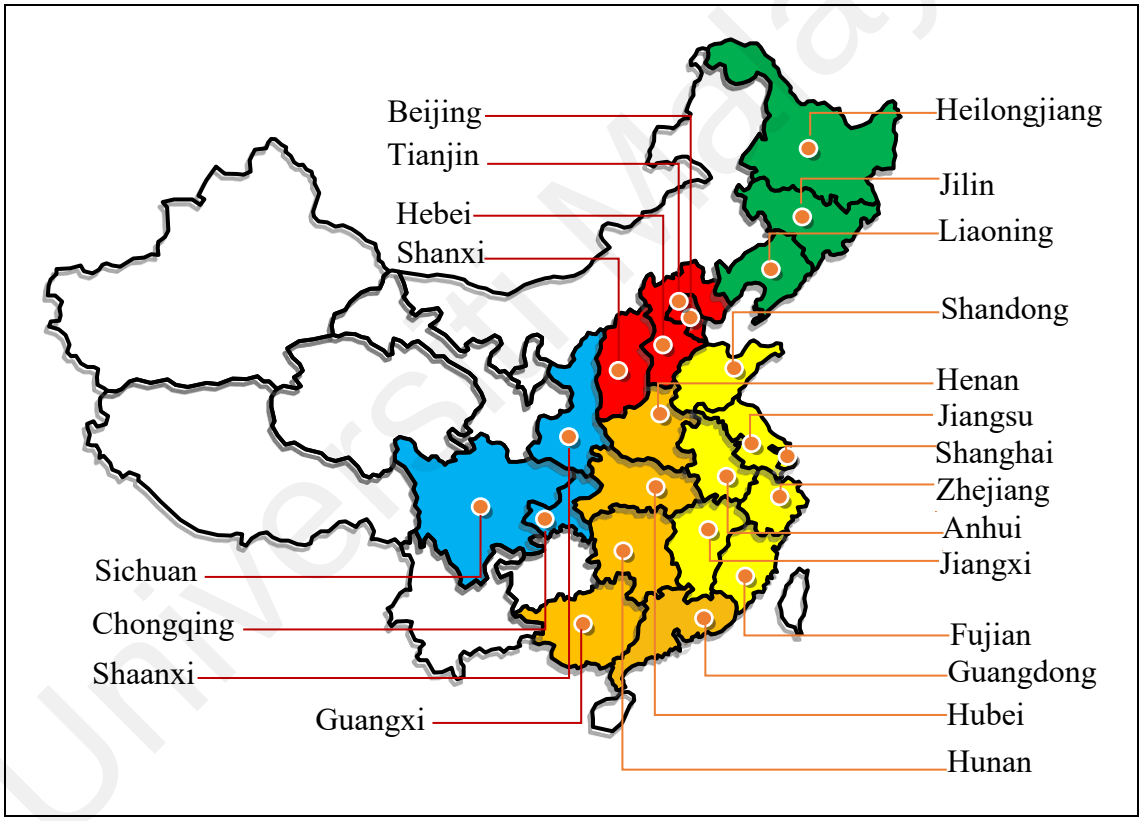
The main study variables are older adults' engagement in paid jobs and unpaid work. The latter includes housework, care-taking, poultry farming, and planting vegetables that have an economic value. In the United States alone, it is estimated that older adults provide USD500 billion in caregiving (The Gerontological Society of America, 2018). In their analysis of Organisation for Economic Co-operation and Development (OECD) countries and China, Ahmad and Koh (2011) estimated that the value of unaccounted household jobs; such as housework; accounted for 17%, 30%, and 31% of the GDPs of China, Japan, and the United States in 2008, respectively. Therefore, the criteria that were used to categorise the participation of older adults in productive engagements was as follows:

a. The older adults who participated in paid jobs, either full-time and part-time.
b. The older adults who participated almost daily in one of the activities such as housework (including taking care of young children), personal outdoor activities

(grow vegetables & do other fieldwork), garden work, and raise domestic animals were considered to be involved in the unpaid productive engagement.

c. The old adults who did not involve in paid jobs and not actively involved in the unpaid productive engagement were considered as the less active group.

Kreft and de Leeuw (1998) suggest that, at the highest level, at least 20 units are required to detect cross-level interactions. This study meets the minimum criteria set forth by Kreft & Leeuw (1998) as it examined data from 22 groups (provinces).



Note: Adapted from "Map of China labelled with major provinces," by your free templates, 2019 (https://yourfreetemplates.com/china-map-download/). Copyright by yourfreetemplates.com.

Figure 3.3: The Provinces Surveyed in the CLHLS

3.6 Sample Attrition

Missing data presents a problem in longitudinal studies (Enders, 2010; D. Feng et al., 2012; Menard, 2002) as respondents may not always be available for a scheduled observation or interview or they may drop out before the study is completed. Eysenbach (2005) comments that as attrition is a fact of life, its data may provide insights into real-life adoption problems. Nevertheless, if longitudinal data is incomplete, it has implications during analysis and statistical methods (Enders, 2010; D. Feng et al., 2012; Menard, 2002). Furthermore, missing information may cause bias in the estimates of the regression parameters over time. While some types of missing data do not affect the analysis, others can potentially result in bias in the regression parameter estimates.

Enders (2010) classifies missing data mechanisms into three types: missing completely at random (MCAR), missing at random (MAR), and not missing at random (NMAR). In MCAR, responses that are missing in longitudinal data are unrelated or random to either the specific values (the missing responses) or the set of observed responses (Enders, 2010). As a vital feature of MCAR is that the observed data can be considered a random sample of the complete data, therefore, even when data is MCAR, an analysis can still provide valid inferences. Additionally, data is considered MAR when the missing data relies on the set of observed responses but is unrelated to the missing responses. As such, if similar values stratify subjects for the observed responses, the missing data is simply the result of a chance mechanism. Not missing at random (NMAR) or "non-ignorable missingness" arises when missing responses link to specific values. When longitudinal data is NMAR, almost all standard longitudinal analysis methods are rendered invalid and yield biased estimates. Therefore, when missing data is assumed to be NMAR, it is essential to carefully assess the sensitivity of the inferences to various plausible assumptions concerning the missing data process. Additionally, a good MAR model is

better than a wrong NMAR model (Schafer, 2003) as a severe violation of MAR is relatively rare (Graham et al., 1997; Schafer & Graham, 2002) and making it one of the best options at present (Enders, 2010).

The CLHLS bears a similar percentage of data attrition with studies that have been conducted in Western countries. For instance, in their longitudinal study of adolescent drug use, Newcomb & Bentler (1988) had a 55% attrition rate over an 8-year interval. Clarridge et al. (1978) had an attrition rate of 11% in a follow-up study of high school seniors in the state of Wisconsin 17 years later. However, the Panel Study of Income Dynamics (PSID) and the Survey of Income and Program Participation reported retention rates (for those who responded in the first period of data collection) of 65% to 80% (C. Brown et al., 1996; Hill, 1992; Kalton et al., 1989). As the sample attrition in the CLHLS data was associated with gender, age, ethnicity, urban or rural residence, and health status (D. Gu, 2008), MAR may be plausible (Enders, 2010). Zeng (2012) reported that increasing migration and rapid economic growth were the two main reasons of the lost-to-follow-up rate, especially in the 2008 wave. Besides, it is unlikely that sample attrition in the data will significantly affect the results (D. Gu, 2008).

3.7 Measurement

3.7.1 Time-Invariant and Time-Varying Variables

Longitudinal studies, generally, include two main types of variables: time-invariant and time-varying. In multilevel models for longitudinal data, time invariant variables; also known as person-level variables or level-2 variables; occasions or waves (at level 1) are nested within persons (at level 2) then persons are nested within contextual variables (at level 3). As the values collected from time-invariant variables will not change throughout

the duration of a study, they are measured only once as these variables do not vary within a person and have no possible within-person effect.

In multilevel models for longitudinal data, time-varying variables; also known as longitudinal predictors or as level-1 variables; occasions or waves (at level 1) are nested within older adults (at level 2) then older adults are nested within contextual variables of provinces (at level 3). As the values collected from time-varying variables will change over time, they are usually measured at the same time as outcome variables. Although time-varying variables and outcome variables do not necessarily need to be collected simultaneously, they should be sampled within the same time frame (Hoffman, 2015).

3.7.2 Outcome Variable: Productive Engagement

The question "If you have retired, are you still engaged in a paid job now?" was used to measure whether an older adult was still engaged in a paid job. Those receiving a pension or still deriving an income from work were asked: i) "What are your primary means of financial support?" and ii) "What are your other means of financial support?" (Table 3.2). Older adults who participated daily in any of the following activities: housework (including taking care of young children), personal outdoor activities (growing vegetables and performing fieldwork), garden work, and raise domestic animals - were considered to be involved in unpaid productive engagement. Based on the above measurements, older adults who both had a paid job and participated in unpaid productive engagements were categorised as Group One (paid productive engagement) while those who did not have a paid job but participated only in unpaid productive engagement were categorised as Group 2 (unpaid productive engagement). Finally, older adults who did not have paid jobs and did not actively participate in at least one unpaid productive engagement were classified as the less active group.

3.7.3 Determinants of Productive Engagement

Health and personal determinants included self-rated health (to represent physical health), chronic diseases (to represent multimorbidity), cognitive status (to represent cognitive health) as well as activities of daily living (ADL) and instrumental activities of daily living (IADL) (to represent functional health) (Table 3.3). In order to measure self-rated health, respondents were asked, "How do you rate your health at present?" and provided the following options: very good, good, so-so, bad, and very bad. The codes were then reversed to form a revised value. In order to measure chronic diseases, respondents were provided with the following list of diseases: hypertension, diabetes, heart disease, cerebrovascular disease, stroke, bronchitis, pulmonary emphysema, asthma, pneumonia, pulmonary tuberculosis, cataract, glaucoma, cancer, prostate tumour, gastric or duodenal ulcer, bedsores, arthritis, Parkinson's disease, dementia, and others. They were then split into three classifications: having two or more chronic illnesses, having one chronic illness, or well i.e., no chronic illness that cause disability in daily life.

Cognitive health was assessed using the Chinese version of the Mini-Mental State Examination (MMSE) which comprises of 23 questions across five categories: orientation, registration, attention and calculation, recall, and language (Zeng & Vaupel, 2002). The answers were scored 0 = wrong and 1 = correct. An MMSE or cognitive index was then constructed by summing the scores of all 23 questions, ranging from 0 to 23.

The measurement of functional health or ADL indicates an individual's functional capacity in terms of eating, dressing, getting in and out of a bed or chair, using the toilet, bathing, and continence (Katz et al., 1983; Zeng et al., 2002). Respondents were classified "active" if none of the six ADLs was impaired or as "with mild or severe disability" otherwise. The instrumental activities of daily living (IADL) were also employed to evaluate functional health and capabilities. The IADL consists of eight items include

visiting neighbours, shopping, preparing meals, doing laundry, walking one kilometre, carrying 5 kg weight, crouching and standing three times, and taking public transportation. Respondents were classified "independent" if they had no functional limitations in all the 8 IADL items and otherwise as "dependent".

Table 3.2: Description of Productive Engagement Measurements

Outcomes (Time-Invariant or Time-Varying Variable)	Measure (For the details of the questionnaires' linkages, please refer to the footnote below)3
Productive Engagement (Time-Varying Variable)	1. Less Active Group 2. Unpaid Productive Engagement 3. Paid Job and Other Productive Engagement For the paid job, the older adults were still engaging in paid jobs or were still receiving income from their work (full-time and part-time). - "if you have retired, are you still engaged in paid jobs now?" - for those who have received pension) - Yes - "What is your primary means of financial support?" and "what are your other means of financial support?" The elderly participating in one activity – housework (including taking care of young children), personal outdoor activities, garden work, and raise domestic animals - are considered to be involved in other productive engagement. The elderly who did not involve in paid jobs and not actively involved in at least one of the activities (housework, personal outdoor activities, garden work, and raise domestic animals) are considered as a less active group.

[3] Questionnaire for the 2002 wave - https://sites.duke.edu/centerforaging/files/2015/12/2002_survivor_questionnaire_in_english_final.pdf
Questionnaire for the 2005 wave - https://sites.duke.edu/centerforaging/files/2015/12/2005_survivor_questionnaire_in_english_final.pdf
Questionnaire for the 2008 wave https://sites.duke.edu/centerforaging/files/2015/12/2008_survivor_questionnaire_in_english_final.pdf
Questionnaire for the 2011-12 wave https://sites.duke.edu/centerforaging/files/2016/12/Survivor-CLHLS-2011_questionnaire.pdf

Table 3.3: Description of Health and Personal Determinants Measurements

Determinants (Time-Invariant or Time-Varying Variable)	Measure
Self-rated Health (Time-Varying Variable)	1.Bad 2. Very bad 3. So So 4. Good 5. Very good
Chronic Diseases (Time-Varying Variable)	1.Two or more illness 2.One illness 3.Well
Cognitive Health - Mini-Mental State Examination (Time-Varying Variable)	Summed score based on 23 dichotomous items (1= yes; 0 = no). These 23 items Chinese version of the Mini-Mental State Examination evaluated "the facets orientation, registration, attention and calculation, recall, and language and movement". The sum of the 23 scores (from 0 to 23) was adopted for the analysis.
Functional Health - Activities of Daily Living (ADL) (Time-Varying Variable)	Respondents were asked whether they have difficulties in "(1) bathing, (2) dressing, (3) toilet, (4) transfer, (5) continence, and (6) feeding". The classification of an individual as "active" if he or she needs no assistance in any ADL; as "mildly disabled" and as "severely disabled" if he or she needs assistance in one or two ADLs, and at least three of these ADLs, respectively. 0. Severely or Mildly disabled 1. Active
Functional Health - Instrumental Activities of Daily Living (IADL) (Time-Varying Variable)	The elderly are perceived to be independent if they have no functional limitation in all the 8 IADL items and as dependent otherwise. 0. Dependent 1. Independent The original items are as follow: a. "Can you visit your neighbours by yourself?" b. "Can you go shopping by yourself?" c. "Can you cook a meal by yourself whenever necessary?" d. "Can you wash clothing by yourself whenever necessary?" e. "Can you walk continuously for 1 kilometre at a time by yourself?" f. "Can you lift a weight of 5kg, such as a heavy bag of groceries?" g. "Can you continuously crouch and stand up three times?" h. "Can you take public transportation by yourself?"

Behavioural determinants included smoking, drinking, and physical exercise (Table 3.4). All the behavioural determinants coded as dichotomous. For example, respondents who currently smoke or previously smoked, currently drink or previously drank, and currently exercise were coded as "1" or otherwise "0".

Social factors included participation in social activities (to represent social participation), living arrangements, and marital status (Table 3.4). Social activities with others included playing cards or mah-jong and attending organised activities. Each activity was indexed at three levels: 0 = never, 1 = sometimes, 2 = almost every day. The sum of the two scores (from 0 to 4) was used in the analysis. Living arrangements were similarly coded into three categories: 1 = living alone or in a nursing home, 2 = living with spouse only, and 3 = living with other household members. As only seven respondents lived in a nursing home, they put into the "living alone" category. Marital status was a dummy variable with 0 = not married and others and 1 = married.

The economic factor was represented by perception towards financial sufficiency. Financial sufficiency was a dummy variable and measured with the question, "Does all of your financial support sufficiently pay your daily cost of living?" with 0 = No and 1 = Yes. The physical environment determinant represented an urban-rural residence. The rural or urban environment was measured by 1 = city, 2 = town, and 3 = rural.

Gender was also a dummy variable with 0 = male and 1 = female. Age was set at wave 2002 and measured as actual age in years. Pre-retirement occupation was categorised as: 1 = professional or governmental, 2 = worker or farmer, and 3 = housework and others. Educational background was measured as 0 = no schooling and 1 = more than 1 year of schooling (Table 3.5).

Table 3.4: Description of Behavioural, Social, Economic, and Physical Environment Determinants Measurements

Determinants (Time-Invariant or Time-Varying Variable)	Measure
Smoking (Time-Varying Variable)	0.No 1.Yes
Drinking (Time-Varying Variable)	0.No 1.Yes
Physical Exercise (Time-Varying Variable)	0.No 1.Yes
Social Activities (Time-Varying Variable)	Summed scores from two items. Social activities with others include "playing cards/mah-jong and attending activities (organised)". Each activity was indexed at three levels: 0 = "never"; 1 = "sometimes"; 2 = "almost every day". The sum of the two scores (from 0 to 4) adopted for the analysis.
Living Arrangement (Time-Varying Variable)	0.Living alone 1.Living with spouse only 2.Living with family members
Marital Status (Time-Varying Variable)	0. Never married and others 1. Married and living with a spouse
Financial Sufficiency (Time-Varying Variable)	0.No 1.Yes
Rural-urban environment (Time-Varying Variable)	1. City 2. Town 3. Rural

The contextual variable was a categorical variable that included the following 22 provinces in China: Heilongjiang, Jilin, Liaoning, Beijing, Tianjin, Hebei, Shanxi, Shanghai, Jiangsu, Zhejiang, Anhui, Jiangxi, Fujian, Shandong, Henan, Hubei, Hunan, Guangdong, Guangxi, Chongqing, Sichuan, and Shaanxi. The GDP per capita of each

province was taken to reflect the material wealth of its population (Bérenger & Verdier-Chouchane, 2007; Dingemans & Henkens, 2019).

Table 3.5: Description of Demographic and Contextual Variables Measurements

Determinants (Time-Invariant or Time-Varying Variable)	Measure
Gender (Time-Invariant Variable)	0. Men, 1. Women
Age (Time-Invariant Variable)	65 – 74 Years Old Actual age
Pre-retirement Occupation (Time-Invariant Variable)	1. Professional or governmental 2. Worker or farmer 3. Housework or others
Education (Years of Schooling) (Time-Invariant Variable)	0. No schooling 1. One year and above schooling
Province (Time-Invariant Variable)	1. Beijing 2. Tianjin 3. Hebei 4. Shanxi 5. Liaoning 6. Jilin 7. Heilongjiang 8. Shanghai 9. Jiangsu 10. Zhejiang 11. Anhui 12. Fujian 13. Jiangxi 14. Shandong 15. Henan 16. Hubei 17. Henan 18. Guangdong 19. Guangxi 20. Chongqing 21. Sichuan 22. Shaanxi
Provincial GDP Per Capita (Time-Varying Variable)	Actual Gross Domestic Product (GDP) per Capita at the provincial level

3.8 Statistical Analyses

This study employed descriptive analysis, bivariate analysis, and multivariate analysis. In the descriptive analysis, the means, standard deviations, and percentages of the dependent variables, determinants, demographics, and contextual factors were calculated at baseline and over time. A bivariate analysis was carried out to examine the correlation between productive engagement and determinants over time while a multivariate analysis was performed using multilevel modelling or mixed-effects models, namely, random-intercept multilevel multinomial logit models for longitudinal data to assess the effect that the determinants as well as demographic and contextual variables had on the productive engagement among older adults.

The results were presented in an odds ratio (or exponentiated coefficient) with a 95% confidence interval. The results of the descriptive, bivariate, and multivariate analyses were calculated using SPSS® Statistics version 25.0. The software's generalised linear mixed model (GLMM) was used to estimate the random-intercept multilevel multinomial logit models for longitudinal multilevel data while the Satterthwaite correction was used to calculate the standard errors to address the small number of groups (provinces). This approach provides more conservative estimates of standard errors (Heck et al., 2012; W. Y. Loh, 1987).

3.9 Multilevel Modelling and Generalised Linear Mixed Models (GLMMs)

The term 'multilevel' refers to a hierarchical or nested data structure, usually subjects within organisational groups or respondents within clusters. However, the nesting may also consist of repeated measures within-subjects (Hox, 2010). Multilevel modelling enables the analysis of the different aggregation levels present in the data (determinants and provincial variables), the examination of the random coefficients (subject- or unit-

specific) model, and the explanation of multilevel problems with multilevel theories. However, this area seems underdeveloped (Hox, 2010). The use of multilevel modelling provides models for data collected in longitudinal studies (Laird & Fitzmaurice, 2013). For example, repeated measurement occasions or waves (level 1 units) nested within individuals or older persons (level 2 units), and individuals clustered within the province (level 3 units).

Multilevel models provide several advantages when used to analyse repeatedly measured data. It not only avoids ecological fallacy, obviates the loss of information if the data is aggregated, and avoids more than usual significance tests (reject the null hypothesis) if the data is disaggregated (Hox, 2010) but provides varying growth curves for each subject due to modelling varying regression coefficients at the measurement occasion level (Raudenbush & Bryk, 1992; Willett, 1998). It also allows for analysis of several repeated measures and different spacing across subjects and model covariances between the repeated measures (Raudenbush & Bryk, 1992). Furthermore, it is simple to include in higher contextual levels. Lastly, it is straightforward enough to include time-invariant and time-varying variables (Hox, 2010).

3.9.1 Mixed-Effects Models and Random-Intercept Multilevel Multinomial Logit Models for Longitudinal Data

When modelling longitudinal data, researchers often encounter response outcomes characterised by three or more ordinal or nominal categories. GLMMs or mixed-effects models are the most frequently used mixed-effects model for discrete outcomes (Verbeke & Molenberghs, 2013) and to account for the potential lack of independence that exists in longitudinally clustered data (Hedeker & Gibbons, 2006). Extending GLMMs to longitudinal data enables a subset of the regression coefficients to vary randomly from

one individual to another. In GLMMs, the mean response model is conditional upon both measured covariates (X_i) and unobserved random effects (μ_i) as it is the inclusion of the latter that causes marginal correlation among the repeated responses in non-linear link functions (Laird & Fitzmaurice, 2013) while the insertion of random effects affects the interpretation of fixed-effect regression parameters (Laird & Fitzmaurice, 2013). As such, the nature of the multilevel data and nominal coding for productive engagements as the dependent variable required the use of mixed-effects models or random-intercept multilevel multinomial logit models for longitudinal data.

3.9.2 Multilevel Models with Missing Data

Estimating longitudinal models requires a stacked or long data format in which a case (or row) holds the data of one occasion for an individual. A stacked data format is advantageous because, even if a respondent misses some occasions, the case for his or her other occasions could still be included in the model. Multilevel models use likelihood-based estimations that do not necessarily require listwise deletion. Unlike its alternatives, this feature of multilevel models provides a significant advantage based on the least squares estimation that requires listwise deletion. For instance, when faced with a respondent with missing time-varying predictors on some occasions, the respondent's complete cases for other occasions can still be included. However, deleting missing cases from any time-varying predictors or outcomes still creates a problem, namely, potentially biased model results. This will result in biased effects if the data is not missing at random (MAR) (Enders, 2010). As an assumption of MAR is not testable, including the respondent's other complete occasions as well as any predictors related to the missing data should make the results of the MAR assumption more plausible (Enders, 2010). As such, mixed-effects models have more advantages than traditional repeated measure analyses as this technique uses all available data with the condition that the data is missing

at random (Garcia & Marder, 2017; Little & Rubin, 2019). Twisk et al. (2013) state that it may not be necessary to employ multiple imputations to handle missing values when using a mixed-model analysis on longitudinal data. Gueorguieva & Krystal (2004) hold that mixed-effects models are the preferred choice for repeated-measure data analysis. This is because these models use all available data and adequately account for correlation between repeated measurements on the same subject, have greater flexibility, and can handle missing data more appropriately.

Garcia & Marder (2017) also prefer mixed-effects as their flexible methods can accommodate the challenges of longitudinal data; such as missing data, irregularly spaced visits, complex correlation structures, and mixtures of time-varying and time-invariant covariate effects.

3.9.3 Person-Mean Centring and Grand-Mean Centring

The scale of all model predictors should have a meaningful zero (0) in order for the model intercept to be meaningful and interpretable (Bell et al., 2018; Heck et al., 2012; Hoffman, 2015). Besides, the multilevel model treats the intercept as an outcome and centring make this possible (Heck et al., 2012). If the original scale of the predictors does not include 0, then a constant should be subtracted or added so that 0 is meaningful. This procedure is known as centring (Heck et al., 2012; Hoffman, 2015). Although the predictor's sample mean is most often used as its centring constant, a useful alternative is to choose a centring point with meaningful value within the original scale of the predictor (Hoffman, 2015). In some situations, mean centring may alleviate the multicollinearity problem (Iacobucci et al., 2016; Olvera Astivia & Kroc, 2019).

There are two techniques for centring: grand-mean centring and person-mean centring (Bell et al., 2018; Brincks et al., 2017; Hamaker & Grasman, 2015; Hoffman, 2015). In grand-mean centring, the time-varying predictor is centred at a constant or simply rescaled so that 0 is a meaningful value. However, it tends to smush the between-person and within-person effects of a predictor together, known as a convergence effect or a conflated effect (Hoffman, 2015).

Longitudinal variables, especially time-varying predictors, contain both within-person and between-person information and variations (time-to-time variation at level 1 and person-to-person variation at level 2) (Curran & Bauer, 2011; Hoffman, 2015; Hoffman & Stawski, 2009; Wang & Maxwell, 2015). Each source of variation can have a different effect on the outcome, a within-person, and a between-person effect. Under person-mean-centring, time-varying predictors centred at a variable or have centred the variable on each higher-level group's mean. Hoffman and Stawski (2009) have listed two reasons that between-person and within-person effects of time-varying predictors might vary. The first reason is due to the theoretical construct assessed by the predictor at each level of analysis. The second reason is that there are unstandardised coefficients on different scales. Wang and Maxwell (2015) suggest centring is needed, and recommend the person-mean centring approach when disaggregating between-person and within-person on the time-varying predictor.

In this study, grand-mean centring and person-mean centring were techniques applied in multilevel analysis to facilitate regression coefficient interpretation (Bickel, 2007; Heck et al., 2012; Hoffman, 2015; Hox, 2010; Kenny et al., 1998). In general, it is less useful for categorical predictors that already have a natural 0 point and a limited range of possible values, and not all effects of categorical time-varying predictors can be specified

(Hoffman, 2015). Besides, another potential complication is that time-varying predictors with three or more categories will require two or more dummy codes to represent their within-person effects in the level-1 model. Thus, grand-mean centring and person-mean-centring apply to all the continuous variables such as self-rated health, MMSE, engagement in social activities, and the GDP per capita of each province.

3.9.4 Data Preparation for Multivariate Analysis

Some of the explanatory variables; such as ADL and obtaining adequate medical services; were excluded from the multivariate statistical analysis due to lack of variability as a high proportion of the respondents reported that they were active in ADL and had access to adequate medical services. Some of the subgroups were combined for further analysis. For instance, in the living arrangements determinant, "living with spouse only" was combined with "living with other household members" to avoid multicollinearity in the marital status determinant as married persons lived with their spouses. In the physical environment determinant, "town" and "city" were combined based on the definition of an area with an average population density of 1,500/sq. km and adjacent to where the local government is located (K. W. Chan & Hu, 2003). As the contextual variable was a categorical variable that included 22 provinces in China, four provinces were combined with other nearby provinces to ensure enough cases for multivariate analysis. For example, the first wave of Hebei and Jiangxi lacked the Less Active group, the fourth wave of Tianjin lacked the Less Active group, and the fourth wave of Hebei and Heilongjiang lacked Group One (paid productive engagement). Thus, the final sample of 18 provinces were 1) Beijing + Tianjin, 2) Hebei + Henan, 3) Shanxi, 4) Liaoning, 5) Jilin + Heilongjiang, 6) Shanghai, 7) Jiangsu, 8) Zhejiang, 9) Fujian, 10) Anhui + Jiangxi, 11) Shandong, 12) Hubei, 13) Hunan, 14) Guangdong, 15) Guangxi, 16) Chongqing, 17) Sichuan, and 18) Shaanxi.

Table 3.6: Person-Mean and Grand Mean Centring of the Quantitative Time-Varying Variables

Variables	Person-Mean and Grand Mean Centring (Two-Level)	Person-Mean and Grand Mean Centring (Three-Level)
Self-Rated Health (SRH)	Overall mean = 3.44	-
Between-Person Self-Rated Health (BPSRH)	$BPSRH_i = \overline{SRH}_i - 3.0$	$BPSRH_{ij} = \overline{SRH}_{ij} - 3.0$
Within-Person Self-Rated Health (WPSRH)	$WPSRH_{ti} = SRH_{ti} - \overline{SRH}_i$	$WPSRH_{tij} = SRH_{tij} - \overline{SRH}_{ij}$
Grand Mean Self-Rated Health (GMSRH)	$GMSRH_{ti} = SRH_{ti} - 3.44$	$GMSRH_{tij} = SRH_{tij} - 3.44$
MMSE	Overall mean = 20.59	-
Between-Person MMSE	$BPMMSE_i = \overline{MMSE}_i - 20.0$	$BPMMSE_{ij} = \overline{MMSE}_{ij} - 20.0$
Within-Person MMSE	$WPMMSE_{ti} = MMSE_{ti} - \overline{MMSE}_i$	$WPMMSE_{tij} = MMSE_{tij} - \overline{MMSE}_{ij}$
Grand Mean MMSE	$GMMMSE_{ti} = MMSE_{ti} - 20.59$	$GMMMSE_{tij} = MMSE_{tij} - 20.59$
Social Activities	Overall mean = 0.72	-
Between-Person Social Activities	$BPSocialactivities = \overline{SocialActivities}_i - 0.72$	$BPSocialactivities_{ij} = \overline{SocialActivities}_{ij} - 0.72$
Within-Person Social Activities	$WPSocialActivities_{ti} = SocialActivities_{ti} - \overline{SocialActivities}_i$	$WPSocialActivities_{tij} = SocialActivities_{tij} - \overline{SocialActivities}_{ij}$
Grand Mean Social Activities	$GMSocialActivities_{ti} = SocialActivities_{ti} - 0.72$	$GMSocialActivities_{tij} = SocialActivities_{tij} - 0.72$
Provincial LNGDP per Capita (PGDP)[#]	-	Overall Mean = 9.91
Within Provincial LNGDP per Capita (WPPGDP)	-	$WPLNPGDP_{tij} = LNPGDP_{tij} - \overline{LNPGDP}_j$
Between Provincial LNGDP per Capita	-	$BPLNPGDP_{tij} = \overline{LNPGDP}_j - 9.91$
Grand Mean Provincial LNGDP per Capita	-	$GMLNGDP = LNPGDP_{tij} - 9.91$

[#] The overall mean of the provincial LNGDP per capita was based on the 22 provinces selected in the sample; LNGDP per capita = natural logarithm of provincial GDP per capita.

One way to ensure a meaningful and interpretable intercept or constant is to revise the determinants in a way that makes 0 a meaningful value (Heck et al., 2012). This study "centred" the determinants to 0 or nearly 0 by subtracting the grand mean and group mean

of the relevant determinants (Heck et al., 2012; Hoffman, 2015). Table 3.6 provides the constants chosen for centring the two-level and three-level modelling estimated in Chapter Five and Chapter Six. As seen in Table. 3.6, the new variables with which to measure between-person, within-person, and the grand mean for time-varying quantitative variables were formulated based on the suggestions of Hoffman (2015).

The multicollinearity test was based on the method suggested by Field (2013). The findings indicated that the assumption of no serious multicollinearity was met as none of the variance inflation factors (VIF) exceeded five and none of the tolerance limits were below 0.2 (Appendix A).

3.9.5 Equation of the Random-Intercept Multilevel Multinomial Logit Models for Longitudinal Data

Multivariate analysis was performed using the generalised linear mixed (effects) models (GLMM) or the mixed-effects models with the multinomial logit models. At Level 1, the multinomial logistic regression model was used to predict the odds of an occasion or wave *t* in individual *i* and individual *i* in group *j* being in outcome category c relative to outcome C (reference category) using a set of q predictors. A common and convenient link function for multinomial regression models is the multinomial logit. The residual variance at Level 1 (σ^2_{within}) was scaled to 1.0, so it cannot test for statistical significance (Heck et al., 2012). The general model links the expected values of the outcome to the predicted values of $\eta_{ctij,}$ as shown in equation 3.1.

$$\eta_{tij(c)} = \log\left(\frac{\pi_{ctij}}{\pi_{Ctij}}\right) = \beta_{0ij(c)} + \sum_{q=1}^{Q} \beta_{qij(c)} X_{qij}$$

Equation 3.1

The lowest level, the model formulation, suggests that the underlying continuous variate η_{ctij} is a ratio of two odds (i.e., the probability of each category c versus the selected reference category C) that is explained by a set linear combination of (X) predictors (q=1…Q). At Level 2, the equation is as follows:

$$\beta_{qi(c)} = \gamma_{q0(c)} + \sum_{s=1}^{S_q} \gamma_{qs(c)} W_{sj} + u_{qi(c)}$$

--- Equation 3.2

$$\beta_{qi(c)} = \gamma_{q0(c)} + \sum_{s=1}^{S_q} \gamma_{qs(c)} W_{sj} + v_{qi(c)}$$

--- Equation 3.2

At Level 2, one can model one or more Level-1 intercepts or slopes as a function of a set of Level-2 predictors (W) and corresponding variance term (u_{qi}). For each intercept or slope modelled, there would be C-1 equations. With a nominal outcome, it is suggested to keep random slopes at Level 2 to a minimum (Heck et al., 2012).

For this study, the multilevel modelling was focus on the random-intercept multilevel models. Thus, the random-intercept multilevel multinomial logit models for longitudinal data can be applied to assess the effects of the determinants and contextual variables on productive engagement. The specification of the three-level random-intercept multilevel model is shown in the following equation:

$$\eta_{tij(c)} = \log(\pi_{ctij}/\pi_{Ctij}) = \beta_{oij(c)} + \beta_{1ij(c)} X_{1ij(c)} + \beta_{02j(c)} X_{tij(c)} + \ldots + \beta_{tqj(c)} X_{qij(c)} + v_{00j(c)} + u_{0ij(c)}$$

--- Equation 3.3

The left side of each symbol indicates the likelihood of the nominal outcome of the dependent variables. The right side, X_{1tij} and X_{2ij}, represent the time-varying and time-invariant independent variables of individual characteristics, respectively, and X_{3j} represents the contextual variables at the province level. At Level 1, there is a separate residual variance term because it depends on the mean. The Level-1 variance was set to a scale factor of 1.0. The equation also contains two error terms: v_{00j} is an error term at the province level that measures the deviation of each province, and u_{0ij} measures each individual's deviation. Besides, both error terms are assumed to be independent and normally distributed with zero means and constant variances (Ko & Yeung, 2018).

Intraclass correlation coefficients (ICC, denoted as ρ) describes the proportion of variance that lies between units or contextual variable (i.e.$\sigma^2_{Between}$, or $\sigma^2_{Province}$) relative to the total variance (i.e., $\sigma^2_{within\ 2+\sigma\ Between} + \sigma^2_{Province}$). The residual variance at Level 1 (σ^2_{within}) cannot test for statistical significance, but the scale factor can be used to calculate an ICC (Heck et al., 2012). The variance of a logistic distribution (including multinomial distribution) with a scale of 1.0 is $\frac{\pi^2}{3}$ (Hedeker, 2008; Hox, 2010). The formula for Intraclass correlation coefficients or variance components lie between subjects and between schools is as follows:

ICC for Level 2: $\rho = \frac{\sigma^2_{Between}}{\sigma^2_{within}+\sigma^2_{Between}+\sigma^2_{Province}}$

Equation 3.4

ICC for Level 3: $\rho = \frac{\sigma^2_{Province}}{\sigma^2_{within}+\sigma^2_{Between}+\sigma^2_{Province}}$

Equation 3.5

Six multilevel longitudinal models were performed to examine the effects on productive engagement. Model 1 was the two-level unconditional model. Model 2 and 3 included determinants for the productive engagement, but Model 2 focused on person-mean centred variables, and Model 3 emphasised on grand-mean centred variables. Variables related to contextual variables or provinces were specified in Models 4, 5, and 6. Model 4 was a three-level unconditional model. Model 5 and 6 included determinants for productive engagement and Provincial GDP per capita, but Model 5 focused on person-mean centred variables while Model 6 focused on grand-mean centred variables.

3.9.5.1 Equation for Model 1: Two-Level Unconditional Model

The multilevel longitudinal multinomial logit regression equation based on GLMM for the Model 1 with the two-level unconditional model is as follows:

Level 1 Wave:

$$\eta_{ti(c)} = \beta_{0i(c)}$$

Level 2 Older Person:

Intercept: $\beta_{0i(c)} = \gamma_{00(1)} + u_{0i(c)}$

Composite:

$$\eta_{ti(c)} = \gamma_{00(1)} + u_{0i(c)}$$

--- Equation 3.6

Note: c = 1 (paid job versus less active group) and 2 (unpaid productive engagement versus less active group).

3.9.5.2 Equation for Model 2: Two-Level Random-Intercept Multilevel Multinomial Logit Models Based on Person-Mean Centred

The equation for Model 2 or the two-level random-intercept multilevel multinomial logit models based on person-mean-centred model is as follows:

Level 1 Wave:

$$\eta_{ti(c)} = \beta_{0i} + \beta_{1i}(SRH_{ti} - \overline{SRH}_i) + \beta_{2i}OneChronic_{ti} + \beta_{3i}TwoChronic_{ti} + \beta_{4i}(MMSE_{ti} - \overline{MMSE}_i) + \beta_{5i}IADL_{ti} + \beta_{6i}Smoking_{ti} + \beta_{7i}Drinking_{ti} + \beta_{8i}Exercising_{ti} + \beta_{9i}(SocialActivities_{ti} - \overline{SocialActivities}_i) + \beta_{10i}Marital_{ti} + \beta_{11i}LA + \beta_{12i}Economic_{ti} + \beta_{13i}Rural_{ti}$$

Level 2 Older Person:

Intercept: $\beta_{0i(c)} = \gamma_{00} + \gamma_{01}(\overline{SRH}_i - 3.0) + \gamma_{04}(\overline{MMSE}_i - 20.0) + \gamma_{09}(\overline{SocialActivities}_i - 0.72) + \gamma_{014}Women_i + \gamma_{015}(Age_i - 70) + \gamma_{016}PG_i + \gamma_{017}WF_i + \gamma_{018}Edu_i + u_{0i}$

Within Person SRH: $\beta_{1i} = \gamma_{10}$
Within Person One Chronic Disease: $\beta_{2i} = \gamma_{20}$
Within Person Two Chronic Diseases: $\beta_{3i} = \gamma_{30}$
Within Person MMSE: $\beta_{4i} = \gamma_{40}$
Within person IADL: $\beta_{5i} = \gamma_{50}$
Within Person Smoking: $\beta_{6i} = \gamma_{60}$
Within Person Drinking: $\beta_{7i} = \gamma_{70}$
Within Person Exercising: $\beta_{8i} = \gamma_{80}$
Within Person Engagement in Social Activities: $\beta_{9i} = \gamma_{90}$
Within Person Marital Status: $\beta_{10i} = \gamma_{100}$
Within Person Living Arrangement: $\beta_{11i} = \gamma_{110}$
Within Person Economic: $\beta_{12i} = \gamma_{120}$
Within Person Rural: $\beta_{13i} = \gamma_{130}$

Composite:

$$\eta_{ti(c)} = \gamma_{00} + \gamma_{10}(SRH_{ti} - \overline{SRH}_i) + \gamma_{01}(\overline{SRH}_i - 3.0) + \gamma_{20}OneChronic_{ti} + \gamma_{30}TwoChronic_{ti} + \gamma_{40}(MMSE_{ti} - \overline{MMSE}_i) + \gamma_{04}(\overline{MMSE}_i - 20.0) + \gamma_{50}IADL_{ti} + \gamma_{60}Smoking_{ti} + \gamma_{70}Drinking_{ti} + \gamma_{80}Exercising_{ti} + \gamma_{90}(SocialActivties_{ti} - \overline{SocialActivities}_i) + \gamma_{09}(\overline{SocialActivities}_i - 0.72) + \gamma_{100}Marital_{ti} + \gamma_{110}LA + \gamma_{120}Economic_{ti} + \gamma_{130}Rural_{ti} + \gamma_{014}Women_i + \gamma_{015}(Age_i - 70) + \gamma_{016}PG_i + \gamma_{017}WF_i + \gamma_{018}Edu_i + u_{ti}$$

--- Equation 3.7

Note: c = 1 (paid job versus less active group) and 2 (unpaid productive engagement versus less active group); SRH = self-rated health; OneChronic = One chronic disease; TwoChronic = Two chronic diseases and above; SocialActivities = social activities; Marital = Marital status; LA = Living arrangement; Economic = Financial sufficiency; Rural = city/town; PG = Professional or governmental; WF = Worker or farmer; Edu = Education (Years of Schooling).

3.9.5.3 Equation for Model 3: Two-Level Random-Intercept Multilevel Multinomial Logit Models Based on Grand-Mean Centred

The equation for Model 3 or the two-level random-intercept multilevel multinomial logit model based on grand-mean centred is as follow:

Level 1 Wave:

$$\eta_{ti(c)} = \beta_{0i} + \beta_{1i}(SRH_{ti} - 3.44) + \beta_{2i}OneChronic_{ti} + \beta_{3i}TwoChronic_{ti} + \beta_{4i}(MMSE_{ti} - 20.59) + \beta_{5i}IADL_{ti} + \beta_{6i}Smoking_{ti} + \beta_{7i}Drinking_{ti} + \beta_{8i}Exercising_{ti} + \beta_{9i}(SocialActivities_{ti} - 0.72) + \beta_{10i}Marital_{ti} + \beta_{11i}LA_{ti} + \beta_{12i}Economic_{ti} + \beta_{13i}Rural_{ti}$$

Level 2 Older Person:

Intercept: $\beta_{0i(c)} = \gamma_{00} + \gamma_{014}\,Women_i + \gamma_{015}\,(Age_i - 70) + \gamma_{016}\,PG_i + \gamma_{017}\,WF_i + \gamma_{018}\,Edu_i + u_{0i}$

Time Varying SRH: $\beta_{1i} = \gamma_{10}$
Time Varying One Chronic Disease: $\beta_{2i} = \gamma_{20}$
Time Varying Two Chronic Diseases: $\beta_{3i} = \gamma_{30}$
Time Varying MMSE: $\beta_{4i} = \gamma_{40}$
Time Varying IADL: $\beta_{5i} = \gamma_{50}$
Time Varying Smoking: $\beta_{6i} = \gamma_{60}$
Time Varying Drinking: $\beta_{7i} = \gamma_{70}$
Time Varying Exercising: $\beta_{8i} = \gamma_{80}$
Time Varying Engagement in Social Activities: $\beta_{9i} = \gamma_{90}$
Time Varying Marital Status: $\beta_{10i} = \gamma_{100}$
Time Varying Living Arrangement: $\beta_{11i} = \gamma_{110}$
Time Varying Economic: $\beta_{12i} = \gamma_{120}$
Time-Varying Rural: $\beta_{13i} = \gamma_{130}$

Composite:

$$\eta_{ti(c)} = \gamma_{00} + \gamma_{10}(SRH_{ti} - 3.44) + \gamma_{20}OneChronic_{ti} + \gamma_{30}TwoChronic_{ti} + \gamma_{40}(MMSE_{ti} - 20.59) + \gamma_{50}IADL_{ti} + \gamma_{60}\,Smoking + \gamma_{70}Drinking_{ti} + \gamma_{80}Exercising_{ti} + \gamma_{90}(SocialActivities_{ti} - 0.72) + \gamma_{100}\,Marital + \gamma_{110}\,LA + \gamma_{120}Economic_{ti} + \gamma_{130}Rural_{ti} + \gamma_{014}\,Women_i + \gamma_{015}\,(Age_i - 70) + \gamma_{016}\,PG_i + \gamma_{017}\,WF_i + \gamma_{018}\,Edu_i + u_{ti}$$

--- Equation 3.8

Note: c = 1 (paid job versus less active group) and 2 (unpaid productive engagement versus less active group); SRH = self-rated health; OneChronic = One chronic disease; TwoChronic = Two chronic diseases and above; SocialActivities = social activities; Marital = Marital status; LA = Living arrangement; Economic = Financial sufficiency; Rural = city/town;

PG = Professional or governmental; WF = Worker or farmer; Edu = Education (Years of Schooling).

3.9.5.4 Equation for Model 4: Three-Levels Unconditional Model

The equation for Model 4 or the three-level unconditional model is as follow:

Level 1 Wave:

$$\eta_{tij(c)} = \beta_{ti}$$

Level 2 Older Person:

Intercept:

$$\beta_{0ij(c)} = \delta_{00j} + u_{0ij}$$

Level 3 Province:

Intercept: $\delta_{00j(c)} = \gamma_{000} + v_{00j}$

Composite:

$$\eta_{tij(c)} = \gamma_{000} + v_{00j} + u_{0ij}$$

--- Equation 3.9

3.9.5.5 Equation for Model 5: Three-Level Random-Intercept Multilevel Multinomial Logit Models Based on Person-Mean Centred

The equation for Model 5 or the three-level random-intercept multilevel multinomial logit model based on person-mean centred is as follow:

Level 1 Wave:

$$\begin{aligned}\eta_{tij(c)} = {} & \beta_{0ij} + \beta_{1ij}(\mathrm{SRH}_{tij} - \overline{SRH}_i) + \beta_{2ij}\,\mathrm{OneChronic}_{tij} + \beta_{3ij}\,\mathrm{TwoChronic}_{tij} \\ & + \beta_{4ji}(\mathrm{MMSE}_{tij} - \overline{MMSE}_i) + \beta_{5ij}\,\mathrm{IADL}_{tij} + \beta_{6ij}\,\mathrm{Smoking} \\ & + \beta_{7ij}\,\mathrm{Drinking}_{tij} + \beta_{8ij}\,\mathrm{Exercising} + \beta_{9ij}(\mathrm{SocialActivities}_{ti} - \overline{\mathrm{SocialActivities}}_i) + \beta_{10ij}\mathrm{Marital}_{tij} + \beta_{11ij}\mathrm{LA}_{tij} + \beta_{12ij}\,\mathrm{Economic}_{tij} + \beta_{13ij} \\ & \mathrm{Rural}_{tij} + \beta_{19ij}(\mathrm{LNPGDP}_{tij} - \overline{LNPGDP}_j)\end{aligned}$$

Level 2 Older Person:

Intercept:

$$\begin{aligned}\beta_{0ij(c)} = {} & \delta_{00j} + \delta_{01j}(\overline{SRH}_i - 3.0) + \delta_{04j}(\overline{MMSE}_i - 20.0) \\ & + \delta_{09j}(\overline{\mathrm{Activities}}_i - 0.72) + \delta_{014j}\,\mathrm{Women} + \delta_{015j}(\mathrm{Age}_i - 70) \\ & + \delta_{016j}\,\mathrm{PG} + \delta_{017j}\,\mathrm{WF} + \delta_{018j}\,\mathrm{Edu} + u_{0ij}\end{aligned}$$

SRH: $\beta_{1ij} = \delta_{10j}$
One Chronic Disease: $\beta_{2ij} = \delta_{20j}$
Two Chronic Diseases: $\beta_{3ij} = \delta_{30j}$
MMSE: $\beta_{4ij} = \delta_{40j}$

IADL: $\beta_{5ij} = \delta_{50j}$
Smoking: $\beta_{6ij} = \delta_{60j}$
Drinking: $\beta_{7ij} = \delta_{70j}$
Exercising: $\beta_{8ij} = \delta_{80j}$
Engagement in Social Activities: $\beta_{9ij} = \delta_{90j}$
Marital Status: $\beta_{10ij} = \delta_{100j}$
Living Arrangement: $\beta_{11ij} = \delta_{110j}$
Economic: $\beta_{12ij} = \delta_{120j}$
Rural: $\beta_{13ij} = \delta_{130j}$
Provincial GDP: $\beta_{19ij} = \delta_{190j}$

Level 3 Province:

Intercept: $\delta_{00j(c)} = \gamma_{000} + \gamma_{0019}(\overline{LNPGDP}_j - 9.91) + v_{00j}$

SRH: $\delta_{10j} = \gamma_{100}$
SRH: $\delta_{01j} = \gamma_{010}$
One Chronic Disease: $\delta_{20j} = \gamma_{200}$
Two Chronic Diseases: $\delta_{30j} = \gamma_{300}$
MMSE: $\delta_{40j} = \gamma_{400}$
MMSE: $\delta_{04j} = \gamma_{040}$
IADL: $\delta_{50j} = \gamma_{500}$
Smoking:$\delta_{60j} = \gamma_{600}$
Drinking: $\delta_{70j} = \gamma_{700}$
Exercising: $\delta_{80j} = \gamma_{800}$
Engagement in Social Activities: $\delta_{90j} = \gamma_{900}$
Engagement in Social Activities: $\delta_{09j} = \gamma_{090}$
Marital Status: $\delta_{100j} = \gamma_{1000}$
Living Arrangement: $\delta_{110j} = \gamma_{1100}$
Economic: $\delta_{120j} = \gamma_{1200}$
Rural: $\delta_{130j} = \gamma_{1300}$
Women: $\delta_{014j} = \gamma_{0140}$
Age: $\delta_{015j} = \gamma_{0150}$
Professional or Government: $\delta_{016j} = \gamma_{0160}$
Worker or Farmer: $\delta_{017j} = \gamma_{0170}$
Education: $\delta_{018j} = \gamma_{0180}$
Provincial GDP: $\delta_{190j} = \gamma_{1900}$

Composite:

$$\eta_{tij(c)} = \gamma_{000} + \gamma_{100}(SRH_{tij} - \overline{SRH}_i) + \gamma_{010}(\overline{SRH}_i - 3.0) + \gamma_{200}OneChronic_{tij} + \gamma_{300}TwoChronic_{tij} + \gamma_{400}(MMSE_{ti} - \overline{MMSE}_i) + \gamma_{040}(\overline{MMSE}_i - 20.0) + \gamma_{500}IADL_{tij} + \gamma_{600}Smoking_{tij} + \gamma_{700}Drinking_{tij} + \gamma_{800}Exercising_{tij} + \gamma_{900}(SocialActivities_{ti} - \overline{SocialActivities}_i) + \gamma_{090}(\overline{SocialActivities}_i - 0.72) + \gamma_{1000}Marital_{tij} + \gamma_{1100}LA_{tij} + \gamma_{1200}Economic_{tij} + \gamma_{1300}Rural_{tij} + \gamma_{0140}Women_{ij} + \gamma_{0150}(Age_i - 70) + \gamma_{0160}PG_{ij} + \gamma_{0170}WF_{ij} + \gamma_{0180}Edu_{ij} + \gamma_{1900}(LNPGDP_{tij} - \overline{LNPGDP}_j) + \gamma_{0019}(\overline{LNPGDP}_j - 9.91) + v_{00j} + u_{0ij}$$

--- Equation 3.10

Note: c = 1 (paid job versus less active group) and 2 (unpaid productive engagement versus less active group); SRH = self-rated health; OneChronic = One chronic disease; TwoChronic = Two chronic diseases and above; SocialActivities = social activities; Marital = Marital status; LA = Living arrangement; Economic = Financial sufficiency; Rural = city/town; PG = Professional or governmental; WF = Worker or farmer; Edu = Education (Years of Schooling); LNGDP = natural logarithm of Provincial GDP per capita.

3.9.5.6 Equation for Model 6: Three-Level Random-Intercept Multilevel Multinomial Logit Models Based on Grand-Mean Centred

The equation for Model 6 or the three-level random-intercept multilevel multinomial logit model based on grand-mean centred is as follow:

Level 1 Wave:

$$\begin{aligned}\eta_{tij(c)} = {} & \beta_{0ij} + \beta_{1ij}(SRH_{tij} - 3.44) + \beta_{2ij}\,OneChronic_{tij} + \beta_{3ij}\,TwoChronic_{tij} \\ & + \beta_{4ji}(MMSE_{tij} - 20.59) + \beta_{5ij}\,IADL + \beta_{6ij}Smoking + \beta_{7ij}\,Drinking_{tij} \\ & + \beta_{8ij}Exercising_{tij} + \beta_{9ij}(SocialActivities_{tij} - 0.72) + \beta_{10ij}Marital_{tij} \\ & + \beta_{11ij}LA + \beta_{12ij}\,Economic_{tij} + \beta_{13ij}\,Rural_{tij} \\ & + \beta_{19ij}(LNPGDP_{tij} - 9.91)\end{aligned}$$

Level 2 Older Person:

Intercept: $$\begin{aligned}\beta_{0ij(c)} = {} & \delta_{00j} + \delta_{014j}\,Women + \delta_{015j}(Age_i - 70) \\ & + \delta_{016j}\,PG + \delta_{017j}\,WF + \delta_{018j}\,Edu + u_{0ij}\end{aligned}$$

SRH: $\beta_{1ij} = \delta_{10j}$
One Chronic Disease: $\beta_{2ij} = \delta_{20j}$
Two Chronic Diseases: $\beta_{3ij} = \delta_{30j}$
MMSE: $\beta_{4ij} = \delta_{40j}$
IADL: $\beta_{5ij} = \delta_{50j}$
Smoking: $\beta_{6ij} = \delta_{60j}$
Drinking: $\beta_{7ij} = \delta_{70j}$
Exercising: $\beta_{8ij} = \delta_{80j}$
Engagement in Social Activities: $\beta_{9ij} = \delta_{90j}$
Marital Status: $\beta_{10ij} = \delta_{100j}$
Living Arrangement: $\beta_{11ij} = \delta_{110j}$
Economic: $\beta_{12ij} = \delta_{120j}$
Rural: $\beta_{13ij} = \delta_{130j}$
Provincial GDP: $\beta_{19ij} = \delta_{190j}$

Level 3 Province:

Intercept: $\delta_{00j(c)} = \gamma_{000} + v_{00j}$

SRH: $\delta_{10j} = \gamma_{100}$
One Chronic Disease: $\delta_{20j} = \gamma_{200}$
Two Chronic Diseases: $\delta_{30j} = \gamma_{300}$
MMSE: $\delta_{40j} = \gamma_{400}$
IADL: $\delta_{50j} = \gamma_{500}$
Smoking:$\delta_{60j} = \gamma_{600}$
Drinking: $\delta_{70j} = \gamma_{700}$
Exercising: $\delta_{80j} = \gamma_{800}$
Engagement in Social Activities: $\delta_{90j} = \gamma_{900}$
Marital Status: $\delta_{100j} = \gamma_{1000}$
Living Arrangement: $\delta_{110j} = \gamma_{1100}$
Economic: $\delta_{120j} = \gamma_{1200}$
Rural: $\delta_{130j} = \gamma_{1300}$
Women: $\delta_{014j} = \gamma_{0140}$
Age: $\delta_{015j} = \gamma_{0150}$
Professional or Government: $\delta_{016j} = \gamma_{0160}$
Worker or Farmer: $\delta_{017j} = \gamma_{0170}$
Education: $\delta_{018j} = \gamma_{0180}$
Provincial GDP: $\delta_{190j} = \gamma_{1900}$

Composite:

$$\eta_{tij(c)} = \gamma_{000} + \gamma_{100}(SRH_{tij} - 3.44) + \gamma_{200}OneChronic_{tij} + \gamma_{300}TwoChronic_{tij} + \gamma_{400}(MMSE_{tij} - 20.59) + \gamma_{500}IADL_{tij} + \gamma_{600}Smoking_{tij} + \gamma_{700}Drinking_{tij} + \gamma_{800}Exercising_{tij} + \gamma_{900}(SocialActivities_{tij} - 0.72) + \gamma_{1000}Marital_{tij} + \gamma_{1100}LA + \gamma_{1200}Economic_{tij} + \gamma_{1300}Rural_{tij} + \gamma_{0140}Women_{ij} + \gamma_{0150}(Age_i - 70) + \gamma_{0160}PG_{ij} + \gamma_{0170}WF_{ij} + \gamma_{0180}Edu_{ij} + \gamma_{1900}(LNPGDP_{tij} - 9.91) + v_{00j} + u_{0ij}$$

--- Equation 3.11

Note: c = 1 (paid job versus less active group) and 2 (unpaid productive engagement versus less active group). SRH = self-rated health; OneChronic = One chronic disease; TwoChronic = Two chronic diseases and above; SocialActivities = social activities; Marital = Marital status; LA = Living arrangement; Economic = Financial sufficiency; Rural = city/town; PG = Professional or governmental; WF = Worker or farmer; Edu = Education (Years of Schooling); natural logarithm of Provincial GDP per capita.

3.10 Sample Eligible for Analysis

As this study only targeted those aged 65 to 74 years old in 2002, the final sample size was 3,208 (Table 3.7). Of this number, 2,501 (78%) respondents were re-interviewed in 2005, 241 (8%) died between 2002 and 2005, and 466 (15%) failed to follow-up. In 2008,

1,836 (73%) respondents were re-interviewed, 248 (10%) died between 2005 and 2008, and an additional 417 (17%) failed to follow-up. In 2011, 1,385 (75%) respondents were re-interviewed, 266 (15%) died between 2008 and 2011, and an additional 185 (10%) failed to follow-up. The total sample size in wave 2011 was 1,385.

Table 3.7: Percentage Distribution of Deaths, Failure To Follow-Up, and Survival Status in Waves

	2002		2005		2008		2011	
	%	n	%	n	%	n	%	n
Drop-out (excluding deaths)	-	-	14.5	466	16.7	417	10.1	185
Died between waves	-	-	7.5	241	9.9	248	14.5	266
Surviving at the current survey	100.0	3,208	78.0	2,501	73.4	1,836	75.4	1385
Total	100.0	3,208	100.0	3,208	100.0	2,501	100.0	1,836

CHAPTER 4: BASIC CHARACTERISTICS AND CHANGES OF PRODUCTIVE ENGAGEMENT OVER TIME

4.1 Introduction

This chapter presents the characteristics of respondents and changes in productive engagement over time. The bivariate analysis is carried out to examine the changes in productive engagement over time by the selected variables. The purpose is to address the first objective of this study. The subjects for this analysis include the 3,208 older adults aged between 65 and 74 years in 2002.

4.2 Socio-demographic Characteristics and Descriptive Statistics of Various Determinants and Variables

There was about an equal number of males and females in the sample from wave 2002 to wave 2011. The average age of the respondents was 69.5 years as of 2002 (Table 4.1). Around 46% of the respondents had not attended formal education, and three-quarters (75%) worked as menial workers or farmers, while 15% worked as professional or governmental employees at the age of 60. The finding indicated that more workers and farmers survived up to the 2011 wave.

The respondents in this sample were in reasonably good health. However, the score had declined slightly from 3.50 in 2002 to 3.34 in 2011 (Table 4.2). An increasing number of older adults reported having two or more chronic diseases (29% to 41%) throughout the four waves. More than 90% of older adults had access to medical services. Older adults maintained their cognitive health rather well, having experienced only a slight drop in average MMSE from 21.2 in 2002 to 19.6 in 2011. Activities of daily living (ADL) limitations increased slightly over time. The results indicated that there was no substantial

decrease in functional health as measured by ADLs. In 2002, about 95% of older adults reported being active in ADLs or performing routine daily activities without assistance. The percentage of the active group in ADLs only decreased to 87% in the 2011 wave. These findings showed that older adults in China maintain their functional health as they age. However, the proportion of older people who reported a dependency on Instrumental Activities of Daily Living (IADLs) nearly doubled from 26% in 2002 to 51%. This trend shows that a greater number of older adults were losing some of their skills and abilities to perform daily tasks to live an independent lifestyle. These skills include doing laundry, preparing meals, crouching and standing three times, carrying 5 kg weight, visiting neighbours, walking one kilometre, shopping, and taking public transportation.

Table 4.1: Descriptive Statistics of the Sample by Waves

Variables	**2002 Mean/ %**	**2005 Mean/ %**	**2008 Mean/ %**	**2011 Mean/ %**
Sample Size	3,208	2,501	1,836	1,385
Gender				
Male	49.8	49.1	49.2	50.3
Female	50.2	50.9	50.8	49.7
Age	69.54±2.86	72.48±2.88	75.53±2.90	78.41±2.92
Education				
No schooling	45.5	45.2	46.6	47.4
One-year schooling and above	54.5	54.8	53.4	52.6
Primary Occupation before Age 60				
Professional or governmental	15.3	14.8	13.0	12.1
Worker or farmer	74.5	75.6	78.1	79.1
Housework or others	10.2	9.5	8.9	8.7

About 28% of older adults smoked, and around one quarter consumed alcohol in 2002 (Table 4.2). Nine years later, these percentages fell to 22% and one-fifth, respectively.

More than 40% of older adults did exercise, and about 47% of those who survived until the 2011 wave, still exercising.

Table 4.2: Descriptive Statistics of the Health, Personal, and Behavioural Determinants by Waves

Variables	2002 Mean/ %	2005 Mean/ %	2008 Mean/ %	2011 Mean/ %
Health & Personal Determinants				
Self-rated health (1-5)	3.50±0.91	3.42±0.94	3.42±0.96	3.34±0.98
Chronic diseases				
Well	39.4	36.8	49.7	31.9
One illness	31.6	30.3	17.6	27.1
Two or more illnesses	29.0	32.9	32.7	40.9
Get adequate medical service at present				
No	7.4	10.7	7.2	4.8
Yes	92.6	89.3	92.8	95.2
Cognitive status (0-23)	21.23±2.41	20.64±3.83	20.11±4.35	19.60±4.72
Activities of daily living (ADL)				
Severely/ mildly disabled	5.0	5.7	5.1	12.6
Active	95.0	94.3	94.9	87.4
Instrumental Activities of Daily Living (IADL)				
Dependent living	26.2	36.4	36.9	50.6
Independent living	73.8	63.6	63.1	49.4
Behavioural determinants				
Smoking				
No	72.3	72.7	76.7	77.9
Yes	27.7	27.3	23.3	22.1
Drinking				
No	75.2	74.6	79.4	80.1
Yes	24.8	25.4	20.6	19.9
Physical exercise				
No	58.9	58.9	59.2	53.4
Yes	41.1	41.1	40.8	46.6

Table 4.3: Descriptive Statistics of the Social, Economic, and Physical Environment Determinants by Waves

Variables	2002 Mean/ %	2005 Mean/ %	2008 Mean/ %	2011 Mean/ %
Social determinants				
Participation in social activities (0-4)	0.80±1.80	0.75±1.03	0.63±1.00	0.63±0.99
Marital status				
Single and others	33.0	39.1	44.4	49.5
Currently married	67.0	60.9	55.6	50.5
Living arrangement				
Alone	11.3	12.8	16.4	17.1
With spouse only	35.7	36.9	37.0	29.9
With household members and others	53.0	50.4	46.6	53.0
Economic determinants				
Financial sufficiency				
No	18.0	26.5	22.9	24.1
Yes	82.0	73.5	77.1	75.9
Physical Environment determinants				
Place of Residence				
City	24.7	22.0	18.2	19.9
Town	19.5	20.0	20.8	34.7
Rural	55.8	58.1	61.0	45.4

There was an appreciable drop in their engagement in social activities from 0.80 to 0.63 points (Table 4.3). The percentage of those currently married declined from 67% in 2002 to about 50% in the 2011 wave. Older adults living alone increased from 11% in 2002 to 17% in the 2011 wave. Those who lived with a spouse decreased from 36% to 30% over the same period. A little more than half of the older people were residing with household members and others.

Table 4.4: Descriptive Statistics of the Contextual Variable (Provinces) by Waves

Provinces	2002 %	2005 %	2008 %	2011 %
North China				
Beijing	2.0	1.9	2.0	1.9
Tianjin	1.2	1.0	1.1	0.7
Hebei	1.0	1.1	1.0	0.9
Shanxi	1.2	1.4	1.5	1.4
Northeast China				
Liaoning	4.8	4.4	4.2	4.6
Jilin	3.2	3.1	2.8	2.7
Heilongjiang	2.9	2.8	2.6	2.0
East China				
Shanghai	4.3	4.1	3.4	1.7
Jiangsu	12.9	13.6	11.4	12.1
Zhejiang	9.0	8.4	8.6	9.4
Anhui	4.0	4.5	4.7	4.0
Jiangxi	1.8	2.0	2.1	2.2
Fujian	3.3	2.3	1.6	1.7
Shandong	4.8	4.7	4.8	5.1
South Central				
Henan	3.3	3.7	4.2	4.8
Hubei	3.9	3.1	3.4	2.9
Hunan	4.9	5.0	5.8	5.9
Guangdong	4.5	3.3	2.2	2.4
Guangxi	12.1	14.1	16.8	17.8
Western China				
Chongqing	3.4	3.4	3.9	3.8
Sichuan	9.3	9.9	9.7	9.6
Shaanxi	2.2	2.3	2.1	2.3

More than 80% of the older adults in the 2002 wave reported that they were financially sufficient. However, the percentage of older adults who reported financial insufficiency increased from 18% in wave 2002 to 24% in wave 2011. About 25% and 20% of the older adults resided in a city or town, respectively. The percentage of older people who lived in rural areas decreased from 56% in 2002 to 45% in 2011.

Almost half of the respondents came from five provinces: Jiangsu (13%), Guangxi (12%), Sichuan (9%), Zhejiang (9%), and Hunan (5%) (Table 4.4). Interestingly, the older people

in Guangxi were more likely than those from other provinces to survive the 2011 wave. People living in the east and north regions had the highest GDP per capita, and those living in the western region had the lowest (Table 4.5).

Table 4.5: Provincial GDP Per Capita by Waves

Provinces/ Provincial GDP Per Capital (in CNY)	2002 (CNY)	2005 (CNY)	2008 (CNY)	2011 (CNY)
North China				
Beijing	30,323	45,315	62,761	80,495
Tianjin	21,358	37,446	57,134	83,449
Hebei	8,936	14,614	22,910	33,857
Shanxi	7,058	12,610	21,446	31,276
Northeast China				
Liaoning	12,986	19,065	31,677	50,711
Jilin	8,702	13,329	23,504	38,446
Heilongjiang	9,539	14,434	21,737	32,817
East China				
Shanghai	33,514	48,929	65,716	81,788
Jiangsu	14,322	24,511	39,915	62,173
Zhejiang	16,758	26,884	41,179	59,160
Anhui	5,729	8,742	14,428	25,638
Jiangxi	5,804	9,410	15,843	26,076
Fujian	12,853	18,428	29,742	47,205
Shandong	11,314	19,860	32,848	47,071
South Central				
Henan	6,278	11,287	19,110	28,687
Hubei	7,427	11,541	19,837	34,096
Hunan	6,263	10,427	18,111	29,820
Guangdong	15,271	24,535	37,195	50,652
Guangxi	5,234	8,550	14,578	25,233
Western China				
Chongqing	7,935	12,394	20,407	34,297
Sichuan	5,826	8,993	15,484	26,120
Shaanxi	6,153	10,660	19,673	33,429

Note: CNY = Chinese Yuan; Source: National Bureau of Statistics of China, 2018

The unpaid productive engagement was the largest group, and the less active group was seen as the smallest (Table 4.6). Both groups were gaining in proportionate share over the 2002-2011 period. The percentage engaged in unpaid productive engagement and the less

active group rose from 48% and 6% to 59% and 16%, respectively. Those in paid jobs declined from 46% in 2002 to 25% in 2011. These changes indicated that many who were associated with this category had to move to unpaid productive engagement and less active groups.

Table 4.6: Descriptive Statistics of the Dependent Variable by Waves

Productive engagement	2002 %	2005 %	2008 %	2011 %
Less active group	6.1	12.2	13.0	15.7
Unpaid productive engagement	48.3	47.7	50.4	59.2
Paid job	45.5	40.1	36.6	25.1
Sample Size	**3,208**	**2,501**	**1,836**	**1,385**

4.3 Bivariate Analyses

4.3.1 Bivariate Analysis of Productive Engagement by Health and Personal Determinants

Health is a crucial predictor of productive engagement, particularly paid jobs. Figure 4.1 shows that those with better health were more likely to be involved in productive engagement, either paid or unpaid. Older adults with better health were more likely to participate in paid jobs and unpaid productive engagement groups. For all health statuses, the proportion engaged in unpaid jobs increased from the 2002 wave to the 2011 wave, with a corresponding decrease of those in paid jobs and less active (Figure 4.1). Besides, those who claimed that they had an illness, especially those with two or more diseases, were more likely to become less active through the years (Figure 4.2).

Figure 4.3 shows that those who have better cognitive health were more likely involved in productive engagement, either paid or unpaid. Older people with better MMSE were more likely to be involved in paid jobs and unpaid productive engagement than those with

low MMSE scores. Among those with low MMSE scores, the percentage falling into the less active group increased from 12% in wave 2002 to 32% in wave 2011.

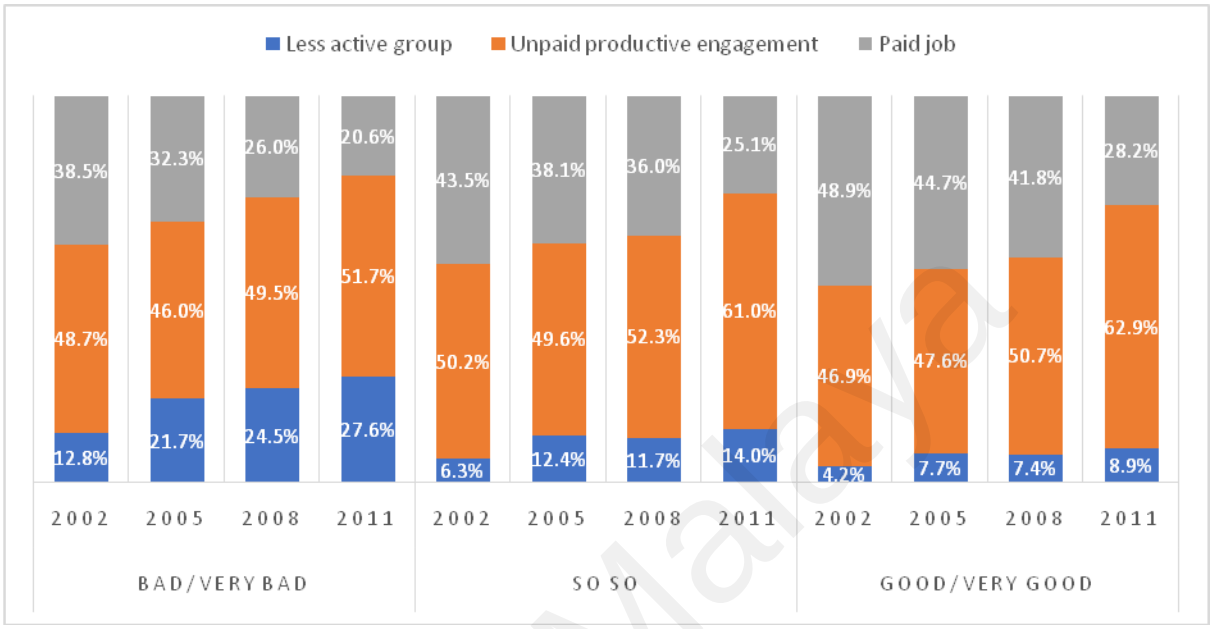


Figure 4.1: Percentage Distribution of Productive Engagement by Self-Rated Health between Wave 2002 and 2011

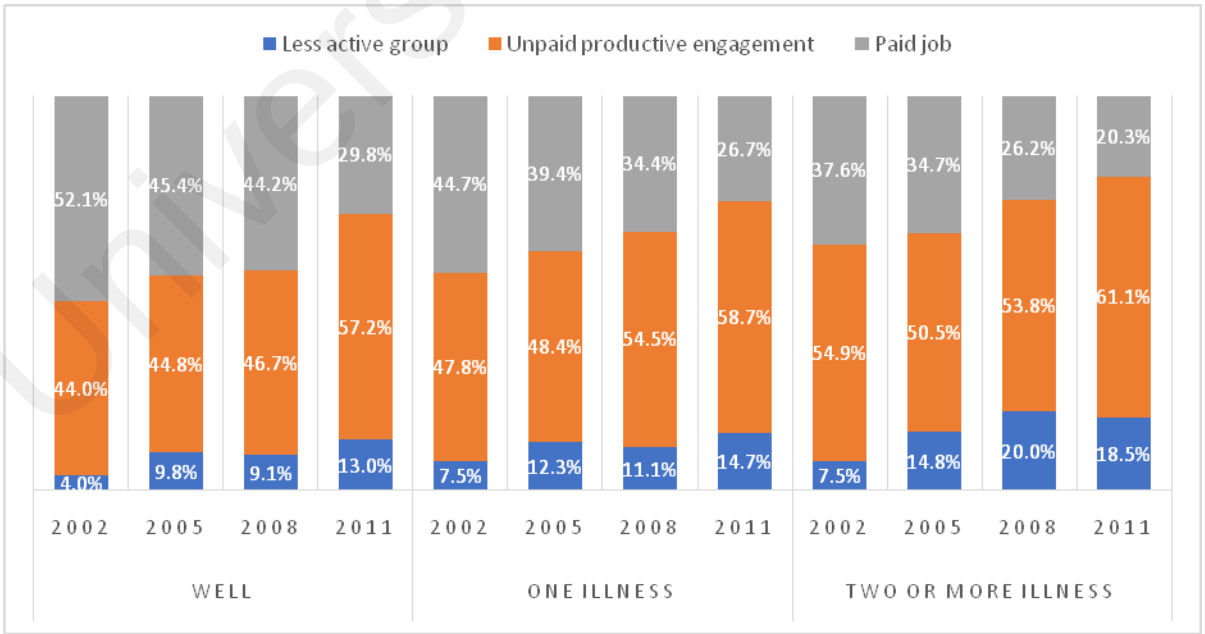


Figure 4.2: Percentage Distribution of Productive Engagement by Health Status between Wave 2002 and 2011

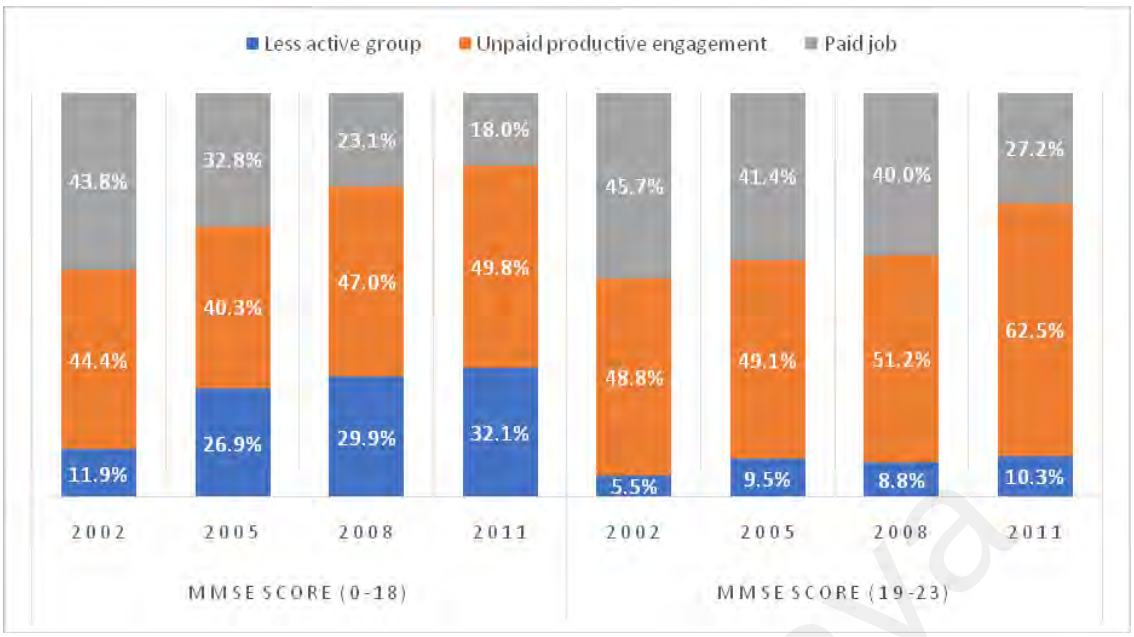


Figure 4.3: Percentage Distribution of Productive Engagement by MMSE Score between Wave 2002 and 2011

Performance in Instrumental Activities of Daily Living (IADLs) is crucial in the productive engagement of older adults. Those who need assistance in IADL (dependence) were more likely to be less active. Among those who needed help for IADL, the percentage falling into the less active group increased from 14% in wave 2002 to 27% in wave 2011 (Figure 4.4). As anticipated, those who were independent in IADL were more likely to participate in a paid job. Among the able-bodied elderly, the percentage of having a paid job declined from around 50% to 35% over the nine years. However, there was a corresponding increase in unpaid engagement.

4.3.2 Bivariate Analysis of Productive Engagement by Behavioural Determinants

Figure 4.5 shows that smokers were more likely than non-smokers to be involved in paid jobs throughout the 2002-2011 period. Between 2002 and 2011, non-smokers and smokers engaged in paid jobs decreased by 20 percentage points each to 23% and 33%, respectively, as they aged. More non-smokers participated in unpaid productive engagement than smokers. Both percentages of non-smokers and smokers involved in

unpaid productive engagement increased gradually over the years. The less active group increased steadily from 6% to 17% and 12% for non-smokers and smokers.

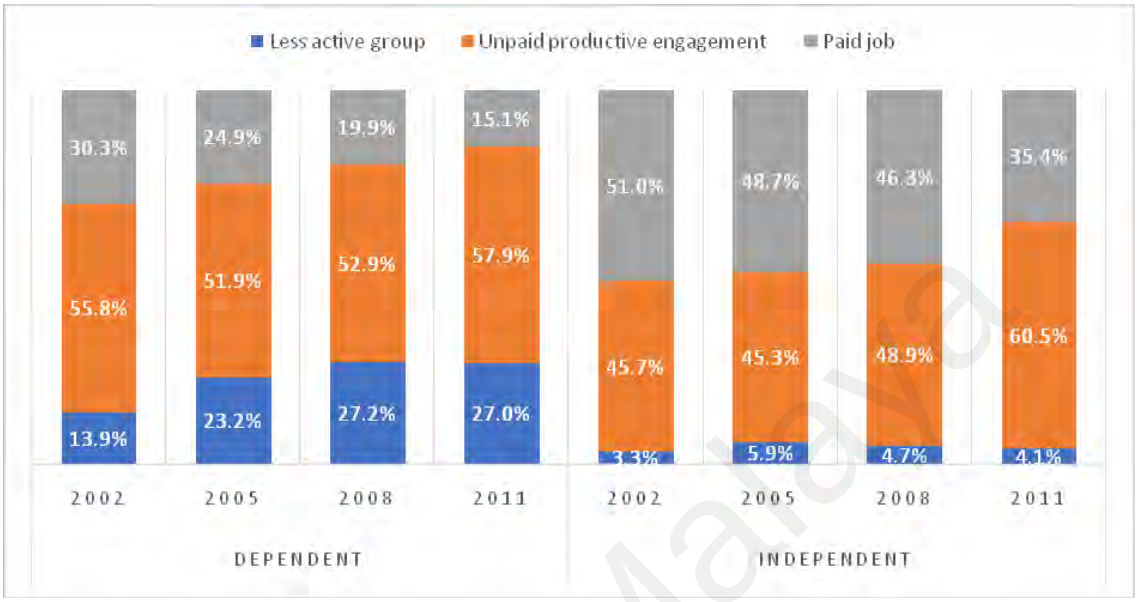


Figure 4.4: Percentage Distribution of Productive Engagement by IADL between Wave 2002 and 2011

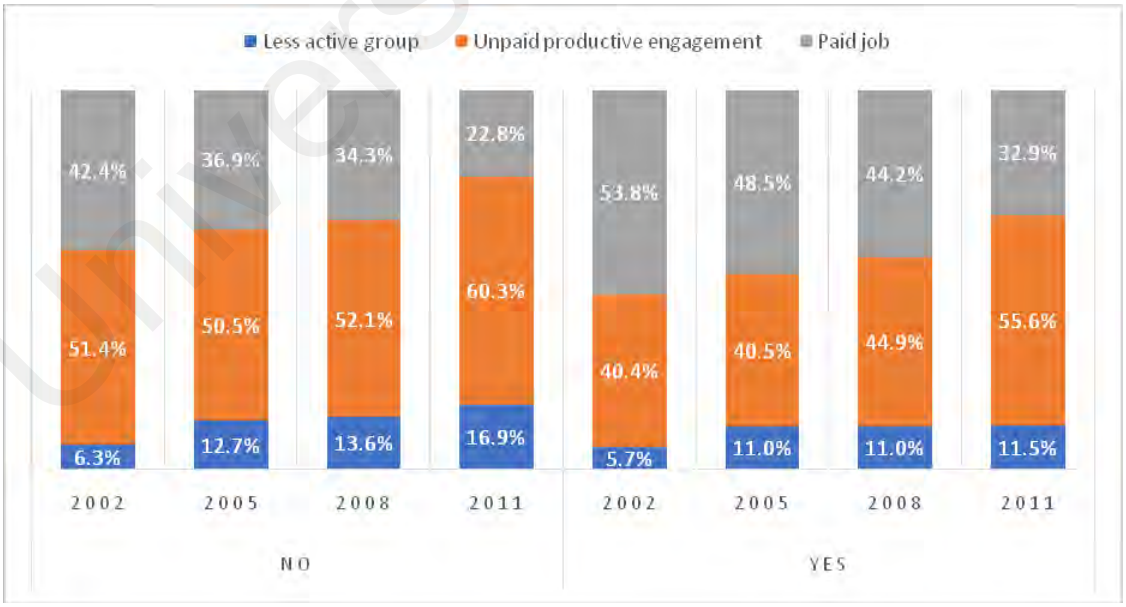


Figure 4.5: Percentage Distribution of Productive Engagement by Smoking Status between Wave 2002 and 2011

More drinkers were involved in paid jobs than non-drinkers between 2002 and 2011 (Figure 4.6). However, the percentage of drinkers involved in paid jobs decreased from 60% in 2002 to 40% in 2011. Also, more non-drinkers than drinkers participated in unpaid productive work. Both percentages of drinkers and non-drinkers in unpaid productive engagement increased gradually over the nine years since 2002. This striking result suggests that only 4% and 7% of drinkers were less active in wave 2002 and wave 2011, respectively.

Figure 4.7 below shows that those who exercised (the exercisers) were more likely than non-exercisers to be involved in a paid job. Between 2002 and 2011, the percentage of non-exercisers and exercisers involved in paid jobs decreased from 52% to 29% and from 36% to 22%. Notably, more exercisers participated in unpaid productive engagement as

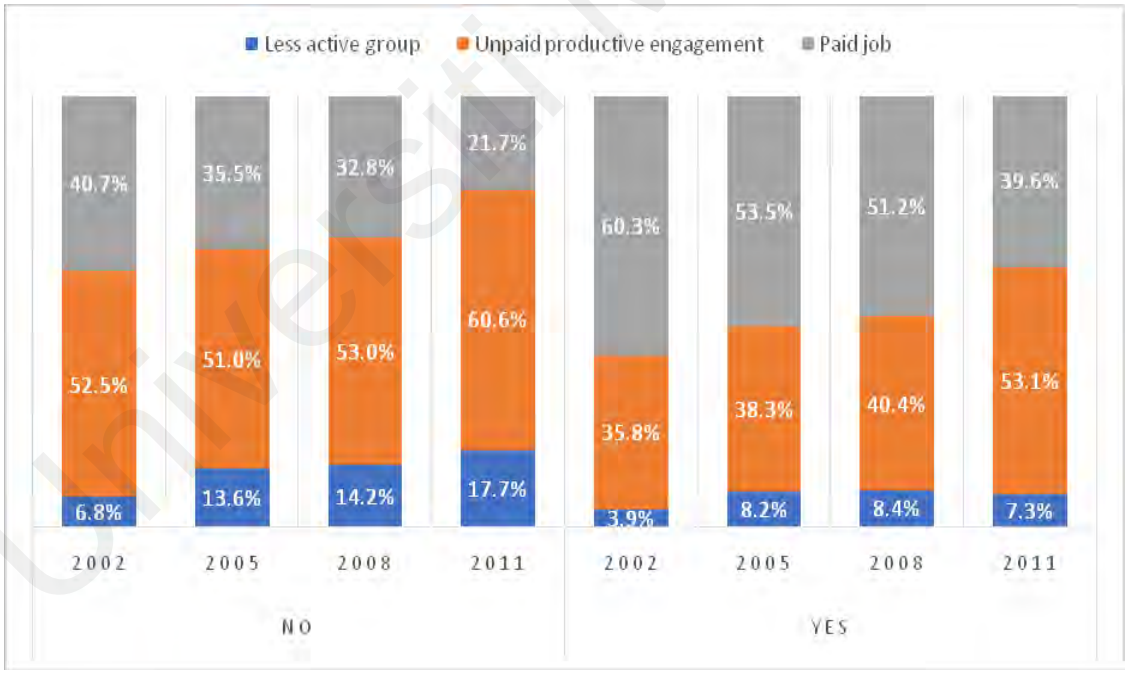


Figure 4.6: Percentage Distribution of Productive Engagement by Drinking Status between Wave 2002 and 2011

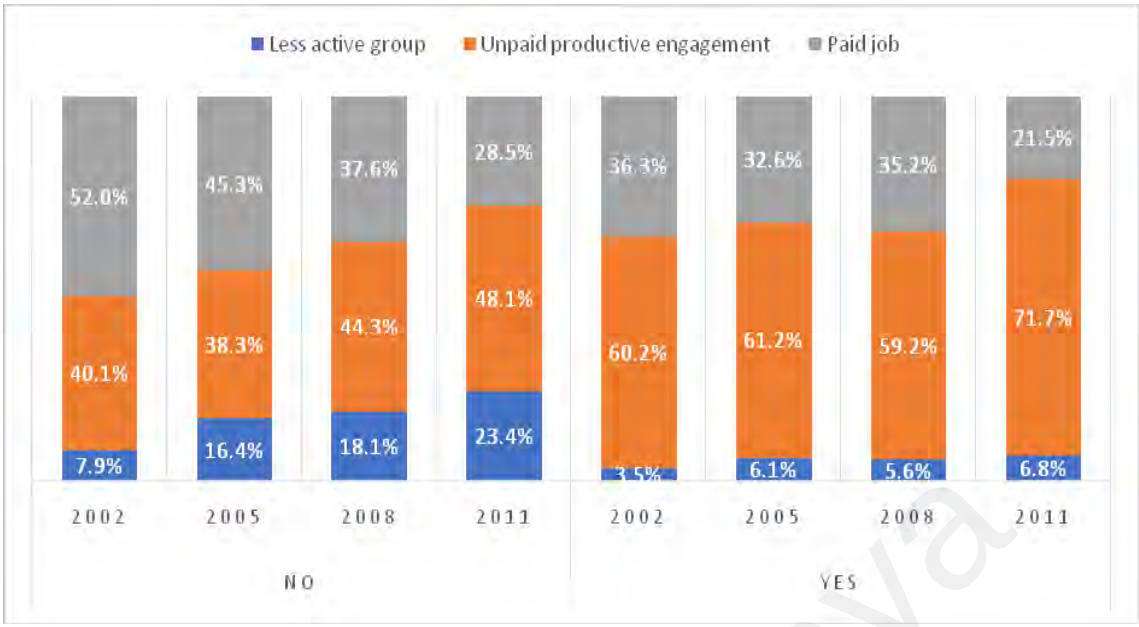


Figure 4.7: Percentage Distribution of Productive Engagement by Exercise Status between Wave 2002 and 2011

compared to exercisers. Interestingly, the percentages of non-exercisers and exercisers involved in unpaid productive engagement increased gradually over the years. The percentage of less active rose steadily rose from 8% to 23% and 4% to 7% for non-exercisers and exercisers, respectively.

4.3.3 Bivariate Analysis of Productive Engagement by Social Determinants

Those who were socially more active were more likely to be involved in a paid job or unpaid job. For instance, the percentage of those less active increased from 7% in 2002 to 21% among those who were socially inactive compared to a slight rise from 5% to 7% among those who had two or more social activities (Figure 4.8). For the socially inactive older adults, the percentage engaged in a job decreased from 48% to 23% over the nine years.

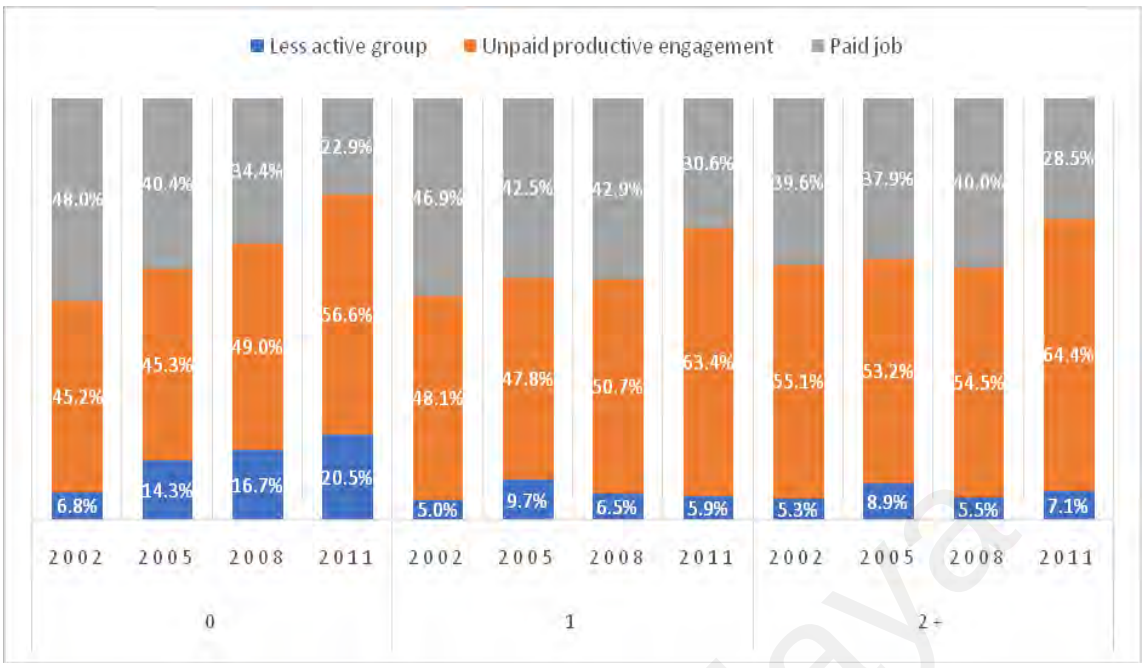


Figure 4.8: Percentage Distribution of Productive Engagement by the Participation in Social Activities between Wave 2002 and 2011

The single, widowed, and divorced older adults (others) were more likely than those married to be less active (Figure 4.9). The less active group increased from 7% to 17% and 6% to 14% for those currently married and living with a spouse or partner. Figure 4.10 shows that those who resided with their spouse were more likely to be involved in a paid job than those with other living arrangements. In 2002, more than half of older people resided with spouses only. However, this figure fell to 31% at wave 2011, given the spouse's demise during this period. Slightly more than half of those living with household members belonged to the unpaid productive group in 2002, increasing gradually to 58% nine years later. Those who remained alone were more likely to work in unpaid productive engagement than their other counterparts; this percentage increased from 53% in 2002 to 68% in 2011. Interestingly, those living alone were less likely to be in less active groups than their other counterparts.

4.3.4 Bivariate Analysis of Productive Engagement by Economics and Physical Environment Determinants

Figure 4.11 shows that the elderly with financial problems were more likely to work on a paid job than those claiming to be financially sufficient throughout the nine years. Furthermore, between 2002 and 2011, the involvement of older people in paid jobs with and without financial sufficiency decreased by 45% (from 44% to 24%) and 47% (from 53% to 28%), respectively. Those who were financially sufficient were more likely to be involved in unpaid productive engagement than those financially inadequate. The financially inadequate older people were also more likely to fall into the less active group over time, which increased 5-fold over the nine years from 2002 to 2011.

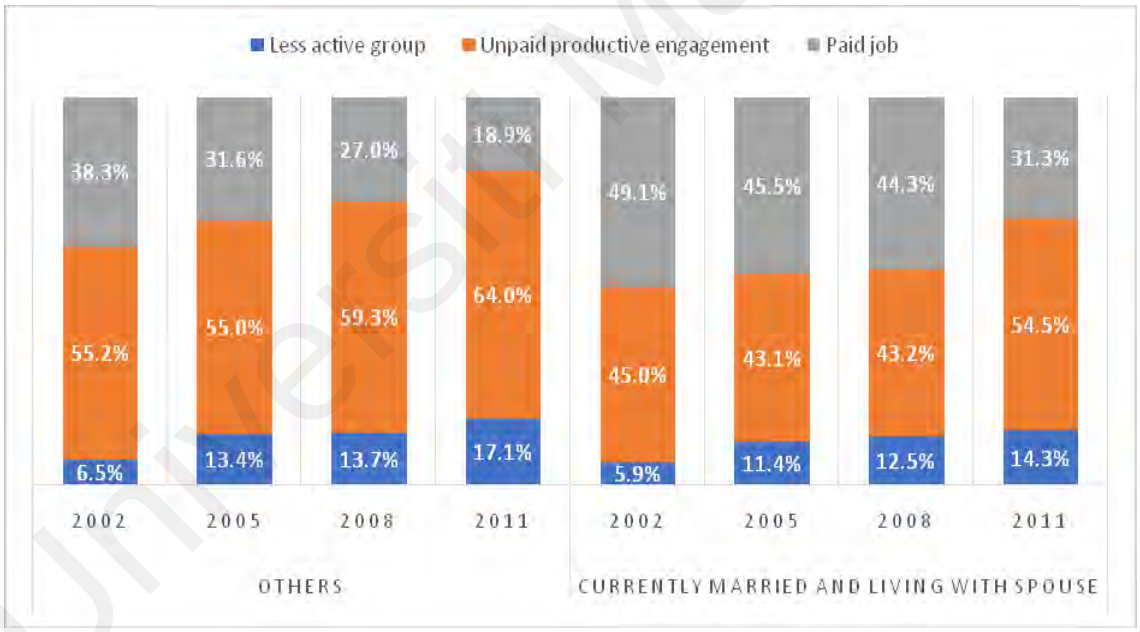


Figure 4.9: Percentage Distribution of Productive Engagement by Marital Status between Wave 2002 and 2011

Older adults living in the city were more likely than their rural counterparts to be involved in unpaid productive engagement. Here, nearly 70% of those who resided in the city were involved in unpaid productive activities. Figure 4.12 shows that about 55% of the rural

elderly were engaged in a paid job, which fell to 30% in 2011. Most had retired from their paid job, and about 54% were involved in unpaid productive activities in wave 2011.

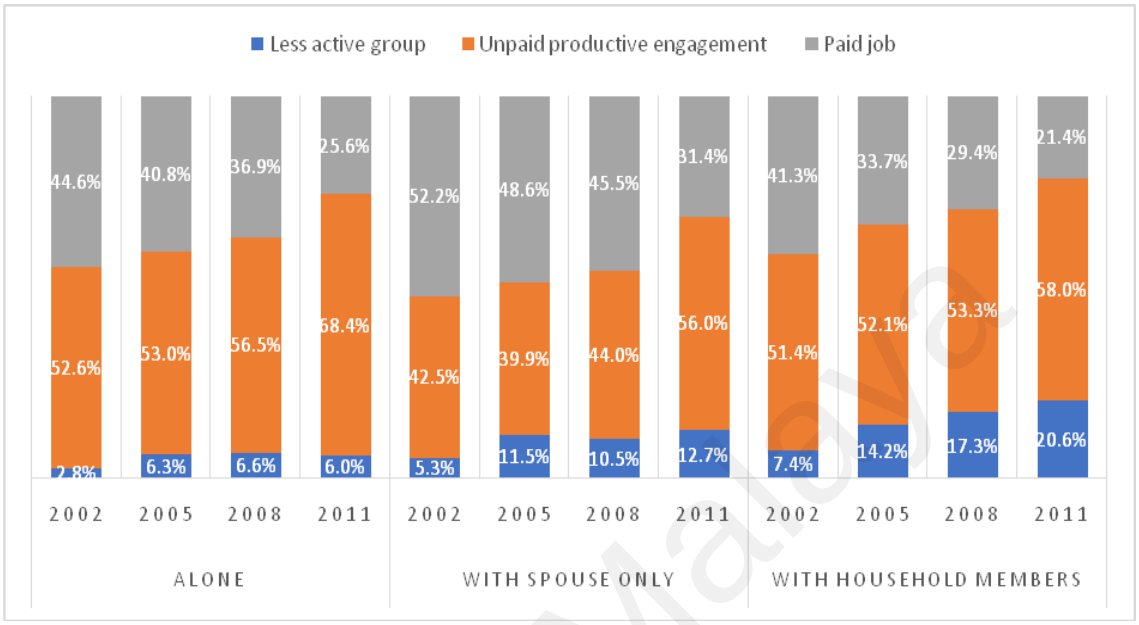


Figure 4.10: Percentage Distribution of Productive Engagement by Living Arrangement between Wave 2002 and 2011

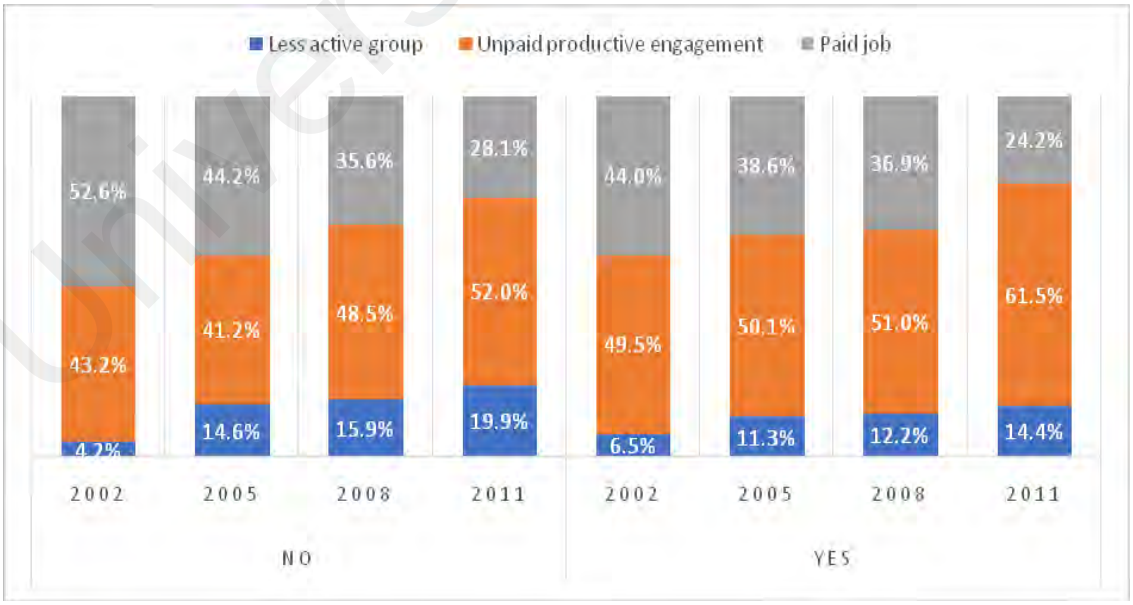


Figure 4.11: Percentage Distribution of Productive Engagement by Financial Sufficiency between Wave 2002 and 2011

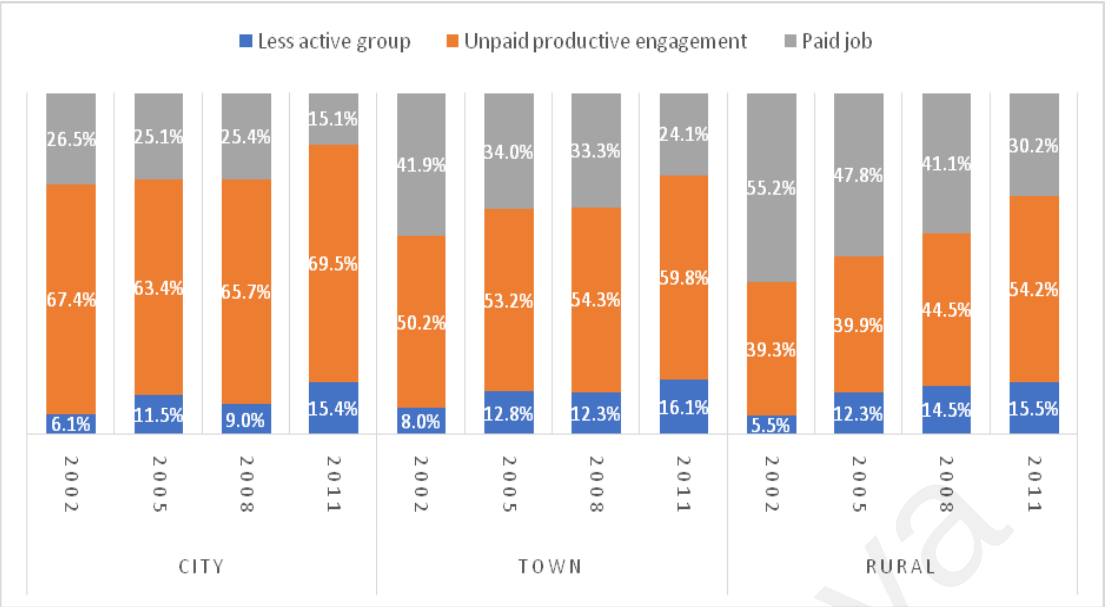


Figure 4.12: Percentage Distribution of Productive Engagement by Residential Areas between Wave 2002 and 2011

4.3.5 Bivariate Analysis of Productive Engagement by Demographic Variables

Throughout the nine years, more males than females worked in a paid job (Figure 4.13). Older women in paid jobs decreased by 51% (from 37.8% to 18.6%) between 2002 and 2011, while the rate for males fell by 41% (53.3% to 31.7%). More females than males participated in unpaid productive engagement. The percentage of males and females involved in unpaid productive engagement rose gradually over this period under study. The less active rose considerably from 5% to 17% and 7% to 15% for females and males.

Figure 4.14 shows that those who worked as menial workers or farmers before reaching 60 were more likely to work in a paid job than those from other occupational groups. In 2002, nearly half of the former menial workers and farmers were still engaged in a paid job. The corresponding figure for those engaged in housework and the professional and government employees was about one-third. Nevertheless, these figures fell to 18% and 25% respectively at wave 2011. Those who worked as menial workers or farmers and those doing housework were more likely to fall into the less active group over time. The

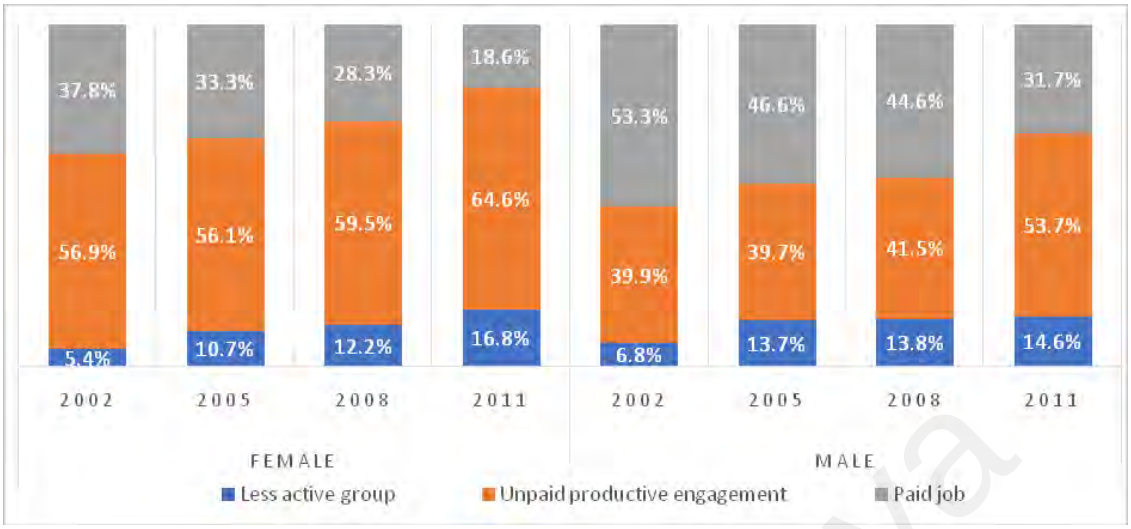


Figure 4.13: Percentage Distribution of Productive Engagement by Gender between Wave 2002 and 2011

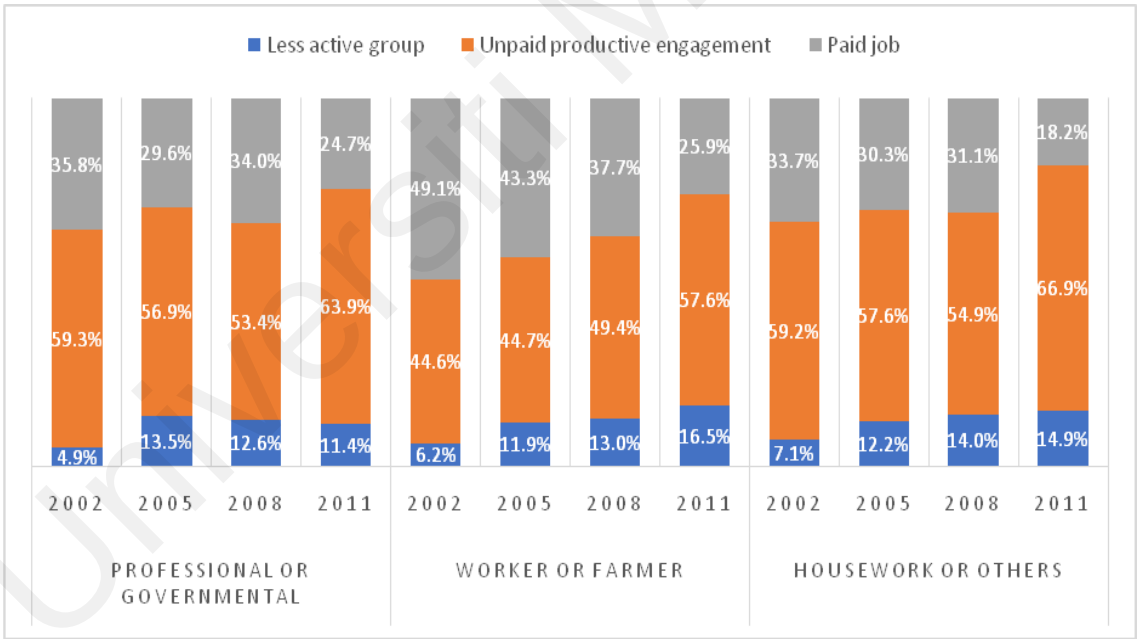


Figure 4.14: Percentage Distribution of Productive Engagement by Employment between Wave 2002 and 2011

pattern of being in a paid job and unpaid productive engagement for those who previously worked as professional and government employees was somewhat erratic. It is interesting to note that for those who worked as professionals and or in government, the distribution for the less active group peaked in 2005 and fell slightly to 11% in wave 2011. The trend

may imply that the professional and governmental group may respond to an active ageing policy involved in productive engagement, either paid or unpaid. Figure 4.15 shows that 7% of those without formal schooling were in the less active group in 2002, which rose to 18% in 2011.

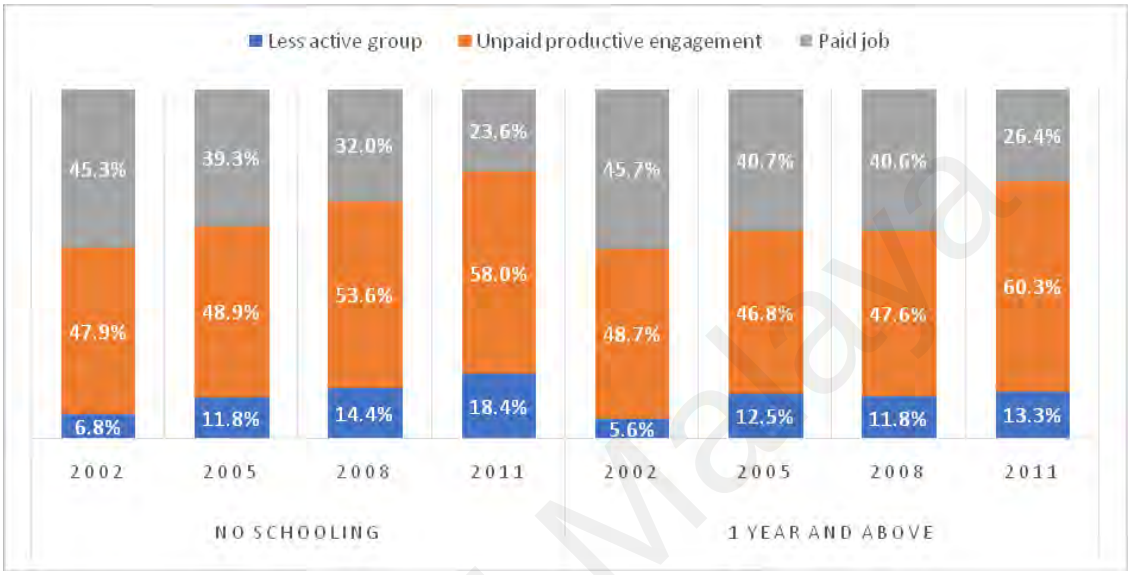


Figure 4.15: Percentage Distribution of Productive Engagement by Education between Wave 2002 and 2011

4.4 Conclusion

This study showed that older people in China make a valuable contribution to their families and communities. In wave 2002, about 6%, 48%, and 46% of the older adults were in, the less active group, unpaid productive engagement, and paid group, respectively. The corresponding percentages were 16%, 59 %, and 25% nine years later. Some of the studies applying the Active Ageing Index (AAI) showed the prevalence rate of job participation was about 39%, 35%, and 12% for older adults aged between 65 and 69 years in Korea, China, and the European Union (EU), respectively (Zaidi et al., 2019). This study reported a higher job participation rate since it included those involved in a part-time job. Also, the immature state of the public pension system in China and the high self-employment rate might be the reasons for the high job participation rate for those older adults in China compared to Western countries (T. Liu & Sun, 2016). Thus, the

findings indicated that a substantial number of older Chinese adults were still participating in the workforce. A high percentage of older workers in China, particularly in rural areas, chose to work at least part-time as part of their old-age coping strategies (Henry et al., 2018). Thus, there is a need to include sound policies to protect the rights of those employed to exit the workforce while also combatting the weak sustainability of social welfare systems and potential problems of declining labour supplies.

Health is the key predictor of productive engagement (Morrow-Howell, Halvorsen, et al., 2017), especially for paid jobs (O. E. Lee & Lee, 2014; Ling & Chi, 2008) over time. Those who claimed that they had an illness, especially those with two or more diseases, were more likely to become less active as they age. This finding corroborates with previous studies where older adults with one or more chronic diseases (i.e., hypertension, diabetes, and arthritis) were less committed to participating in productive engagement, whether paid or unpaid, than those without chronic diseases (Sebastião et al., 2017). The involvement in a paid job and unpaid productive engagement for those with higher MMSE scores declined slightly from wave 2002 to 2011. The study of older adults in Korea indicated that older adults with high and moderate cognition were almost two times more likely to participate in the labour force than those with low cognition (O. E. Lee & Lee, 2014). Moreover, a recent study also supports the close association between paid and unpaid productive engagement with reduced risk of cognitive decline over two years (Y. Luo et al., 2019).

Notably, while alcohol consumption may facilitate relaxation through social interaction activities, drinking may have been a habit among those involved in paid and unpaid productive engagement in this study. Any physical activity or exercise is better than no

activity. It is also worth noting that those who exercised were less likely to be in the less active group.

Those who were socially more active were more likely to be involved in productive engagement over time. This study indicated that those married were more likely to work in a paid job. Under the Asian culture, married older adults assume responsibility for their families, including their children and elderly parents (T. L. Giang & Nguyen, 2016; O. E. Lee & Lee, 2014; Ling & Chi, 2008). Besides, there was a positive indication that those who lived alone were not lonely and were actively involved in paid and unpaid productive engagement. Those in the less active group who resided with household members were more likely to receive caregiving from their spouse and household members (National Alliance for Caregiving (NAC) & AARP, 2009). Visaria and Dommaraju (2019) found that living with children reduces the likelihood of paid jobs but not unpaid productivity engagement.

Those having financial problems may have difficulties maintaining their health. Here, involvement in paid work offers income and other financial benefits to maintain their health (E. Choi et al., 2016; Wickrama et al., 2013). Full or part-time involvement in paid work was significantly associated with better health functioning (Azar et al., 2019). This result was contrary to Morrow-Howell et al.'s (2014) findings that urban older adults were more likely to be involved in paid jobs. Nevertheless, this could be the difference between a developed country and a developing country, such as China, where agricultural activities are still prominent. The study on older South Koreans also showed that those who resided in rural areas were more likely to be involved in labour force participation than urban residents (O. E. Lee & Lee, 2014).

This finding is consistent with Morrow-Howell et al. (2014), where older men were more likely to be involved in paid jobs than older women. Ling and Chi (2008) found that Chinese females were less likely to be involved in employment than their male counterparts. Nevertheless, older women were more likely to be engaged in unpaid productive activities than older men (J. H. Kim, 2019; Morrow-Howell et al., 2014; Teerawichitchainan et al., 2019).

CHAPTER 5: TWO-LEVEL RANDOM-INTERCEPT MULTILEVEL MULTINOMIAL LOGIT MODELS FOR LONGITUDINAL DATA

5.1 Introduction

This chapter presents the findings of the two-level random-intercept multilevel multinomial logit models that used data from the Chinese Longitudinal Healthy Longevity Survey (CLHLS). A description of the data and models sets the stage for the multivariate analysis. The analysis began with a two-level unconditional model; Model 1; which was then extended to a two-level random-intercept multilevel multinomial logit model by including time-invariant variables and time-varying variables. The time-varying variables, especially the quantitative variables for Model 2, were analysed based on person-mean centring whereas Model 3 utilised grand-mean centring. Although the 2002 wave of the CLHLS began with 3,208 respondents, this number decreased to 2,501, 1836, 1,385 in 2005, 2008, and 2011, respectively, due to non-participation in subsequent waves or death.

5.2 Results of the Two-Level Random-Intercept Multilevel Multinomial Logit Models for Various Engagements

Two-level random-intercept multilevel multinomial logit models, with a generalised logit link function, were used to examine predictors of fluctuations in the participation of older adults in productive engagement. This sample consisted of 3,208 older adults aged between 65 to 74 years old (mean = 69.5, standard deviation = 2.9), half of whom were women. Four waves of data were collected between 2002 and 2011. All the models were estimated using the maximum likelihood (ML) method. The Wald chi-square tests and p-values were applied to test the significance of the individual fixed effects.

5.2.1 Results of the Model 1: Unconditional Model

The log odds intercept for Category One from Model 1 was 1.232 and referred to the grand mean log-odds coefficient across the four waves (Table 5.1). This intercept represented the predicted log odds when all the variables in the model were equal to 0. The estimated intercept showed that individuals were about 3.4 times more likely to engage a paid job than the less active group in the wave 2002 (odds ratio (OR) = 3.427, $p < 0.01$). Similarly, for Category Two, the log-odds of participating in unpaid productive engagement (1.523) were also higher than that of the less active group (OR = 4.587, $p < 0.01$). The estimated intercept showed that the individuals were about 4.6 times more likely to be involved in unpaid productive engagement than the less active group in 2002.

For those involved in the paid job, the average individual-level probability was 38%. The probability of participating in unpaid productive engagement was 51%, and the reference group was 11%. For the variance components suggested that both intercepts vary across individuals ($\sigma^2_{uoj(1)}$= 0.699, SE = 0.070; $\sigma^2_{uoj(2)}$= 0.320, SE = 0.061). In both cases, the Z tests suggested significant variability in productive engagement between individuals. Therefore, the results justified developing a two-level multilevel model. The estimated probability for each response category in the first model (with just the intercept) is as follows:

$$\pi_{tij} = (\exp(\eta_{tij})/(1 + \sum_{t=1}^{t-1} \exp(\eta_{tij}))$$

$$P(Y = 0) = \frac{1}{1 + \exp(1.232) + \exp(1.523)} = 11.1\%$$

$$P(Y = 1) = \frac{\exp(1.232)}{1 + \exp(1.232) + \exp(1.523)} = 38.0\%$$

$$P(Y = 2) = \frac{\exp(1.523)}{1 + \exp(1.232) + \exp(1.523)} = 50.9\%$$

The intraclass correlation (ICC) of the empty means, random intercept model (Model One) indicated 17.5% $[\frac{0.699}{0.699+\frac{\pi^2}{3}}]$ of the paid job compared to the less active group was between persons, whereas 82.5% was within-persons. For unpaid productive engagement versus less active group, the ICC is 8.9% $[\frac{0.320}{0.320+\frac{\pi^2}{3}}]$, indicating that 8.9% of the variation in unpaid productive engagement compared to the less active group was between whereas 91.1% was within-persons.

Table 5.1: Results of the Unconditional Model of the Two-Level Random-Intercept Multilevel Multinomial Logit Models

		Model 1			
Variables	**Log-Odds**	**Odds Ratio**	**95% CI Lower**	**95% CI Upper**	**Sig.**
Paid job vs Less Active Group					
Intercept	**1.232**	**3.427**	**3.154**	**3.724**	***
Unpaid productive engagement vs Less Active Group					
Intercept	**1.523**	**4.587**	**4.247**	**4.955**	***
	Co-efficient	**Std. Error**	**95% CI Lower**	**95% CI Upper**	**Sig.**
Random Effect Block 1					
Paid job: Variance	**0.699**	**0.070**	**0.575**	**0.850**	***
Unpaid productive engagement: Variance	**0.320**	**0.061**	**0.220**	**0.464**	***
Intraclass correlation (ICC)					
Paid job: Level 2	17.5%				
Unpaid productive engagement: Level 2	8.9%				
-2 log-likelihood	68,122				
Akaike Corrected	68,126				
Bayesian	68,140				

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

5.2.2 Results of Model 2: Paid Job Versus the Less Active Group

In Model 2, an attempt to explicitly separate the between-person from the within-person from the time-varying quantitative predictors (Table 5.2). For category one, the log odds intercept for the odds ratio (0.454) from Model 2 showed the likelihood of an individual involving in the paid job versus the less active group as all the predictors were equal to zero. The odds ratio of 1.575 from Model 2 suggested that that the males, being the reference group, with all the predictors set as zero, was about 1.6 times more likely to participate in the paid job as compared to the less active group at the wave 2002 (OR=1.575, $p<0.10$).

Based on the person-mean centring model, the log of the odds of the between-person effect (0.322) of self-rated health was more significant than the within-person effect (0.273). The significant between-person effect of self-rated health at level 2 of 0.322 indicated that for every one-unit higher person average self-rated health than other people, the predicted odds of being involved in the paid job versus less active group were estimated to be higher by 0.322 (OR=1.380, $p<0.01$). The significant within-person effect of self-rated health at level 1 of 0.273 indicated that for every one-unit higher self-rated health than one's average, the odds involved in the paid job versus less active group was estimated to be higher by 0.273 (OR=1.314, $p<0.01$). This result showed that being a healthier person (than other people) matters more for predicting the likelihood to be involved in the paid job versus less active group than did having a healthier occasion (than usual). However, both inter-individual differences and intra-individual differences variation in self-rated health do matter to some extent. The cross-sectional effect did translate longitudinally for self-rated health.

Table 5.2: Two-Level Random-Intercept Multilevel Multinomial Logit Models for Various Engagements

Determinants/Variables	Model 2					Model 3				
Fixed Effects	**Log-Odds**	**Odds Ratio**	**95% LCI**	**95% UCI**	**Sig.**	**Log-Odds**	**Odds Ratio**	**95% LCI**	**95% UCI**	**Sig.**
Paid job vs Less Active Group										
Intercept	**0.454**	**1.575**	**0.951**	**2.609**	*	**0.673**	**1.961**	**1.181**	**3.257**	***
Between person self-rated health	**0.322**	**1.380**	**1.203**	**1.584**	***					
Within person self-rated health	**0.273**	**1.314**	**1.158**	**1.490**	***					
Grand mean self-rated health						**0.295**	**1.343**	**1.218**	**1.482**	***
One chronic disease (ref. well)	-0.102	0.903	0.731	1.115		-0.105	0.900	0.729	1.112	
Two chronic diseases and above (ref. well)	**-0.275**	**0.759**	**0.619**	**0.931**	***	**-0.282**	**0.754**	**0.615**	**0.924**	***
Between person MMSE	**0.099**	**1.104**	**1.068**	**1.142**	***					
Within person MMSE	**0.110**	**1.116**	**1.084**	**1.149**	***					
Grand mean MMSE						**0.106**	**1.112**	**1.087**	**1.137**	***
IADI (ref. dependence)	**1.744**	**5.717**	**4.721**	**6.924**	***	**1.753**	**5.712**	**4.717**	**6.917**	***
Smoking (ref. no smoking)	0.000	1.000	0.802	1.248		-0.007	0.993	0.795	1.239	
Drinking (ref. no drinking)	**0.689**	**1.992**	**1.583**	**2.507**	***	**0.689**	**1.992**	**1.583**	**2.507**	***
Exercising (ref. no exercise)	**0.562**	**1.754**	**1.418**	**2.170**	***	**0.561**	**1.753**	**1.418**	**2.167**	***
Between person social activities	-0.050	0.952	0.833	1.087						
Within person social activities	**0.164**	**1.178**	**1.025**	**1.355**	**					
Grand mean social activities						0.049	1.050	0.950	1.161	
Marital status (ref. others)	**0.789**	**2.202**	**1.807**	**2.682**	***	**0.779**	**2.179**	**1.790**	**2.653**	***
Living arrangement: (ref. alone)	**-1.472**	**0.229**	**0.165**	**0.319**	***	**-1.469**	**0.230**	**0.166**	**0.320**	***
Financial sufficiency (ref. financially insufficient)	**-0.362**	**0.696**	**0.569**	**0.853**	***	**-0.368**	**0.692**	**0.566**	**0.847**	***
Rural (ref. city/town)	**0.540**	**1.716**	**1.428**	**2.062**	***	**0.561**	**1.752**	**1.459**	**2.103**	***
Age at wave 2002	**-0.084**	**0.920**	**0.891**	**0.949**	***	**-0.083**	**0.920**	**0.892**	**0.949**	***
Female (ref. male)	**0.390**	**1.477**	**1.178**	**1.853**	***	**0.398**	**1.489**	**1.188**	**1.865**	***
Professional or governmental (ref. housemaker & others)	-0.040	0.961	0.646	1.430		-0.078	0.925	0.622	1.375	
Worker or farmer (ref. housemaker and others)	**0.357**	**1.430**	**1.060**	**1.929**	**	**0.364**	**1.439**	**1.066**	**1.941**	**
Education (Year of Schooling) (ref. unschooled)	-0.162	0.851	0.683	1.060		**-0.201**	**0.818**	**0.659**	**1.016**	*

Table 5.2, continued

Determinants/Variables	Model 2					Model 3				
Fixed Effects	Log-Odds	Odds Ratio	95% LCI	95% UCI	Sig.	Log-Odds	Odds Ratio	95% LCI	95% UCI	Sig.
Unpaid productive engagement vs Less Active Group										
Intercept	**1.249**	**3.486**	**2.187**	**5.557**	***	**1.440**	**4.220**	**2.642**	**6.742**	***
Between person self-rated health	**0.294**	**1.341**	**1.179**	**1.525**	***					
Within person self-rated health	**0.179**	**1.196**	**1.059**	**1.350**	***					
Grand mean self-rated health						**0.230**	**1.258**	**1.146**	**1.381**	***
One chronic disease (ref. well)	-0.033	0.968	0.788	1.189		-0.036	0.965	0.786	1.185	
Two chronic diseases and above (ref. well)	-0.075	0.928	0.765	1.126		-0.087	0.916	0.755	1.112	
Between person MMSE	**0.113**	**1.119**	**1.086**	**1.154**	***					
Within person MMSE	**0.100**	**1.105**	**1.075**	**1.136**	***					
Grand mean MMSE						**0.105**	**1.111**	**1.088**	**1.134**	***
IADI (ref. dependence)	**1.014**	**2.757**	**2.307**	**3.294**	***	**1.020**	**2.774**	**2.322**	**3.314**	***
Smoking (ref. no smoking)	0.004	1.004	0.813	1.239		0.001	1.001	0.811	1.236	
Drinking (ref. no drinking)	**0.234**	**1.263**	**1.008**	**1.583**	***	**0.238**	**1.269**	**1.013**	**1.591**	**
Exercising (ref. no exercise)	**1.190**	**3.286**	**2.687**	**4.019**	***	**1.195**	**3.304**	**2.703**	**4.039**	***
Between person social activities	0.074	1.076	0.954	1.214						
Within person social activities	**0.153**	**1.166**	**1.018**	**1.336**	**					
Grand mean social activities						**0.110**	**1.117**	**1.015**	**1.228**	**
Marital status (ref. others)	**0.167**	**1.182**	**0.986**	**1.418**	*	**0.162**	**1.176**	**0.981**	**1.410**	*
Living arrangement: (ref. alone)	**-1.190**	**0.304**	**0.222**	**0.417**	***	**-1.188**	**0.305**	**0.223**	**0.418**	***
Financial sufficiency (ref. financially insufficient)	**-0.196**	**0.822**	**0.676**	**0.999**	**	**-0.188**	**0.828**	**0.682**	**1.006**	*
Rural (ref. city/town)	-0.011	0.989	0.830	1.178		-0.010	0.990	0.832	1.178	
Age at wave 2002	-0.014	0.986	0.957	1.015		-0.016	0.984	0.956	1.013	
Female (ref. male)	**0.982**	**2.669**	**2.163**	**3.294**	***	**0.979**	**2.661**	**2.159**	**3.280**	***
Professional or governmental (ref. housemaker & others)	-0.002	0.998	0.695	1.432		-0.013	0.987	0.688	1.414	
Worker or farmer (ref. housemaker and others)	0.094	1.098	0.836	1.443		0.090	1.094	0.833	1.438	
Education (Year of Schooling) (ref. unschooled)	-0.091	0.913	0.743	1.120		-0.092	0.912	0.745	1.116	

Table 5.2, continued

Random Effects	Model 2					Model 3				
	Co-efficient	**Std. Error**	**95% LCI**	**95% UCI**	**Sig.**	**Co-efficient**	**Std. Error**	**95% LCI**	**95% UCI**	**Sig.**
Random Effect Block 1										
Paid job: Variance	**0.456**	**0.072**	**0.334**	**0.622**	***	**0.457**	**0.072**	**0.335**	**0.622**	***
Unpaid productive engagement: Variance	**0.165**	**0.063**	**0.078**	**0.347**	***	**0.162**	**0.063**	**0.076**	**0.345**	**
Intraclass correlation (ICC)										
Paid job: Level 2	12.2%					12.2%				
Unpaid productive engagement: Level 2	4.8%					4.7%				
-2 log-likelihood	74,517					74,483				
Akaike Corrected	74,531					74,497				
Bayesian	74,513					74,479				

Note: ***p<0.01, **p<0.05, *p<0.10; ref. = reference group; MMSE = Mini-Mental State Examination; IADL=Instrumental Activities of Daily Living, LCI = Lower confidence interval; UCI = Upper confidence interval.

The effect of having one illness was unrelated to the odds of involvement in the paid job compared to the less active group (OR=0.903, p=ns). However, individuals involved in the paid job versus the less active group were significantly less likely to have two illnesses or more than those who were well. The log of the odds of being involved in the paid job versus the less active group was 0.275 units lower for those who reported two illnesses or more than those who were well. The odds of involving in the paid job versus the less active group were 24% (1-0.759=0.241) lower for those who reported two illnesses or more compared with those who were well, holding other variables constant (OR=0.759, $p<0.01$).

The person-mean centring model showed that the log of the odds of the between-person effect (0.099) of MMSE (cognitive health) was smaller than the within-person effect (0.110). For every one-unit increase in the person's own mean MMSE, the predicted odds of being involved in a paid job were higher by 0.099 (OR=1.104, $p<0.01$) than the active group. For every one-unit increase in MMSE than the person's mean, the odds of being involved in the paid job versus the less active group were estimated to be higher by 0.110 (OR=1.116, $p<0.01$). This result shows that having higher MMSE (than other people) matters slightly less for predicting likelihood to involved in the paid job versus less active group than did having a higher MMSE occasion (than usual). However, both inter-individual differences and intra-individual differences variation in MMSE do matter to some extent.

The log of the odds of being involved in the paid job versus less active group increased by 1.744 units for those with IADL independence (with good functional health) compared with those was IADL dependent. The odds of participating in the paid job versus less active group for IADL independent was 5.7 times higher than those with

IADL dependent, holding other variables constant (OR=5.717, $p < 0.01$). Thus, those who were IADL independent were nearly six times more likely to be involved in the paid job versus the less active group than IADL dependent.

The impact of smoking was unrelated to the odds of involvement in the paid job compared to the less active group (OR=1.000, p=ns). On the other hand, holding other variables constant, the log of the odds of being involved in the paid job versus less active group was increased by 0.689 units for drinkers compared with a non-drinker. The odd ratio indicated the predicted odds that drinkers involved in the paid job versus less active group were 1.992 the odds of non-drinker (OR=1.992, $p<0.01$). Thus, drinkers were two times more likely to be in the paid job versus the less active group.

Based on the person-mean centring model, the log of the odds of working in a paid job versus less active group for those who exercised was 0.562 units higher than those who did not exercise. The odds of participating in a paid job versus the less active group who exercised were 75% higher than those who did not, holding other variables constant (OR=1.754, $p<0.01$). Thus, individuals who exercised were nearly two times more likely to be in the paid job versus the less active group.

The effect of participation in social activities was within-person as the between-person effect was not significant. The significant within-person effect at level 1 of 0.164 indicates that for every one-unit increase in the participation in social activities above one's average, the odds of being involved in a paid job versus a less active group would be 0.164 units higher (OR=1.178, $p<0.05$). The between-person effect of participation in social activities at level 1 of 0.050 indicates that for every one-unit increase in the person mean participation in social activities than other people, the predicted odds to be

involved in the paid job versus less active group would be lower by 0.050 (OR=0.952, p=ns). It meant that whenever people report higher participation in social activities than the average, the likelihood of being involved in the paid job versus the less active group is higher than usual.

The person-mean centring model showed that the log of the odds of being involved in a paid job versus the less active group for the married older adults would be 0.789 units higher than the single ceteris paribus. The odd ratio indicated the predicted odds that those who were married were involved in the paid job versus the less active group were 2.202 the odds of singles (OR=2.202, $p<0.01$). Therefore, married individuals were about 2.2 times more likely than the singles to be in the paid job versus the less active group.

The log of the odds of working in a paid job versus the less active group for those living with spouse or others would be 1.472 units lower than those living alone. The odds of involving in the paid job versus the less active group were reduced by 77% (1-0.229=0.771) for those who resided spouse or others compared with those who live alone, holding other variables constant. Hence, individuals who live alone were 4.4 times (1/0.771) more likely than those who resided with a spouse or others to be in the paid job versus the less active group.

The log of the odds of involving in the paid job versus less active group for those who were financially sufficient would be 0.362 units lower than those who were financially insufficient. The odds of involving in the paid job versus the less active group were decreased by 30% (1-0.696=0.304) for those who were financially sufficiency compared with those who were financially insufficient, holding other variables constant

(OR=0.696, p<0.01). Financially insufficient individuals were 1.4 times (1/0.696=1.4) more likely to be in the paid job versus the less active group.

Based on the person-mean centring model, the log of the odds of working in a paid job versus the less active group for the rural older adults was 0.540 units than dwellers in the city or town. The odd ratio indicated the predicted odds that those who resided in rural areas involving the paid job versus less active group were 1.716 the odds of those who lived in city or town, holding other variables constant (OR=1.716, p<0.01). Thus, individuals who resided in rural were 1.7 times significantly more likely to be in the paid job versus the less active group.

After holding other variables constant, an increase in age by one year at wave 2002 (centred at 70 years old) would result in a decrease in the odds of involving in a paid job by 8% (1-0.920=0.08) (OR=0.920, p<0.01) as compared to the less active group. Hence, younger individuals were significantly more likely to be in a paid job versus less active groups than older individuals.

The log of the odds of being involved in a paid job versus less active group for the females was 0.39 higher than the males. The odds ratio of participating in the paid job versus less active group was increased by 48% for females versus males. Hence, females were 1.5 times more likely to be in the paid job versus the less active group than males (OR=1.477, p<0.01).

The impact of the number of years of schooling or education (OR=0.851, p=ns) and worked as a professional (OR=0.961, p=ns) were unrelated to the odds of involvement in the paid job as compared to the less active group. The labourers or farmers were 1.4

times more likely to be in a paid job than homemakers or others. The log of the odds of involving in the paid job versus less active group was increased by 0.357 units for those who worked as labourers or farmers compared to homemakers or others, holding other variables constant (OR=1.430, $p<0.05$).

5.2.3 Results of Model 2: Unpaid Productive Engagement Versus the Less Active Group

For category two, the log odds intercept for the odds ratio (1.249) from Model 2 showed the likelihood of an individual involving in unpaid productive engagement versus a less active group as all the predictors were equal to zero. The odds ratio of 3.486 from Model 2 suggested that males with all the predictors set as zero or average were about 3.5 times more likely to participate in unpaid productive engagement than the less active group at the wave 2002 (OR=3.486, $p<0.01$).

The person-mean centring model showed that the log of the odds of the between-person effect (0.294) of self-rated health was more significant than the within-person effect (0.179). The between-person effect of self-rated health at level 2 of 0.294 means that with a one-point increase in a person's average self-rated health over others, the predicted odds of being involved in unpaid productive engagement would be 0.294 (OR=1.341, $p<0.01$) higher than the less active group. The within-person effect of self-rated health at level 1 of 0.179 indicated that for every one-point higher self-rated health than one's average, the odds of being involved in unpaid productive engagement versus less active group was estimated to be higher by 0.179 (OR=1.196, $p<0.01$). This result shows that being healthy matters more for predicting the likelihood of involvement in unpaid productive engagement versus less active group. However, both individual differences and intra-individual differences variation in self-rated health do matter to

some extent. The cross-sectional effect did translate longitudinally for self-rated health. The impact of having one illness or more was unrelated (OR=0.968 and 0.928, p=ns) to the odds of involvement in unpaid productive engagement as compared to the less active group.

The person-mean centring model showed that the log of the odds of the between-person effect, at 0.113 (OR=1.119, $p<0.01$) of MMSE (cognitive health) was slightly more significant than the within-person effect, at 0.100 (OR=1.105, $p<0.01$). This result showed that having higher MMSE matters more for predicting the likelihood of involvement in unpaid productive engagement versus less active group. However, both individual differences and intra-individual differences variation in MMSE do matter to some extent. The cross-sectional effect did translate longitudinally for MMSE.

The log of the odds of involving in unpaid productive engagement versus less active group for those without IADL limitation was 1.014 units higher than those with IADL limitation. The odds of participating in unpaid productive engagement versus less active group were significantly increased by 2.8 times for those without IADL limitation compared with those with IADL limitation, holding other variables constant (OR=2.757, $p < 0.01$).

The impact of smoking was unrelated to the odds of involvement in unpaid productive engagement compared to the less active group (OR=1.004, p=ns). On the other hand, holding other variables constant, the log of the odds of involvement in unpaid productive engagement versus less active group was increased by 0.234 units for the drinker than the non-drinkers. The odd ratio indicated the predicted odds that drinkers involved in unpaid productive engagement versus less active group were 1.263 the odds of non-

drinker (OR=1.263, p<0.01). Thus, those who were drinkers were almost 1.3 times significantly more likely to be involved in unpaid productive engagement versus less active group.

Based on the person-mean centring model, the log of the odds of involving in unpaid productive engagement versus less active group for those who exercised would be 1.19 units higher than those who did not exercise. The odds of participating in unpaid productive engagement versus less active group were increased by 3.3 times for those who exercise compared with those no exercise, holding other variables constant (OR=3.286, p<0.01).

The effect of participation in social activities was attributed to within-person as the between-person effect was nonsignificant. The odds of being involved in unpaid productive engagement were 0.153 (OR=1.166, p<0.05) higher than the less active group. The between-person effect of participation in social activities on unpaid productive activities compared to the less active group at level 1 of 0.074 (OR=1.076, p=ns) is insignificant.

After holding other variables constant, the log of the odds of involvement in unpaid productive engagement versus less active group was increased by 0.167 units for those who were married compared with a single. The odd ratio indicated the predicted odds that those who were married were involving in unpaid productive engagement versus less active group were 1.182 the odds of singles (OR=1.182, p<0.10). Therefore, those who were married were about 1.2 times significantly more likely to be involved in unpaid productive engagement versus the less active group.

The person-mean centring model showed that the log of the odds of being involved in unpaid productive engagement versus less active group for those residing with spouses or others were 1.190 units lower than those living alone. The odds of involving in unpaid productive engagement versus less active group were decreased by 70% (1-0.304=0.696) for those who resided spouse or others compared with those who live alone, holding other variables constant (OR=0.304, $p<0.01$). Hence, individuals who live alone were 3.3 times (1/0.304=3.3) more likely to be involved in unpaid productive engagement versus the less active group than those who live with spouses and others.

The log of the odds of being involved in unpaid productive engagement versus less active group for those who were financially sufficient was 0.196 units lower than those who were financially insufficient. The odds of being involved in unpaid productive engagement versus the less active group were decreased by 18% (1-0.822=0.178) for those who were financially sufficient compared with those who were financially insufficient, holding other variables constant (OR=0.822, $p<0.05$). The financially insufficient older people were 1.2 times (1/0.822=1.2) more likely than those who were financially sufficient to be involved in unpaid productive engagement versus the less active groups. The effect of rural residence was unrelated to the odds of involvement in unpaid productive engagement compared to the less active group.

Based on the person-mean centring model, the log of the odds of involvement in unpaid productive engagement versus less active group increased by 0.982 units for females than the males, holding other variables constant. The odds ratio of participating in unpaid productive engagement versus the less active group for the females was 2.7 times higher than the males (OR=2.669, $p<0.01$). Thus, females were 2.7 times significantly

more likely to be involved in unpaid productive engagement versus less active group than males.

The impact of age (OR=0.986, p=ns), year of schooling or education (OR=0.913, p=ns), and occupation (OR=0.998 and 1.098, p=ns) were unrelated to the odds of involvement in unpaid productive engagement as compared to the less active group.

5.2.4 Results of Model 3: Paid Job Versus the Less Active Group

In this model, the technique of the grand-mean centring was applying to the time-varying quantitative predictors. For category one, the log odds intercept for the odds ratio (0.673) from Model 3 showed the likelihood of an individual involving in the paid job versus a less active group as all the predictors were equal to zero. The odds ratio of 1.961 from Model 3 suggested that the males with all the predictors set as zero or average were about 2.0 times more likely to participate in the paid job than the less active group at the wave 2002 (OR=1.961, $p < 0.01$).

With each one-point increase in self-rated health, the expected odds of paid job versus a less active group increased by 1.343 (OR=1.343, $p<0.01$) times, ceteris paribus. Thus, older adults with better self-rated health were more likely than those with lower self-rated health to participate in a paid job versus less active.

The effect of having the illness was unrelated to the odds of involvement in a paid job as compared to the less active group. However, those who have two illnesses or more were significantly less likely to be involved in the paid job versus the less active group compared with those who were well. The odds of involving in the paid job versus the less active group were decreased by 24.6% (1-0.754=0.246) for those who reported two

illnesses or more compared with those who were well, holding other variables constant (OR=0.754, p<0.01). Thus, those who were well were about 1.3 (1/0.754) times significantly more likely to be involved in the paid job versus the less active group.

Holding other variables constant, as MMSE increases by 1-point, the expected odds of paid job versus less active group were multiplied by 1.112 (OR=1.112, p<0.01). Thus, older adults with higher MMSE were more likely to participate in a paid job than in less active groups.

Based on the grand-mean centring model, the odds of involving in a paid job versus a less active group for those who were IADL independent were 5.7 times higher than those who were IADL dependent, holding other variables constant (OR=5.712, p < 0.01). Thus, those IADL independent were nearly six times significantly more likely to be involved in the paid job than the less active group.

The impact of smoking was unrelated to the odds of involvement in a paid job as compared to the less active group. On the other hand, holding other variables constant, the odd ratio indicated the predicted odds that drinkers involved in the paid job versus less active group were 1.992 the odds of non-drinkers (OR=1.992, p < 0.01). Thus, drinkers were almost two times significantly more likely to be engaged in the paid job versus the less active group.

The log of the odds of involvement in a paid job versus less active group for those who exercised was 0.561 units higher than those who did not exercise. The odds of being involved in the paid job versus less active group were increased by 75% for those who exercised compared with those who did not exercise, holding other variables constant

(OR=1.753, p <0.01). Thus, those who exercised were nearly two times significantly more likely to be involved in the paid job versus the less active group.

The grand-mean centring model showed that the effect of participation in social activities was unrelated to the odds of involvement in a paid job compared to the less active group. After holding other variables constant, the log of the odds of involving in a paid job versus less active group was increased by 0.779 units for those who were married compared with a single. The odd ratio indicated the predicted odds that those who were married were involved in the paid job versus the less active group were 2.179 the odds of a single (OR=2.179, p < 0.01). Therefore, those who were married were about 2.2 times significantly more likely to be involved in the paid job than the less active group.

The log of the odds of involvement in a paid job versus less active group for those residing with spouses or others was 1.469 units lower than those living alone. The odds of participating in the paid job versus less active group were reduced by 77% (1-0.230=0.770) for those who resided spouse or others compared with those who live alone, holding other variables constant (OR=0.230, p < 0.01). Hence, those who live alone were 4.3 times (1/0.230=4.3) more likely to be involved in the paid job versus the less active group.

The log of the odds of involvement in a paid job versus less active group for those who were financially sufficient was 0.368 units lower than those who were financially insufficient. The odds of involving in the paid job versus the less active group were decreased by 30.8% (1-0.692=0.308) for those who were financially sufficiency compared with those who were financially insufficient, holding other variables constant

(OR=0.692, $p < 0.01$). Hence, individuals facing financial insufficiency were 1.4 times (1/0.692) more likely to be involved in the paid job versus the less active group.

Based on the grand-mean centring model, the log of the odds of having a paid job versus a less active group for the rural older people was 0.561 units higher than those living in the city or town. The odd ratio indicated the predicted odds that those who resided in rural was involving in the paid job versus less active group were 1.752 the odds of those who lived in city or town, holding other variables constant (OR=1.752, $p < 0.01$). Thus, those who resided in rural were significantly more likely to be in the paid job than the less active group.

An increase in age at wave 2002 (centred at 70 years old) by one year would bring about a decrease in the odds of being involved in a paid job versus less active group by 8% (1-0.920=0.080). Hence, younger individuals were significantly more likely to be having paid jobs versus less active groups than older individuals (OR=0.920, $p<0.01$), ceteris paribus.

After holding other variables constant, the log of the odds of being involved in a paid job versus a less active group increased by 0.398 units for females than the males. The odds ratio of participating in the paid job versus less active group was increased by 49% for females versus males (OR=1.489, $p<0.01$). Females were 1.5 times more likely to participate in the paid job versus the less active group than males.

The grand-mean centring model showed that the impact of occupation before age 60 was unrelated to the odds of involvement in the paid job as compared to the less active group. Holding other variables constant, however, the log of the odds of involving in

the paid job versus less active group was decreased by 0.201 units for those who had reported one-year schooling and above compared with those who do not attend any formal education. Those without schooling were 1.2 times (1/0.818=1.2) more likely to be involved in the paid job versus the less active group (OR=0.818, p<0.10). The result may due to those without schooling were worked as labourers, farmers, houseworkers, and others.

5.2.5 Results of Model 3: Unpaid Productive Engagement Versus the Less Active Group

For category two, the log odds intercept for the odds ratio (1.440) from Model 3 showed the likelihood of an individual involving in unpaid productive engagement versus a less active group as all the predictors were equal to zero. The odds ratio of 4.220 from Model 3 suggested that males with all the predictors set as zero or average were about 4.2 times more likely to participate in unpaid productive engagement than the less active group at the wave 2002.

The grand-mean centring model showed that holding other variables constant, as self-rated health increases by one point, the expected odds of unpaid productive engagement versus less active group were multiplied by 1.258 (OR=1.258, p<0.01). Older adults with higher self-rated health were more likely to be in unpaid productive engagement versus less active group compared with those with lower self-rated health. Having one illness or more was unrelated to the odds of involvement in unpaid productive engagement compared to the less active group.

Holding other variables constant, as MMSE increases by 1-point, the expected odds of unpaid productive engagement versus less active group were multiplied by 1.111

(OR=1.111, p<0.01). Thus, older adults with higher MMSE were more likely to participate in an unpaid job than in less active groups.

Based on the grand-mean centring model, the log of the odds of involving in unpaid productive engagement versus less active group for those who were IADL independent were 1.02 units higher than those who were IADL dependent. The odds of participating in unpaid productive engagement versus less active group were significantly increased by 2.8 times for those who were IADL independent compared with those IADL dependences, holding other variables constant (OR=2.774, p < 0.01).

The impact of smoking was unrelated to the odds of involvement in unpaid productive engagement as compared to the less active group. On the other hand, holding other variables constant, the log of the odds of involvement in unpaid productive engagement versus less active group was increased by 0.238 units for drinkers than a non-drinker. The odd ratio indicated the predicted odds that drinkers involved in unpaid productive engagement versus less active group were 1.269 the odds of non-drinker (OR=1.269, p < 0.01). Thus, drinkers were almost 1.3 times significantly more likely to be involved in unpaid productive engagement than the less active group.

The log of the odds of involving in unpaid productive engagement versus less active group for those who exercised was 1.195 units higher than those who did not exercise. The odds of participating in unpaid productive engagement versus less active group were increased by 3.3 times for those who exercise compared with those no exercising, holding other variables constant (OR=3.304, p < 0.01).

Holding other variables constant, as participation in social activities increases by 1-point, the expected odds of unpaid productive engagement versus less active group were multiplied by 1.117 (OR=1.117, $p<0.05$). Thus, older adults with higher participation in social activities were more likely to participate in unpaid productive engagement versus the less active group than those with lower participation in social activities.

The grand-mean centring model showed that the log of the odds of being involved in unpaid productive engagement versus less active group for those who were married was 0.162 units higher than the single. The odd ratio indicated the predicted odds that those who were married were involving in unpaid productive engagement versus less active group were 1.176 the odds of the single (OR=1.176, $p < 0.10$). Therefore, those who were married were about 1.2 times significantly more likely to be involved in unpaid productive engagement versus the less active group.

The log of the odds of involving in unpaid productive engagement versus less active group for those residing with spouses or others was 1.188 times lower than those living alone. The odds of involving in unpaid productive engagement versus less active group were decreased by 70% (1-0.305=0.695) for those who resided spouse or others compared with those who live alone, holding other variables constant (OR=0.305, $p < 0.01$). Hence, those who lived alone were 3.3 times (1/0.305=3.3) more likely to be involved in unpaid productive engagement than less active.

Based on the grand-mean centring model, the log of the odds of involving in unpaid productive engagement versus less active group for those who were financially sufficient was 0.188 units lower than those who were financially insufficient. The odds of involving in unpaid productive engagement versus less active group were decreased

by 17.2% (1-0.828=0.172) for those who were financially sufficiency compared with those who were financially insufficient, holding other variables constant (OR=0.828, p < 0.10). Hence, those facing financial insufficiency were 1.2 times (1/0.828) and were significantly more likely to be involved in unpaid productive engagement than less active groups. The effect of residing in rural was unrelated to the odds of involvement in unpaid productive engagement compared to the less active group (OR=0.990, p=ns).

After holding other variables constant, the log of the odds of involvement in unpaid productive engagement versus less active group increased by 0.979 units for females compared to males. The odds ratio of participating in unpaid productive engagement versus less active group increased by 2.7 times for females versus males (OR=2.661, p < 0.01). Thus, females were 2.7 times significantly more likely to be involved in unpaid productive engagement versus less active group than males. The impact of age, year of schooling, education, and occupation were unrelated to the odds of involvement in unpaid productive engagement compared to the less active group.

5.3 Summary of Hypotheses

Based on the above results, Hypothesis One (Individuals with better health-related human capital (physical, cognitive, and functional health, and without chronic diseases) are more likely to involve in productive engagement over time) was mainly supported except for chronic diseases. Individuals with better health-related human capital (physical, cognitive, and functional health) were more likely to involve in productive engagement (paid job and unpaid productive engagement) over time while those with two or more chronic diseases were less likely engage paid jobs over time.

Hypothesis Two (Individuals with smoking, drinking, or exercising behaviour are associated with the participation in productive engagement over time) was mainly supported except for smoking behaviour. Individuals with drinking and exercising behaviour were more likely involved in productive engagement over time.

As for Hypothesis Three (Various social capitals (social activities, marital status, and living arrangement) are associated with the participation in productive engagement over time) was partially supported. Individuals who were more actively involved in social activities (within changes) as well as individuals who were married and living alone were more likely to engage paid jobs over time while individuals who actively participated in social activities, married older adults, and those who lived alone were more likely to participate in unpaid productive engagement over time.

In terms of Hypothesis Four (Financial Sufficiency is associated with participation in productive engagement over time) was supported as individuals who were financially insufficient were more likely to participate in productive engagement over time.

As for Hypothesis Five (The rural-urban environment is associated with participation in productive engagement over time) was partially supported as individuals living in rural areas were more likely to engage paid jobs but physical environment did not affect participation in unpaid productive engagement over time.

This study found that Hypothesis Six (Demographic factors (age, gender, pre-retirement occupation, and education status) are associated with participation in productive engagement over time) was partially supported. It found that younger older adults and individuals who worked as workers or farmers were more likely to engage paid job over

time while women were more likely to participate in unpaid productive engagement over time.

5.4 Discussion

5.4.1. Health and Personal Determinants

This study found that the between-person and within-person effects of self-rated health impacts both paid and unpaid productive engagement (Model 2). The grand mean of self-rated health was also associated with paid and unpaid productive engagement (Model 3). These findings are consistent with that of two separate studies by Morrow-Howell (Morrow-Howell et al., 2014; Morrow-Howell & Greenfield, 2016) as well as other studies that were conducted in Netherland, Vietnam, Norway, and the United States (Dahl et al., 1999; Dingemans et al., 2016; Friedman et al., 2001; Szinovacz & Davey, 2005). Several studies indicate that self-rated health is a significant determinant of productive ageing, successful ageing, active and healthy ageing, and successful ageing (Urtamo et al., 2019). Apart from that, self-rated health also acts as an essential predictor for mortality (Jylhä, 2009; Whitley et al., 2016) and frailty in old age (Huohvanainen et al., 2016). For instance, healthier older adults have a higher likelihood of viewing continuing to work as a viable alternative (Schwingel et al., 2009). Self-rated health was also a vital determinant in distinguishing between workers and retirees in urban China as well as the types of activities that they could engage in (Ling & Chi, 2008). Therefore, health is an essential determinant as it affects the daily activities of older adults.

Self-rated health is also a significant determinant of unpaid productive engagements as well. Similar to other studies, this study found that health significantly enabled older adults to participate in unpaid productive engagements (Di Gessa & Grundy, 2014; V. Loh & Kendig, 2013) as good health empowers them to continue their lifestyle and

remain active as they age (W. Zhang & Wang, 2019). Based on data drawn from the English Longitudinal Study of Ageing (ELSA) and the Survey of Health, Ageing, and Retirement in Europe (SHARE), Di Gessa and Grundy (2014) concluded that better health is gives older adults the momentum to remain more active over time. Morrow-Howell et al. (2014) also concluded that individuals with higher self-rated health had a higher likelihood of participating in activity engagement. Therefore, human capital in the form of physical health strongly correlates with productive engagement in later life.

Although multimorbidity (having two or more chronic diseases) may hinder older adults from engaging paid jobs, it does not deter them from participating in unpaid productive engagement. While an older employee with multimorbidity may experience reduced workability (Kadijk et al., 2019; Ubalde-lopez et al., 2017; Ubalde-Lopez et al., 2014), this impact intensifies if the employee has a mental health problem that affects his/her ability to cope with work (Kadijk et al., 2019). One study revealed that multimorbidity correlates with inferior quality of life (Garin et al., 2014). Consequently, quality of life strongly correlates with workability (Tavakoli-Fard et al., 2016). A recent Indian study found that individuals with chronic health conditions had a lower likelihood engaging paid jobs (Visaria & Dommaraju, 2019).

Nevertheless, it is noteworthy that suffering from one or more chronic diseases does not deter older adults from participating in unpaid productive engagement. One possible reason could be that older adults in China are still actively involved in housework, growing vegetables or performing other fieldwork, gardening, and rearing domestic animals. Hudon et al. (2008) found that multimorbidity did not affect physical activity levels in both men and women after accounting for other factors; such as age, educational background, income, and employment. The previously mentioned Indian study also found

that chronic health conditions did not hinder participating in unpaid productive engagements; such as grandparenting (Visaria & Dommaraju, 2019).

Cognitive health was found to be a significant predictor of paid and unpaid productive activities as individuals with better cognitive health generally had a higher likelihood of participating in paid and unpaid engagement. This study found that the between-person and within-person effects of cognitive health (measured by MMSE) impact paid and unpaid productive engagement (Model 2). Apart from that, the grand mean of cognitive health was also associated with paid and unpaid productive engagement (Model 3). Cognitive abilities impact whether an employee will age successfully at work (Zacher, 2015). This is especially true if the job in question requires high levels of fluid intelligence; such as the fast processing of rapidly changing information, for instance (Kanfer & Ackerman, 2004; Salthouse, 2012). Other studies found that intra-individual age-related changes over time in factors; such as cognitive abilities; might mediate the association between age and task performance (Kanfer & Ackerman, 2004; T. W. H. Ng & Feldman, 2013). Older adults with better cognitive health were also more likely to consider working and continue working (S. Kim, 2020; Schwingel et al., 2009). According to the World Health Organization's Study on Global Ageing and Adult Health (SAGE), people with mild cognitive impairment may significantly benefit from engaging in meaningful occupation (Vancampfort, Lara, et al., 2018). Furthermore, cognitive function plays a significant role in maintaining employment and executing life activities (O. E. Lee & Lee, 2014). Therefore, human capital in the form of cognitive health strongly correlates with productive engagement in old age.

Another notable finding was the strong correlation between functional health or ability (measured by IADL) and paid and unpaid productive engagements (S. Kim, 2020;

Morrow-Howell et al., 2014; Visaria & Dommaraju, 2019). The rate of change in productive activities over time correlates with the trajectory of age-related functional health (E. Choi et al., 2016). Although a paid job may require minimal physical strength to executing tasks; such as travelling to and from work, engagement in paid and unpaid productive activities; such as volunteer work; correlates positively with functional ability (Luoh & Herzog, 2002). Older adults with IADL dependencies were considerably less likely to participate in unpaid productive engagement; such as grandparenting, community activities, and religious programmes (Visaria & Dommaraju, 2019). Therefore, human capital in the form of functional health strongly correlates with productive engagement among older adults.

5.4.2 Behavioural Determinants

Although a few studies have concluded that being a non-smoker (never smoked or former smoker) or a light smoker (smoked less than 30 to 40 packs of cigarettes per year) is a predictive factor of healthy ageing (Ford et al., 2000; Goren et al., 2015; Haveman‐Nies et al., 2003; Newman et al., 2003; Peel et al., 2005; Vaillant & Mukamal, 2001), this study only found limited evidence to indicate that being a current non-smoker impacts paid and unpaid productive engagement. These insignificant findings were consistent with that of a study on the correlation between successful ageing and smoking status in China and Korea (Q. Feng et al., 2015). Furthermore, a study of 24 high-income OECD countries found no correlation between the prevalence of tobacco use and labour force participation (Johnson et al., 2015). One potential reason might be that smoking is ingrained and common in Chinese culture. Yao et al. (2009) found that of 823 male surgeons investigated across six cities in China, 45% were smokers and 43% reported having smoked in front of patients.

Alcohol consumption among older adults is not just a dietary habit but a socio-cultural means of maintaining a "guanxi" or "network" (Q. Feng et al., 2010; X. L. Feng et al., 2014; D. Gu et al., 2008). Pruchno and Wilson-Genderson (2015) suggest that moderate drinking correlates with successful ageing. Therefore, it is no surprise that alcohol consumption correlates with paid and unpaid productive engagement. However, this needs to be addressed in the socio-cultural context of China. A study of China and Korea found that alcohol consumption strongly correlates with a higher likelihood of successful ageing (Q. Feng et al., 2019) while, in the United Kingdom, older adults who reported better-perceived health status with a moderately active and sociable lifestyle were more likely to consume alcohol (Hajat et al., 2004). A few studies also found that light-to-moderate alcohol consumption might also improve self-rated health among older adults; for example by lowering the risk of heart disease (L. Gu & Qiao, 2006; W. Hao et al., 2004; W. C. Hsu et al., 2017; Murray et al., 2002; National Institute on Alcohol Abuse and Alcoholism, 1999). Data obtained from the WHO (WHO, 2014) shows that populations in countries with enormous economic wealth had higher levels of alcohol consumption. Furthermore, cultural norms encourage social drinking while discouraging solitary drinking (W. Hao et al., 1999). In China, social events; such as festivals, weddings, and business interactions; are occasions that promote drinking (J. Li et al., 2017). Apart from that, traditional Chinese customs, especially in rural areas, dictate that moderate consumption of medicinal or herbal wines benefits health and can treat some illnesses and symptoms, such as leg and back pain (W. Hao et al., 2004; J. Li et al., 2017; Tao et al., 2002). Nevertheless, a meta-analysis that evaluated a total of 599,912 active drinkers from 83 long-term prospective studies across 19 high-income countries found that drinkers had the highest risk of all-cause mortality (Wood et al., 2018). It went on to suggest that consumption of less than 100g/week had the lowest risk of all-cause mortality.

Although primary ageing is inevitable, secondary ageing is as it caused by cellular deterioration due to lifestyle factors and environmental exposure and, therefore, preventable through lifestyle changes and exercise (Fragala, 2015). This study examined the correlation between engaging in physical activity and paid and unpaid productive engagements. The perspective of the WHO's Active Ageing Framework on behavioural risk factors is that exercising habits correlate with both paid and unpaid productivity engagement.

Several researchers report that exercise could mitigate age-related changes in body composition, reduce the risk of disability, delay aerobic fitness frailty, palliate chronic conditions; such as heart disease, diabetes, and osteoarthritis; improve psychological and cognitive well-being as well as increase longevity (Benton, 2015; Chodzko-Zajko et al., 2009; Fragala, 2015; W. Han & Shibusawa, 2015). Manas et al. (2019) recorded that moderate-to-vigorous physical activity (about 27 minutes/day) moderated the correlation between sedentary time and frailty status. Olds et al. (2016) indicate that physical activity was the most enjoyable activity of the young and old while Vogelsang (2018) found that regular exercise correlated with health improvements even for the oldest of the old. It also slowed the health deterioration of older adults in China (W. Han & Shibusawa, 2015). A cohort study of 17,708 women in the United States who averaged approximately 4,400 to 7,500 steps per day (instead of 10,000 steps per day) was associated with significantly lower mortality rates (I. Lee et al., 2019).

5.4.3 Social Determinants

Participation in social activities alludes to the extent to which older adults are embedded and connected to the communities that they live in. This study found that within-person, and not between-person, participation in social activities impacted paid job engagement

(Model 3). This implies that intra-individual engagement motivates older adults to engage paid jobs. A similar phenomenon was also observed with regard to participation in unpaid productive engagement. This suggests that those who consistently participated in social activities created more social resources or networks. As such, they were more likely to remain in paid and unpaid productive engagements for longer periods of time (S. Kim, 2020; Morrow-Howell et al., 2014; Morrow-Howell & Greenfield, 2016). Therefore, social capital in the form of social activities correlates with productive engagement among older adults.

Regular meetings and interacting with other people enables older persons to confide in their social groups and family members (Tran et al., 2018). Furthermore, the number of social activities and consistent participation in social activities correlated positively with quality of life (Park et al., 2015). The 10-year Komo-Ise cohort study in Japan observed a higher risk of mortality among retired men who lacked participation in social activities (Tanaka et al., 2018). Employment was also found to enhance social functioning among older adults as they had more opportunities to be physically active and connect socially (Vancampfort, Lara, et al., 2018). Apart from that, social participation correlated with a lower risk of mortality among older Chinese adults, especially women and young-old adults (J. Wu & Li, 2018).

Nevertheless, a more comprehensive measure of participation in social activities is needed in order to support the finding that within-person participation in social activities is more critical than between-person participation in impacting paid job engagement. As this study only included two kinds of social activities; playing cards or mah-jong and attending organised activities; other forms of social activities should be included to enhance the quality of the research.

Older adults, especially married men, may delay retirement to provide more financial support to their families. Using the Urban Institute's Dynamic Simulation of Income Model (DYNASIM3), Butrica et al. (2006) found that workers and low-income workers who delayed retirement may increase their annual retirement income by approximately 9% and 16%, respectively. With the support of a spouse, those who were married were more likely to be engaged in paid jobs (Teerawichitchainan et al., 2019). Kim and Moen's (2002) found that married men may have a higher risk of suffering from depression when their wives retired later than them. Ling and Chi (2008) also found that marital status was an essential factor in determining the work status of older women. Several studies indicate that married older adults are more likely to be involved in unpaid productive engagement; such as caregiving and managing household finances (H. C. Hsu et al., 2019; S. Kim, 2020; Visaria & Dommaraju, 2019). Couples data collected by the Household, Income and Labour Dynamics in Australia (HILDA) survey across 15 waves indicates that participating in social activities is a protective factor against deterioration in health among older adults and their partners (Lam & Bolano, 2019).

Older adults who live alone are more likely to be involved in paid and unpaid productive activities (Utz et al., 2002). S. Liu et al. (2019) found that older Chinese adults aged above 55 years and living alone have relatively lower retirement rates than any other type of living arrangement. One possible explanation could be that individuals who lived alone may need to have sufficient income and economic incentives to sustain their lives at old age. On the other hand, active involvement in unpaid productive engagements and delaying retirement improved financial benefits, social integration, social support, and the ability to cope with the loss of a spouse (Cohen, 2004; Erikson et al., 1986; Johnson, 2009; Utz et al., 2002).

5.5.4 Economics Determinants

The current study found that financially insufficient older adults participated in paid job engagement. Individuals in the paid job group may have no other option but to continue working as they have not adequately prepared financially for retirement and do not have enough pension to fulfil their economic needs (Hu & Das, 2019; J. Kim et al., 2018; O. E. Lee & Lee, 2014). If older adults who are facing financial difficulties are excluded from income-generating activities, they may face decreased income, lower self-esteem, and a sense of loneliness (J. Kim et al., 2018). Furthermore, individual families and society may have to shoulder the responsibility and provide them with care. Apart from that, the financial status of older adults could play an essential role in providing more resources with which to maintain good health. As such, the "affluence or leisure preference" hypothesis may explain the financially insufficient older adults wherein they may have to continue working at old age.

Studies revealed that experiencing economic hardships for four years or more results in worse physical capabilities, poorer cognitive function, and higher inflammatory levels (Al Hazzouri et al., 2017; Foverskov et al., 2020; Leone & Hessel, 2016). Therefore, escaping economic hardship prevents accelerated ageing in older adults (Foverskov et al., 2020; Willson & Shuey, 2016).

On the contrary, relative poverty may be associated with higher death rates among retired men (Tanaka et al., 2018). This study showed that financial insufficiency correlated with unpaid productive engagement. Interestingly, older adults with lower household incomes had a higher likelihood of participating in domestic work (V. Loh & Kendig, 2013).

5.4.5 Physical Environment Determinants

Studies indicate that most urban workers in China have a pension after reaching the mandatory retirement age of 55 for women and 60 for men (G. Chen & Gao, 2013; Giles et al., 2011). However, most older adults in rural China do not have pensions (Giles et al., 2011; Ravallion & Chen, 2007). Y. Wang et al. (2017) also found that older adults; aged 50 and above; in rural China were significantly more likely to work-for-pay than their urban counterparts. This is because older adults in rural China, the women included, may view work as a necessity rather than a choice and believe that they need to continue working so long as they are physically capable and able to (G. Chen & Gao, 2013; Giles et al., 2011; F. Tang et al., 2018). These individuals work on their farms or through extended family arrangements (Benjamin et al., 2003). Many studies have found that older adults in developing countries often engage in productive activities until late in life due to low lifetime earnings, low household savings, and limited welfare provisions (Benjamin et al., 2003; Hu & Das, 2019; Pang et al., 2004). Despite this, older adults in rural areas achieved higher life satisfaction than their urban peers (F. Tang et al., 2018). There was no difference in participation in unpaid productive engagement between rural areas and cities or towns. In this study, the ecological system theory explains that those who living in rural areas were more likely engage paid job than participate in unpaid productive engagement.

5.4.6 Demographic Variables

After accounting for other factors in the model, the gender differential was reversed to show women having higher odds of participating in both paid and unpaid productive engagement than men. A few studies reported that women, especially rural women, are expected to work into old age. Based on the CHARLS, Henry et al. (2018) found that older female workers were more likely than males to work in agriculture and non-

agricultural work for as long as they could. For instance, 64% of older urban women and 74% of older rural women aged 60 estimated they would work until they were physically unable to in comparison to 50% of older urban men and 58% of older rural men in non-agricultural work. Lortie (2012) observed a trend in some countries whereby the employment of rural women was higher than that of men due to the rural-urban migration of the men. Bond et al. (2005) found that the likelihood of older female employees working part-time was higher than that of men. A Vietnamese study also showed that urban females were significantly more likely to work than urban males after controlling for other factors (L. T. Giang et al., 2018). This could be because urban women face a lower mandatory retirement age, lower pension benefits, and less opportunities to build savings (Henry et al., 2018). Apart from that, women also faced issues of vulnerability, lack of formal work status, pension, and sources of alternative income as well as longer life expectancy, reliance on household agriculture, and engaging in care work(Henry et al., 2018).

Many studies report that older women are more actively involved in unpaid productive engagements (Y. Luo et al., 2012; Morrow-Howell et al., 2014; Teerawichitchainan et al., 2019; Visaria & Dommaraju, 2019). A study by Lam & Bolano (2019) study found that individuals with spouses who were socially inactive or less socially active had worsening health, especially among men. This may because older men are more dependent on their spouses for social participation.

Similar to the findings of previous studies, this study also found that the likelihood of involvement in paid jobs decreased with age (L. T. Giang et al., 2018; J. H. Kim, 2019; Morrow-Howell et al., 2014; Visaria & Dommaraju, 2019). However, unlike previous studies (J. H. Kim, 2019; Morrow-Howell et al., 2014), this study found limited evidence

of age-related decline in unpaid productive engagement. Instead, this study found that older adults still participated in productive engagements as they aged. Although the likelihood of involvement in paid jobs decreased with age, it did not affect participation in unpaid productive engagement. This supports the social-location context of the life course perspective.

Pre-retirement employment; be it worker or farmer; was another factor that affected the likelihood of involvement in paid jobs. The findings of this study indicate that older adults may not have accumulated sufficient economic resources to sustain them throughout their golden years. Furthermore, individuals who previously worked in the agricultural sector may have more opportunities to continue working after retirement. Regardless, pre-retirement employment was found to be an insignificant factor in determining the participation of older adults in unpaid productive engagement.

Several studies have concluded that educational background is essential when estimating the likelihood of job participation among older adults in other countries (Dahl et al., 1999; Friedman et al., 2001; Morrow-Howell et al., 2014; Szinovacz et al., 2001). In Model 3, individuals with no schooling were more likely to continue working because they had previously worked as labourers or farmers. This is corroborated by findings in Vietnam and Thailand, where the education variable was correlated negatively with labour force participation (Adhikari et al., 2001; Long & Ly, 2015). This is because individuals with higher levels of education were more likely to have previously worked in the formal sector and, therefore, had pensions after retirement. A study of longitudinal data from 24 OECD countries between 1980 to 2010 also found that educational background did not impact labour force participation (Johnson et al., 2015).

Furthermore, limited education did not prevent older adults from participating in productive activities. Nevertheless, the future generation of older adults will be better educated (The World Bank, 2016). Therefore, increased investment in life-long learning is needed in order for older adults to improve their capacity for productive engagement later in life.

5.5 Conclusion

Based on the analysis of the two-level random-intercept multilevel multinomial logit models, the person-mean centring models offered more insights than the grand-mean centring models in explaining the active participation of older people. The findings revealed that the impact of participation in social activities on paid and unpaid productive engagement was from intra-individual differences. The between-person and within-person self-rated health and MMSE had a significant impact on paid and unpaid productive engagement.

The human capital in the form of physical health, cognitive health and functional health, drinking and exercising behavioural variables under the WHO active ageing framework and the "affluence or leisure preference" hypothesis were supported in this study. Meanwhile, variables that related to social capital, social-location contexts under the life course perspective (age and female), human capital such as pre-retirement occupation and education status, and the ecological system theory were partially supported. Table 5.3 showed the summary of the results of the two-level random-intercept multilevel multinomial logit models.

Table 5.3: Summary of the Results of the Two-Level Random-Intercept Multilevel Multinomial Logit Models

Determinants/Variables	Paid Job vs Less Active Group				Unpaid productive engagement versus Less Active Group			
	Model 2 PM-2L		Model 3 GM-2L		Model 2 PM-2L		Model 3 GM-2L	
Fixed Effects	**OR**	**Sig.**	**OR**	**Sig.**	**OR**	**Sig.**	**OR**	**Sig.**
Intercept	**1.575**	*	**1.961**	***	**3.486**	***	**4.220**	***
Between person self-rated health	**1.380**	***			**1.341**	***		
Within person self-rated health	**1.314**	***			**1.196**	***		
Grand mean self-rated health			**1.343**	***			**1.258**	***
One chronic disease (ref. well)	0.903		0.900		0.968		0.965	
Two chronic diseases and above (ref. well)	**0.759**	***	**0.754**	***	0.928		0.916	
Between person MMSE	**1.104**	***			**1.119**	***		
Within person MMSE	**1.116**	***			**1.105**	***		
Grand mean MMSE			**1.112**	***			**1.111**	***
IADI (ref. dependence)	**5.717**	***	**5.712**	***	**2.757**	***	**2.774**	***
Smoking (ref. no smoking)	1.000		0.993		1.004		1.001	
Drinking (ref. no drinking)	**1.992**	***	**1.992**	***	**1.263**	***	**1.269**	**
Exercising (ref. no exercise)	**1.754**	***	**1.753**	***	**3.286**	***	**3.304**	***
Between person social activities	0.952				1.076			
Within person social activities	**1.178**	**			**1.166**	**		
Grand mean social activities			1.050				**1.117**	**
Marital status (ref. others)	**2.202**	***	**2.179**	***	**1.182**	*	**1.176**	*
Living arrangement: (ref. alone)	**0.229**	***	**0.230**	***	**0.304**	***	**0.305**	***
Financial sufficiency (ref. financial insufficiency)	**0.696**	***	**0.692**	***	**0.822**	**	**0.828**	*
Rural (ref. city/town)	**1.716**	***	**1.752**	***	0.989		0.990	
Age at wave 2002	**0.920**	***	**0.920**	***	0.986		0.984	
Female (ref. male)	**1.477**	***	**1.489**	***	**2.669**	***	**2.661**	***
Professional or governmental (ref. housemaker & others)	0.961		0.925		0.998		0.987	
Worker or farmer (ref. housemaker and others)	**1.430**	**	**1.439**	**	1.098		1.094	
Education (Year of Schooling) (ref. unschooled)	0.851		**0.818**	*	0.913		0.912	
Random Effects	**CE**	**Sig.**	**CE**	**Sig.**	**CE**	**Sig.**	**CE**	**Sig.**
Random Effect Block 1	**0.456**	***	**0.457**	***	**0.165**	***	**0.162**	**
Intraclass correlation (ICC) Level 2	12.2%		12.2%		4.8%		4.7%	

Note: Note: ***p<0.01, **p<0.05, *p<0.10; OR = Odds Ratio; PM = Personal-Mean Centring; GM = Grand-Mean Centring; 2L = Two-Level Modelling; CE = coefficient.

CHAPTER 6: THREE-LEVEL RANDOM-INTERCEPT MULTILEVEL MULTINOMIAL LOGIT MODELS FOR LONGITUDINAL DATA

6.1 Introduction

This chapter presents the findings based on three-level random-intercept multilevel multinomial logit models for longitudinal data. The main purpose is to investigate if the differences of provinces affect the productive engagement of the older population in China. The analyses begin with the three-level unconditional model (Model 4), followed by three-level random-intercept multilevel multinomial logit models that include time-invariant and time-varying variables. The person-mean centring and grand-mean centring were used in Model 5 and Model 6, respectively.

6.2 Results of the Three-Level Random-Intercept Multilevel Multinomial Logit Models for Various Engagements

6.2.1 Results of Model 4: Unconditional Model

Models 4 to 6 signify the three-level multilevel models with the wave nested within an individual and individuals nested within the provinces (Table 6.1). The log-odds intercept for category one (paid job versus less active group) from Model 4 is 1.168, which refers to the grand mean log-odds coefficient across the four waves. The intercept represents the predicted log odds when all variables in the model are equal to 0. The estimated intercept shows that the individual was about 3.2 times more likely to be involved in a paid job than the less active group at wave 2002 (OR= 3.217, $p < 0.01$).

For category two (unpaid productive engagement versus less active group), the odds ratio of participating in unpaid productive engagement was 4.9 times greater than the less active group (OR = 4.853, $p < 0.01$).

For those involved in a paid job, the average individual-level probability was 36%. The probability of participating in unpaid productive engagement was 54%, and for the reference, the group was 11%. The variance components at level 2 suggested that both intercepts vary across individuals ($\sigma^2_{uoj(1)}$= 0.106, SE = 0.049; $\sigma^2_{uoj(2)}$= 0.082, SE = 0.036). In both cases, the *Z* tests suggested significant variability in productive engagement between individuals. The variance components at level 3 suggested that both intercepts vary across individuals ($\sigma^2_{voj(1)}$= 0.659, SE=0.069; $\sigma^2_{voj(2)}$= 0.269, SE = 0.059). In both cases, the *Z* tests suggested significant variability in productive engagement between provinces. Therefore, the results justified developing a three-level multilevel model. The estimated probability for each response category in Model 4 (with just the intercept) is as follows:

$$\pi_{tij} = (\exp(\eta_{tij})/(1 + \sum_{t=1}^{t-1} \exp(\eta_{tij}))$$

$$P(Y = 0) = \frac{1}{1 + \exp(1.168) + \exp(1.580)} = 11.0\%$$

$$P(Y = 1) = \frac{\exp(1.168)}{1 + \exp(1.168) + \exp(1.580)} = 35.5\%$$

$$P(Y = 2) = \frac{\exp(1.580)}{1 + \exp(1.168) + \exp(1.580)} = 53.5\%$$

An intraclass correlation (ICC) as calculated from empty means, and the random intercept model (Model 4) indicated 2.6% [$\frac{0.106}{0.106+0.659+\frac{\pi^2}{3}}$] of the variation in a paid job than the less active group between persons, and 16.2% [$\frac{0.659}{0.106+0.659+\frac{\pi^2}{3}}$] of the variation in a paid job than the less active group between provinces. For unpaid productive engagement versus less active group, the ICC is 2.2% [$\frac{0.082}{0.082+0.269+\frac{\pi^2}{3}}$] of the variation in

unpaid productive engagements compared to the less active group between persons and 7.4% $[\frac{0.269}{0.082+0.269+\frac{\pi^2}{3}}]$ of the variation in unpaid productive engagement as compared to the less active group was between provinces.

Table 6.1: Results of Unconditional Model of the Three-Level Random-Intercept Multilevel Multinomial Logit Models

Variables	Model 4				
	Log-Odds	**Odds Ratio**	**95% CI Lower**	**95% CI Upper**	**Sig.**
Paid Job vs Less Active Group					
Intercept	1.168	3.217	2.684	3.856	***
Unpaid Productive Engagement vs Less Active Group					
Intercept	1.580	4.853	4.138	5.690	***
Random Effect	**Co-efficient**	**Std. Error**	**95% CI Lower**	**95% CI Upper**	**Sig.**
Random Effect Block 1					
Paid job: Variance	0.106	0.049	0.043	0.261	**
Unpaid productive engagement: Variance	0.082	0.036	0.035	0.192	**
Random Effect Block 2					
Paid job: Variance	0.659	0.069	0.537	0.808	***
Unpaid productive engagement: Variance	0.269	0.059	0.175	0.415	***
Intraclass correlation (ICC)					
Paid job: Level 2	2.6%				
Unpaid productive engagement: Level 2	2.2%				
Paid job: Level 3	16.2%				
Unpaid productive engagement: Level 3	7.4%				
-2 log-likelihood	68,430				
Akaike Corrected	68,438				
Bayesian	68,466				

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

6.2.2 Results of Model 5: Paid Job Versus the Less Active Group

Model 5 separates the between- and within-person effects from the person parts of the time-varying quantitative predictors, including the provincial factor (Table 6.2). The log odds of the intercept (0.498) in Category One (paid productive engagement versus the less active group) showed an individual's likelihood of participating in paid productive

engagement versus the less active group when all the predictors were = 0. The odds ratio of 1.646 suggested that, with all the predictors set as 0 or average, men were about 1.6 times more likely to participate in paid productive engagement than the less active group in the 2002 wave (OR = 1.646, $p < 0.05$).

The person-mean centring model; which included provincial effects; showed that the log odds of the between-person effect (0.430) in self-rated health was more significant than the within-person effect (0.240). Furthermore, the significant between-person effect in self-rated health at level 2 (1.538) indicated that for every one-point increase in a person's mean self-rated health over another person's mean self-rated health, the odds of participation in paid productive engagement versus the less active group was 1.5 times higher (OR = 1.538, $p < 0.01$). The significant within-person effect in self-rated health at level 1 (1.272) indicated that for every one-point increase in a person's own mean self-rated health, the odds of participation in paid productive engagement versus the less active group was 1.3 times higher (OR = 1.272, $p < 0.01$). This indicated that being healthier than other people was more significant in predicting the likelihood of participation in paid productive engagement versus the less active group than being healthier than usual. Regardless, variations in both inter- and intra-individual differences in self-rated health mattered to some extent. The cross-sectional effect did translate longitudinally in self-rated health. Multimorbidity did not affect the odds of participation in paid productive engagement versus the less Active Group.

Table 6.2: Three-Level Random-Intercept Multilevel Multinomial Logit Models for Various Engagements

Determinants/Variables	Model 5					Model 6				
Fixed Effects	**Log-Odds**	**Odds Ratio**	**95% LCI**	**95% UCI**	**Sig.**	**Log-Odds**	**Odds Ratio**	**95% LCI**	**95% UCI**	**Sig.**
Paid Job vs Less Active Group										
Intercept	**0.498**	**1.646**	**0.949**	**2.854**	**	**0.748**	**2.113**	**1.227**	**3.640**	***
Between person self-rated health	**0.430**	**1.538**	**1.289**	**1.835**	***					
Within person self-rated health	**0.240**	**1.272**	**1.068**	**1.514**	***					
Grand mean self-rated health						**0.323**	**1.382**	**1.213**	**1.574**	***
One chronic disease (ref. well)	-0.129	0.879	0.664	1.162		-0.121	0.886	0.670	1.172	
Two chronic diseases and above (ref. well)	-0.225	0.798	0.571	1.115		-0.240	0.787	0.560	1.106	
Between person MMSE	**0.103**	**1.109**	**1.064**	**1.156**	***					
Within person MMSE	**0.089**	**1.093**	**1.061**	**1.127**	***					
Grand mean MMSE						**0.097**	**1.102**	**1.076**	**1.129**	***
IADI (ref. dependence)	**1.632**	**5.115**	**3.924**	**6.668**	***	**1.650**	**5.209**	**3.960**	**6.851**	***
Smoking (ref. no smoking)	-0.017	0.983	0.730	1.325		-0.022	0.978	0.727	1.315	
Drinking (ref. no drinking)	**0.660**	**1.934**	**1.535**	**2.437**	***	**0.669**	**1.953**	**1.548**	**2.465**	***
Exercising (ref. no exercise)	**0.645**	**1.906**	**1.540**	**2.357**	***	**0.651**	**1.918**	**1.548**	**2.376**	***
Between person social activities	-0.049	0.952	0.828	1.096						
Within person social activities	**0.134**	**1.143**	**0.984**	**1.329**	*					
Grand mean social activities						0.047	1.048	0.927	1.186	
Marital status (ref. others)	**0.757**	**2.132**	**1.573**	**2.890**	***	**0.764**	**2.147**	**1.577**	**2.922**	***
Living arrangement: (ref. alone)	**-1.548**	**0.213**	**0.150**	**0.302**	***	**-1.547**	**0.213**	**0.150**	**0.301**	***
Financial sufficiency (ref. financial insufficiency)	**-0.313**	**0.731**	**0.612**	**0.874**	***	**-0.291**	**0.748**	**0.630**	**0.888**	**
Rural (ref. city/town)	**0.450**	**1.568**	**1.332**	**1.846**	***	**0.454**	**1.575**	**1.346**	**1.843**	***
Age at wave 2002	**-0.097**	**0.908**	**0.874**	**0.943**	***	**-0.097**	**0.907**	**0.873**	**0.943**	***
Female (ref. male)	0.313	1.368	0.708	2.641		**0.316**	**1.372**	**1.080**	**1.743**	***
Professional or governmental (ref. housemaker & others)	-0.134	0.875	0.539	1.420		-0.173	0.841	0.532	1.329	
Worker or farmer (ref. housemaker and others)	0.307	1.360	0.928	1.993		0.295	1.343	0.930	1.939	
Education (Years of Schooling) (ref. unschooled)	-0.200	0.819	0.648	1.034		-0.216	0.805	0.646	1.004	

Table 6.2, continued

Determinants/Variables	Model 5					Model 6				
Fixed Effects	**Log-Odds**	**Odds Ratio**	**95% LCI**	**95% UCI**	**Sig.**	**Log-Odds**	**Odds Ratio**	**95% LCI**	**95% UCI**	**Sig.**
Between Provincial GDP per Capita	**-0.706**	**0.494**	**0.380**	**0.642**	***					
Within Provincial GDP per Capita	-0.259	0.772	0.470	1.267						
Grand Mean Provincial GDP per Capita						**-0.591**	**0.554**	**0.432**	**0.709**	***
Unpaid Productive Engagement vs Less Active Group										
Intercept	**1.401**	**4.058**	**2.737**	**6.015**	***	**1.584**	**4.876**	**3.310**	**7.183**	***
Between person self-rated health	**0.332**	**1.394**	**1.187**	**1.639**	***					
Within person self-rated health	**0.160**	**1.174**	**1.055**	**1.306**	***					
Grand mean self-rated health						**0.240**	**1.271**	**1.155**	**1.399**	***
One chronic disease (ref. well)	-0.052	0.949	0.724	1.244		-0.043	0.958	0.736	1.247	
Two chronic diseases and above (ref. well)	-0.067	0.935	0.690	1.267		-0.078	0.925	0.684	1.250	
Between person MMSE	**0.113**	**1.120**	**1.079**	**1.163**	**					
Within person MMSE	**0.091**	**1.095**	**1.070**	**1.120**	***					
Grand mean MMSE						**0.102**	**1.107**	**1.088**	**1.127**	***
IADI (ref. dependence)	**0.992**	**2.696**	**2.153**	**3.376**	***	**1.013**	**2.755**	**2.175**	**3.490**	***
Smoking (ref. no smoking)	-0.001	0.999	0.791	1.263		0.001	1.001	0.792	1.266	
Drinking (ref. no drinking)	**0.262**	**1.300**	**1.008**	**1.676**	**	**0.273**	**1.313**	**1.020**	**1.691**	**
Exercising (ref. no exercise)	**1.177**	**3.244**	**2.705**	**3.890**	***	**1.186**	**3.274**	**2.714**	**3.950**	***
Between person social activities	**0.118**	**1.125**	**1.035**	**1.223**	**					
Within person social activities	**0.129**	**1.138**	**1.016**	**1.274**	**					
Grand mean social activities						**0.129**	**1.138**	**1.046**	**1.238**	***
Marital status (ref. others)	0.161	1.175	0.886	1.559		0.171	1.187	0.893	1.578	
Living arrangement: (ref. alone)	**-1.242**	**0.289**	**0.222**	**0.376**	***	**-1.243**	**0.289**	**0.222**	**0.376**	***
Financial sufficiency (ref. financial insufficiency)	-0.129	0.879	0.731	1.056		-0.102	0.903	0.761	1.071	
Rural (ref. city/town)	-0.042	0.958	0.800	1.148		-0.052	0.949	0.792	1.137	

Table 6.2, continued

Determinants/Variables	Model 5					Model 6				
Fixed Effects	**Log-Odds**	**Odds Ratio**	**95% LCI**	**95% UCI**	**Sig.**	**Log-Odds**	**Odds Ratio**	**95% LCI**	**95% UCI**	**Sig.**
Age at wave 2002	-0.018	0.982	0.947	1.017		-0.020	0.980	0.947	1.014	
Female (ref. male)	**0.960**	**2.613**	**2.002**	**3.410**	**	**0.956**	**2.601**	**2.096**	**3.229**	***
Professional or governmental (ref. housemaker & others)	-0.124	0.883	0.585	1.334		-0.129	0.879	0.677	1.141	
Worker or farmer (ref. housemaker and others)	0.022	1.022	0.782	1.335		0.009	1.009	0.774	1.316	
Education (Year of Schooling) (ref. unschooled)	-0.144	0.866	0.722	1.038		-0.129	0.879	0.730	1.058	
Between Provincial LNGDP per Capita	**-0.236**	**0.790**	**0.645**	**0.967**	**					
Within Provincial LNGDP per Capita	0.019	1.019	0.668	1.556						
Grand Mean Provincial LNGDP per Capita						-0.133	0.876	0.749	1.024	
Random Effects	**Co-efficient**	**Std. Error**	**95% LCI**	**95% UCI**	**Sig.**	**Co-efficient**	**Std. Error**	**95% LCI**	**95% UCI**	**Sig.**
Random Effect Block 1										
Paid job: Variance	0.120	0.057	0.047	0.305	**	0.136	0.062	0.055	0.333	**
Unpaid productive engagement: Variance	0.093	0.042	0.038	0.225	**	0.083	0.037	0.035	0.198	**
Random Effect Block 2										
Paid job: Variance	0.528	0.075	0.400	0.698	***	0.526	0.075	0.398	0.695	***
Unpaid productive engagement: Variance	0.106	0.063	0.033	0.338	*	0.104	0.063	0.032	0.338	*
Intraclass correlation (ICC)										
Paid job: Level 2	3.0%					3.4%				
Unpaid productive engagement: Level 2	2.7%					2.4%				
Paid job: Level 3	13.4%					13.3%				
Unpaid productive engagement: Level 3	3.0%					3.0%				
-2 log-likelihood	75,052					74,973				
Akaike Corrected	75,060					74,981				
Bayesian	75,088					75,009				

Note: ***p<0.01, **p<0.05, *p<0.10; ref. = reference group; MMSE = Mini-Mental State Examination; IADL= Instrumental Activities of Daily Living, LCI = Lower confidence interval; UCI = Upper confidence interval.

The log odds of the between-person effect (0.103) of MMSE (cognitive health) was slightly higher than the within-person effect (0.089). A one-point increase in a person's mean MMSE over another person's mean MMSE was found to increase the odds of participation in paid productive engagement versus the less active group (OR = 1.109, $p < 0.01$). Likewise, every one-point increase in a person's own mean MMSE resulted in higher odds of participating in paid productive engagement versus the less active group (OR = 1.093, $p < 0.01$). Both inter- and intra-individual differences in MMSE affected the likelihood of participating in paid productive engagement. The cross-sectional effect of MMSE were found to persist with advancement in age.

With an odds ratio of 5.115, IADL-independent older adults were more likely to participate in paid productive engagement versus the less active group than their IADL-dependent peers (OR = 5.115, $p < 0.01$). Therefore, IADL-independent older adults were significantly more likely than IADL-dependent older adults to participate in paid productive engagement than being less active.

Smoking did not affect the odds of participation in paid productive engagement versus the less Active Group. On the other hand, with the other variables remaining the same (*ceteris paribus*), the log odds of participation in paid productive engagement versus the less active group increased by 0.660 for drinkers. With an odd ratio of 1.934, drinkers were more likely to participation in paid productive engagement versus the less active group than non-drinkers (OR = 1.934, $p < 0.01$). Therefore, drinkers were twice as likely to participate in paid productive engagement versus the less active group. As engagement in physical activity is a strong predictor of work engagement, older adults who exercised had a higher likelihood of participating in paid productive engagement versus the less active group than older adults who do not exercise (OR = 1.96, $p < 0.01$).

The person-mean centring model; which included provincial effects; showed that the within-person effects in participation in social activity significantly affected participation in paid productive engagement versus the less active group as indicated by an odds ratio of 1.143 ($p < 0.10$) while the between-person effects in participation in social activity did not significantly affect participation in paid productive engagement versus the less active group as indicated by an odds ratio of 0.952.

Married older adults had higher odds of participating in paid productive engagement versus the less Active Group than unmarried older adults (OR = 2.132, $p < 0.01$). In other words, married older adults were more than twice as likely to participate in paid productive engagement versus the less active group than unmarried older adults.

In comparison to older adults who lived alone, older adults who resided with a spouse or other household members were less likely to participate in paid productive engagement versus the less active group as indicated by an odds ratio of 0.213 ($p < 0.01$). Hence, older adults who lived alone were almost 5.0 times (1/0.213 = 4.7) more likely to participate in paid productive engagement versus the less active group than older adults who resided with a spouse or other household members.

Financially sufficient older adults were less likely to participate in paid productive engagement versus the less active group as indicated by an odds ratio of 0.731 ($p < 0.01$). Therefore, financially insufficient older adults were 1.4 times (1/0.731=1.4) more likely to participate in paid productive engagement versus the less active group.

In terms of physical environment, older adults in rural China were more likely to participate in paid productive engagement versus the less active group. These people were 1.6 times more likely to participate in paid productive engagement versus the less active group than older adults in urban China (OR = 1.568, $p < 0.01$).

The person-mean centring model; which included provincial effects; showed that when age in the 2002 wave (centred at 70 years old) increased by one year, it decreased the odds of participation in paid productive engagement versus the less active group by 9% (1-0.908 = 0.092) (OR = 0.908, $p < 0.01$). Therefore, younger adults were significantly more likely to participate in paid productive engagement versus the less active group than older adults. Furthermore, gender did not affect the odds of participation in paid productive engagement versus the less Active Group (OR = 1.368, p = ns).

Pre-retirement occupation did not affect the odds of participation in paid productive engagement versus the less Active Group (OR = 0.875 and 1.360, p = ns). Similarly, educational background also did not affect the odds of participation in paid productive engagement versus the less active group (OR = 0.819, p = ns).

At a provincial level, every one-point increase in mean LNPGDP per capita (natural logarithm of GDP per capita) over the mean LNPGDP per capita of other provinces lowered the odds of participation in paid productive engagement versus the less active group as indicated by an odds ratio of 0.494 ($p < 0.01$). Although every one-point increase in LNPGDP per capita over the province's own mean LNPGDP per capita lowered the odds of participation in paid productive engagement versus the less active group, it was not statistically significant (OR = 0.772, p = ns). Therefore, older adults from provinces

with higher LNPGDP per capita were less likely to participate in paid productive engagement versus the less active group.

6.2.3 Results of Model 5: Unpaid Productive Engagement Versus the Less Active Group

The log odds of the intercept (1.401) in Category Two (unpaid productive engagement versus the Less active group) showed an individual's likelihood of participating in unpaid productive engagement versus the Less active group when all the predictors were = 0. The odds ratio of 4.058 suggested that, with all the predictors set as 0 or average, men were about 4.1 times more likely to participate in unpaid productive engagement than the less active group in the 2002 wave (OR = 4.058, $p < 0.01$).

The person-mean centring model; which included provincial effects; showed that the log odds of the between-person effect (0.332) in self-rated health was more significant than the within-person effect (0.160). As such, every one-point increase in a person's mean self-rated health over another person's mean self-rated health increased the odds of participation in unpaid productive engagement versus the less active group by 1.4 (OR = 1.394, $p < 0.01$). The significant within-person effect in self-rated health at level 1 (1.174) indicated that for every one-point increase in a person's own mean self-rated health, the odds of participation in unpaid productive engagement versus the less active group was 1.2 times higher (OR = 1.174, $p < 0.01$). This indicated that being healthier than other people was more significant in predicting the likelihood of participation in unpaid productive engagement versus the less active group than being healthier than usual. However, variations in both inter- and intra-individual differences in self-rated health were found to matter to some extent. The cross-sectional effect did translate

longitudinally in self-rated health. Multimorbidity did not affect the odds of participation in unpaid productive engagement versus the less active group.

The log odds of the between-person effect (0.113) of MMSE (cognitive health) was more significant than the within-person effect (0.091). For every one-point increase in a person's mean MMSE over another person's mean MMSE, the odds of participating in unpaid productive engagement versus the less active group was 1.1 times higher (OR = 1.120, $p < 0.05$) while for every one-point increase in a person's own mean MMSE, the odds of participation in unpaid productive engagement versus the less active group was 1.095 times higher (OR = 1.095, $p < 0.01$). This indicated that having a better MMSE than other people was more significant in predicting the likelihood of participation in unpaid productive engagement versus the less active group than having better MMSE than usual. However, variations in both inter- and intra-individual differences in MMSE mattered to some extent. The cross-sectional effect did translate into longitudinally for MMSE.

The person-mean centring model; which included provincial effects; showed that IADL-independent older adults were more likely to participate in unpaid productive engagement versus the less active group than IADL-dependent older adults (OR = 2.696, $p < 0.01$). Therefore, IADL-independent older adults were 2.7 times more likely to participate in unpaid productive engagement versus the less active group than IADL-dependent older adults, *ceteris paribus*.

Smoking did not affect the odds of participation in unpaid productive engagement versus the less active group. However, the log odds of participation in unpaid productive engagement versus the less active group increased by 0.262 for drinkers, *ceteris paribus*.

With an odds ratio of 1.300, drinkers were more likely to participate in unpaid productive engagement versus the less active group than non-drinkers (OR = 1.300, $p < 0.05$). Therefore, drinkers were 1.3 time more likely to participate in unpaid productive engagement versus the less active group.

With an odds ratio of 3.244, older adults who exercised were more likely to participate in unpaid productive engagement versus the less active group than those who did not exercise ($p<0.01$). Therefore, older adults who exercised were 3.2 times more likely to participate in unpaid productive engagement versus the Less active group than those who did not exercise.

The person-mean centring model; which included provincial effects; showed that the between-person effect (0.118) in participation in social activities was slightly less than the within-person effect (0.129). Furthermore, the significant within-person effect at level 1 (0.129) indicated that for every one-point increase in a person's own mean participation in social activities, the odds of participation in unpaid productive engagement versus the less active group was 0.129 times higher (OR = 1.138, $p < 0.05$). Conversely, the between-person effect in participation in social activities at level 1 (0.118) indicated that for every one-point increase in a person's own mean participation in social activities over other peoples' mean participation in social activities, the odds of participation in unpaid productive engagement versus the less active group was 0.118 times higher (OR = 1.125, $p < 0.05$). This indicated that people who reported higher than average participation in social activities had higher than usual likelihood of participation in unpaid productive engagement versus the less active group. Variations in both inter- and intra-individual differences in participation in social activities mattered to some extent.

Older adults who resided with a spouse or other household members were less likely to participate in unpaid productive engagement versus the less active group than older adults who lived alone as indicated by an odds ratio of 0.289 ($p<0.01$). The odds of participating in unpaid productive engagement versus the less active group was 71.1% (1-0.289 = 0.711) lower among older adults who resided with a spouse or other household members, *ceteris paribus*. Therefore, older adults who lived alone were 3.5 times (1/0.289) more likely to participate in unpaid productive engagement versus the less active group. Furthermore, being married did not affect the odds of participating in unpaid productive engagement versus the less active group.

Financial status and a rural physical environment did not affect the odds of participating in unpaid productive engagement versus the less active group.

The person-mean centring model; which included provincial effects; showed that older women were more likely to participate in unpaid productive engagement versus the less active group than older men as indicated by an odds ratio of 2.613 ($p<0.05$). Therefore, older women were 2.61 times more likely to participate in unpaid productive engagement versus less activity than older men. Furthermore, age, educational background, and pre-retirement occupation did not affect the odds of participating in unpaid productive engagement versus the less active group.

Our analysis indicated a different level of correlation between- and within-provinces at a provincial level. Every one-point increase in a province's mean PGDP per capita over the PGDP of other provinces lowered the odds of participation in unpaid productive engagement versus the less active group by 0.236 (OR=0.790, $p < 0.05$) while every one-

point increase in the province's own mean GDP per capita marginally increased the log-odds of participating in unpaid productive engagement versus the less active group by 0.019 (OR = 1.019, p = ns). This indicated that older adults from provinces with higher PGDP per capita were less likely to unpaid productive engagement versus the less active group.

6.2.4 Results of Model 6: Paid Job Versus the Less Active Group

Model 6 is a three-level multilevel model with a wave nested within an individual and an individual nested within a province. Grand-mean-centring was applied to time-varying quantitative predictors in this model. The log odds of the intercept (0.748) in Category One (paid productive engagement versus the less active group) showed an individual's likelihood of participating in paid productive engagement versus the less active group when all the predictors were = 0. The odds ratio of 2.113 suggested that, with all the predictors set as 0 or average, men were about 2.1 times more likely to participate in paid productive engagement than the less active group in the 2002 wave (OR = 2.113, $p < 0.01$).

The grand-mean centring model; which included provincial effects; showed that every one-point increase in a self-rated health increased the odds of participation in paid productive engagement versus the less active group by 1.382 (OR = 1.382, $p < 0.01$), *ceteris paribus*. Therefore, older adults with better self-rated health were more likely to participate in paid productive engagement versus the less active group those older adults with lower self-rated health. Furthermore, multimorbidity did not affect the odds of participating in paid productive engagement versus the less active group.

A one-point increase in MMSE (cognitive health) increased the odds of participation in paid productive engagement versus the less active group by 1.102 (OR = 1.102, $p < 0.01$), *ceteris paribus*. Therefore, older adults with better MMSE (cognitive health) were more likely to participate in paid productive engagement versus the less active group.

IADL-independent older adults were 5.2 times more likely to participate in paid productive engagement versus the less active group than their IADL-dependent peers (OR = 5.209, $p < 0.01$), *ceteris paribus*. Therefore, IADL-independent older adults were nearly 6.0 times more likely to participate in paid productive engagement versus the less active group.

Smoking did not affect the odds of participation in paid productive engagement versus the less active group. However, an odds ratio of 1.953 indicated that drinkers were more likely to participate in paid productive engagement versus the less active group than non-drinkers (OR = 1.953, $p < 0.01$), *ceteris paribus*. Therefore, drinkers were twice as likely to participate in paid productive engagement versus the less active group.

The grand-mean centring model; which included provincial effects; showed that older adults who exercised were more likely participate in paid productive engagement versus the less active group than older adults who did not exercise as indicated by an odds ratio of 1.918 ($p < 0.01$). Therefore, older adults who exercised were more likely participate in paid productive engagement versus the less active group.

Married older adults had higher odds of participation in paid productive engagement versus the less active group than unmarried older adults as indicated by an odds ratio of

2.147 ($p < 0.01$). Therefore, married older adults were about 2.1 times more likely to participate in paid productive engagement versus the less active group.

The log odds of participating in paid productive engagement versus the less active group decreased by 1.547 among older adults who resided with a spouse or other household members. They were 79% (1-0.213 = 0.787) less likely to participate in paid productive engagement versus the less Active reduced in comparison to older adults who lived alone (OR = 0.213, $p < 0.01$), *ceteris paribus*. Therefore, older adults who lived alone were 4.7 times (1/0.213 = 4.7) more likely to participate in paid productive engagement versus the less Active.

The log odds of participating in paid productive engagement versus the less active group decreased by 0.291 among financially sufficient older adults. They were 25% (1-0.748 = 0.252) less likely to participate in paid productive engagement versus the Less active group in comparison to financially insufficient older adults (OR = 0.748, $p < 0.05$), *ceteris paribus*. Therefore, financially insufficient older adults were 1.3 times (1/0.748) more likely to participate in paid productive engagement versus the less active group.

The grand-mean centring model; which included provincial effects; showed that older adults in rural China were more likely to participate in paid productive engagement versus the less active group than their urban counterparts as indicated by an odds ratio of 1.575 ($p < 0.01$). Therefore, older adults in rural China were about 1. 6 times more likely to participate in paid productive engagement versus the less active group.

When age in the 2002 wave (centred at 70 years old) increased by one year, the odds of participating in paid productive engagement versus the less active group decreased by 9% (1-0.907 = 0.093). Therefore, younger adults were significantly more likely to participate in paid productive engagement versus the less active group than older adults (OR = 0.907, $p < 0.01$).

The log odds of women participating in paid productive engagement versus the less active group was 0.316 higher than men. The odds ratio of participating in paid productive engagement versus the less active group increased by 37% for women versus men (OR = 1.372, $p < 0.05$). Therefore, women were 1.4 times more likely to participate in paid productive engagement versus the less active group than men.

Pre-retirement occupation did not affect the odds of participation in paid productive engagement versus the less active group (OR = 0.841 and 1.343, p = ns). Similarly, educational background also did not affect the odds of participation in paid productive engagement versus the less active group (OR = 0.805, p = ns).

At a provincial level, the provincial gross domestic product (PGDP) per capita correlated negatively to participation in paid productive engagement versus the less active group as a one-standard-deviation (SD) increase in LNPGDP per capita decreased the log odds of participation in paid productive engagement by 0.591 (OR = 0.554, $p < 0.01$), *ceteris paribus*. This indicated that older adults in provinces with higher LNPGDP per capita were less likely to participate in paid productive engagement versus the less active group.

6.2.5 Results of Model 6: Unpaid Productive Engagement Versus the Less Active Group

The log odds of the intercept (1.584) in Category Two (unpaid productive engagement versus the less active group) showed an individual's likelihood of participating in unpaid productive engagement versus the less active group when all the predictors were = 0. The odds ratio of 4.876 suggested that, with all the predictors set as 0 or average, men were about 5.0 times more likely to participate in unpaid productive engagement than the Less active group in the 2002 wave.

The grand-mean centring model; which included provincial effects; showed that when self-rated health increased by one-point, the odds of participation in unpaid productive engagement versus the less active group was 1.271 time higher (OR = 1.271, $p < 0.01$), *ceteris paribus*. This indicated that older adults with better self-rated health were more likely to participate in unpaid productive engagement versus the less active group. Furthermore, multimorbidity did not affect the odds of participation in unpaid productive engagement versus the less active group.

When MMSE (cognitive health) increased by one-point, the odds of participation in unpaid productive engagement versus the less active group was 1.107 times higher (OR = 1.107, $p < 0.01$), *ceteris paribus*. Therefore, older adults with better MMSE were more likely to participate in unpaid productive engagement versus the less active group.

IADL-independent older adults were 2.8 times more likely to participate in unpaid productive engagement versus the less active group IADL-dependent older adults (OR = 2.755, $p < 0.01$), *ceteris paribus*.

Smoking did not affect the odds of participation in unpaid productive engagement versus the less active group. However, the log odds of participation in unpaid productive engagement versus the less active group increased by 0.273 for drinkers, *ceteris paribus*. With an odd ratio of 1.313, drinkers were more likely to participate in unpaid productive engagement versus the less active group than non-drinkers (OR=1.313, $p < 0.05$). Therefore, drinkers were 1.3 time more likely to participate in unpaid productive engagement versus the less active group.

Older people who exercised were more likely than those who did not exercise to participate in unpaid productive engagement versus the less active group. An odds ratio of 3.274 ($p < 0.01$) meant that, *ceteris paribus*, the former was 3.3 times more likely than the latter to participate in unpaid productive engagement versus the less active group.

The grand-mean centring model; which included provincial effects; showed that a one-point increase in participation in social activities increased the odds of participation in unpaid productive engagement versus the less active group by 1.138 (OR=1.138, $p<0.01$), *ceteris paribus*. Therefore, older adults who participate in unpaid productive engagement versus the less active group have higher participation in social activities.

Older adults who resided with a spouse or other household members were 71% (1-0.289 = 0.711) less likely to participate in unpaid productive engagement versus the less active group than older adults who live alone (OR = 0.289, $p < 0.01$), *ceteris paribus*. Therefore, older adults who lived alone were 3.5 times (1/0.289=3.5) more likely to participate in unpaid productive engagement versus the less active group. However,

being married did not affect the odds of participating in unpaid productive engagement versus the less active group.

Apart from that, financial status, rural physical environment, and LNPGDP per capita did not affect the odds of participating in unpaid productive engagement versus the less active group.

The grand-mean centring model; which included provincial effects; showed that older women were more likely to participate in unpaid productive engagement versus the less active group than older men as indicated by an odds ratio of 2.61 ($p<0.01$). Therefore, older women were 2.6 times more likely to participate in unpaid productive engagement versus less activity than older males. Furthermore, the effects of age, educational background, and pre-retirement occupation on the odds of participating in unpaid productive engagement versus the less active group were not statistically significant.

6.3 Summary of Hypotheses

Based on the above results, Hypothesis One (Individuals with better health-related human capital (physical, cognitive, and functional health, and without chronic diseases) are more likely to be involved in productive engagement by including provincial effects over time) was supported except for chronic diseases. Individuals with better health-related human capital (physical, cognitive, and functional health) were more likely to be involved in productive engagement by including provincial effects over time.

Hypothesis Two (Individuals with smoking, drinking, or exercising behaviour are associated with participation in productive engagement by including provincial effects over time) was mostly supported except for smoking behaviour. Individuals with

drinking and exercising behaviour were more likely to be involved in productive engagement by including provincial effects over time.

Hypothesis Three (Various social capital (social activities, marital status, and living arrangement) are associated with participation in productive engagement by including provincial effects over time) was partially supported. Individuals who were more actively involved in social activities (within changes), individuals who were married and living alone were more likely to participate in a paid job. In contrast, active participation in social activities and those who stayed alone were more likely to be involved in unpaid productive engagement by including provincial effects over time.

Hypothesis Five (The rural-urban environment is associated with participation in productive engagement by including provincial effects over time) was partially supported. Those who stayed in rural areas were more likely involved in a paid job but was insignificant in unpaid productive engagement by including provincial effects over time.

Hypothesis Six (Demographic factors (age, gender, pre-retirement occupation, and education status) are associated with participation in productive engagement by including provincial effects over time) was partially supported. Younger older adults were more likely to be involved in a paid job over time, whereas females were more likely to be involved in the unpaid productive engagement by including provincial effects over time.

Hypothesis Seven (Provincial Gross Domestic Product (GDP) per Capita is associated with participation in productive engagement over time) was partially supported.

Between Provincial Gross Domestic Product (GDP) per capita was associated with participation in productive engagement over time. Provincial Gross Domestic Product (GDP) per capita was correlated with participation in a paid job over time.

6.4 Discussion

Using the WHO's active ageing framework and productive engagement concept, this study investigated the impacts of personal, health, behavioural, social, economic, and physical environment factors on productive engagement over time while considering province contextual variables. Also, the "empty" model (Model 4) was the validity of specifying a three-level model through significant variations given province differences. Thus, it provides statistical support to specify a three-level model than a single-level model. The three engagement groups were described by less active, unpaid productive engagement and paid job groups in this study.

In this study, the less active group represented the most vulnerable older adults, and the proportion of this group increased from wave 2002 to 2011. Those residing with a spouse or other household members, doing less exercise, less active in social activities, having poorer physical and cognitive health, and physical limitations were more likely to be less active than their counterparts (refer to Tables B1 and B4, Appendix B for more details). This group negates the "active ageing" target of the WHO. It is a significant challenge to promote active and productive engagement as older people's health deteriorates with advancing age.

Next, there was a positive indication that the percentage of unpaid productive engagement groups increased over the years. This unpaid productive engagement group may represent active retirees and possibly the "active and productive retirement" model. Members of

this group were more to be likely female. Besides, they had good physical and cognitive health and better IADL independence (refer to Tables B2 and B4, Appendix B for more details). Despite suffering from some IADL limitations, older adults who were actively engaged in exercises and social activities were more likely to be engaged in unpaid productive activities. This group also had a drinking habit. It is interesting to note that multiple chronic conditions did not impede their participation in unpaid productive engagement, even in provinces that lagged in economic development.

The percentage of the paid job group decreased from wave 2002 to 2011. Members of this older adult group were more likely to be younger, currently married, and resided in a rural area (refer to Tables B3 and B4, Appendix B for more details). Factors associated with engagement in paid work included self-rated health, IADL, and cognitive health ratings. Those who financially insufficient were also more likely to be engaged in paid jobs. Thus, they may spend more time on employment activities and relatively less time participating in exercise as compared to unpaid productive engagement group.

The findings for models 5 and 6 were relatively consistent with Models 2 and 3 after the inclusion of the Provincial GDP per capita.

6.4.1 Health and Personal Determinants

This study indicated the strong effect of physical, cognitive, and functional health as a form of human capital on productivity engagement. Numerous studies have revealed that those with better physical health are more likely to be involved in high activity engagement, including paid jobs (Di Gessa & Grundy, 2017; Dingemans et al., 2016; Ling & Chi, 2008; V. Loh & Kendig, 2013; Morrow-Howell et al., 2014; Morrow-Howell & Greenfield, 2016). The findings are also consistent with studies from Vietnam, Korea,

and the US (L. T. Giang et al., 2018; S. Kim, 2020; O. E. Lee & Lee, 2014). Besides, the current findings indicated that physical health also plays a direct role in housework and caregiving, consistent with western studies (Grünwald et al., 2021; Leopold & Schulz, 2020).

Interestingly, the data does not support the impact of multimorbidity on paid job engagement once the province effects were controlled. Most Chinese older adults live with multiple chronic conditions (Fong, 2019; C. Zhao et al., 2018). However, older adults could adapt to their health conditions, continue their lives, and contribute to their families and society. A study in India also indicated that chronic diseases failed to influence grandparenting (Visaria & Dommaraju, 2019).

As a person ages, cognitive health plays an important role in maintaining one's employment and life activities (O. E. Lee & Lee, 2014; T. W. H. Ng & Feldman, 2013; Zacher, 2015). Older adults with better cognitive health may be better at utilising their abilities in managing their paid or unpaid productivity activities (S. Kim, 2020). A study in Korea also indicated that cognitive health is an important predictor of involvement in a paid job (O. E. Lee & Lee, 2014). However, some research in China indicates the lack of health programmes in dealing with mental and cognitive health in essential public health services (X. Hao et al., 2019).

The rate of change in productive activities over time was associated with age-related trajectories in functional health (E. Choi et al., 2016). This finding is also consistent with studies in India, Myanmar, Thailand, Vietnam, CHARLS study in China, and the US, indicating that functional health is a significant determinant of paid and unpaid productivity engagement (S. Kim, 2020; Ko & Yeung, 2018; Morrow-Howell et al., 2014;

Teerawichitchainan et al., 2019; Visaria & Dommaraju, 2019). Involvement in paid and unpaid productive engagement may require minimal physical strength to perform the work (Luoh & Herzog, 2002), and IADL dependencies make older adults considerably less likely to participate in unpaid productive engagement (Visaria & Dommaraju, 2019).

6.4.2 Behavioural Determinants

This study indicated that moderate drinking and exercising were associated with paid and unpaid productive engagement based on the WHO's active ageing framework. Smoking could be a deep-seated habit in Chinese culture. However, there was limited evidence suggesting that being a current smoker or non-smoker impacting paid and unpaid productive engagement. In many Asian cultures, drinking often occurs at social gatherings or business-related occasions and events (W. Hsu et al., 2017; J. Li et al., 2017; Sudhinaraset et al., 2016). This study also supports the view that drinking habits may be affected by context and place (Sudhinaraset et al., 2016). Also, older adults with better health may perceive that they can sustain drinking habits, whereas those with poor health status may choose to reduce or not drink (Borok et al., 2013; J. Li et al., 2017; Weyerer et al., 2009). Older people may be sceptical about the risks linked to drinking but recognise its role in promoting work, social and leisure-related activities vital to health and well-being in later life (Bareham et al., 2019; Kelly et al., 2018). Thus, moderate alcohol drinking may be prevalent among some older people involved in paid and unpaid productive engagement. Nevertheless, drinkers need to consider the significant risk of excessive drinking as there is a trend of increasing acute and chronic problems resulting from alcohol use and abuse (Y. Tang et al., 2013). Thus, there is a need to develop a comprehensive national alcohol policy based on the WHO recommendations (WHO, 2000).

After including the province-level variables, the exercising habit remained associated with paid and unpaid productive engagement. Some researchers reported an association between exercise and health outcomes in China. For example, low intensity of exercise was linked with the likelihood of reduced depressive symptoms (P. Du et al., 2016). Moreover, participation in daily moderate or vigorous exercises was associated with lower diabetes risk among Chinese older adults (Qin et al., 2010). Similarly, exercise was associated with a reduced likelihood of suffering major chronic diseases (Huang et al., 2015). Insufficient exercise among older adults was also associated with poor health-related quality of life (Dai et al., 2015).

Several studies have revealed that exercise may help employees be more productive by lowering the risk of major non-communicable diseases, reducing absenteeism and presenteeism, and improving mental health and sleep (Hafner et al., 2018; Hroncich, 2019; Kohll, 2019). Exercising may influence older people in maintaining and enhancing their health-related quality of life, enhance chronic disease prevention and risk reduction, prevent loss of muscle strength, and maintain balance in older people (Bauman et al., 2016). Thus, exercising enables older adults to be more actively involved in paid and unpaid productive engagement.

6.4.3 Social Determinants

The impact of social capital demonstrated a less consistent pattern of human capital. The study implied that intraindividual social participation motivates older adults to be involved in a paid job. The findings showed that as long as an individual is more active than usual to be involved in social activities, he or she is more likely to participate in a paid job over time. However, older adults actively involved in social activities, cross-sectionally, may not be more likely to be involved in a paid job. The findings imply that

older adults need to keep involved in social activities over time to preserve and accumulate social capital to participate in paid jobs. The success in preserving and accumulating social capital over time within an individual has rendered the within-person variation more significant.

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The success in preserving and accumulating social capital over time within an individual has rendered the within-person variation to be more significant. On the other hand, the study indicated that intraindividual and interindividual social participation motivates older adults to participate in unpaid productive engagement. The findings suggest that participation in social activities enables older adults to have a stronger, if not tighter social network and more substantial social support cross-sectionally and over time. Hence, they are more likely to remain in paid and unpaid productive engagement for an extended time (S. Kim, 2020; Morrow-Howell et al., 2014; Morrow-Howell & Greenfield, 2016).

On the other hand, marital status was more likely to impact the paid job than unpaid productive engagement. Thus, married older adults need to take responsibility for their families, including their children and elderly parents (T. L. Giang & Nguyen, 2016; O. E. Lee & Lee, 2014; Ling & Chi, 2008). This finding was consistent with other studies in Vietnam and South East Asia (L. T. Giang et al., 2018; T. L. Giang & Nguyen, 2016; Teerawichitchainan et al., 2019). The finding regarding the insignificant impact of marital status on unpaid productive engagement was also consistent with Ko and Yeung (2018), Grünwald et al. (2021), and Morrow-Howell et al. (2014).

Furthermore, there was an indication that those living alone were not lonely but were actively involved in paid and unpaid productive engagement. This result implies that if

older persons did not stay together with their children and others, they might be more likely to be involved in a paid job until older adulthood. Likewise, this indicates that those who did not stay with their children and others might need to devote more time to unpaid productive activities, such as housework. This finding was similar to a study conducted in Korea (J. H. Kim, 2019). Thus, needing to meet their financial, social, and emotional needs by themselves (Cohen, 2004; Erikson et al., 1986; Johnson, 2009; Utz et al., 2002).

6.4.4 Economics and Physical Environment Determinants

Consistent with the "affluence or leisure preference" hypothesis, the current study found that those with financial insufficiency were associated with a paid job, though not correlated with unpaid productive engagement. Thus, older adults might need to work since they might not have sufficient financial resources to support themselves (Hu & Das, 2019; J. Kim et al., 2018; O. E. Lee & Lee, 2014). The insignificant impact of financial status on unpaid productive engagement was also consistent with studies conducted in Korea (J. H. Kim, 2019) and Vietnam (L. T. Giang et al., 2018).

Those who resided in rural areas were associated with a paid job but not correlated with unpaid productive engagement. The finding related to a paid job was consistent with the ecological system theory, where similar results were found in some Asian countries (L. T. Giang et al., 2018; Teerawichitchainan et al., 2019; Visaria & Dommaraju, 2019). Those older adults who resided in rural areas might view rural work as necessary rather than a choice. Moreover, they may need to continue to work until they are no longer physically capable and able (G. Chen & Gao, 2013; Giles et al., 2011; F. Tang et al., 2018). Further, the insignificant impact of rural and urban environments on unpaid productive engagement has been evident in some Asian countries (Teerawichitchainan et al., 2019; Visaria & Dommaraju, 2019). However, the findings of this study were contrary

to a study conducted in the US, where those in urban areas were more likely to participate in paid and unpaid productivity engagement (Morrow-Howell et al., 2014).

6.4.5 Demographical Variables

This study also evidenced a decrease in the likelihood of involvement in a paid job based on age which is consistent with other literature (L. T. Giang et al., 2018; J. H. Kim, 2019; Ko & Yeung, 2018; Ling & Chi, 2008; Morrow-Howell et al., 2014; Teerawichitchainan et al., 2019; Visaria & Dommaraju, 2019). However, there was scant evidence for an age-related decline across unpaid productive engagement. This finding implies that older adults continue to be active in contributing to productive engagement as they aged.

After controlling for other factors in the model, gender affected unpaid productive engagement rather than a paid job. Consistent with other research, females were more likely to be involved in unpaid productive engagement than their male counterparts (Y. Luo et al., 2012; Morrow-Howell et al., 2014; Strawbridge et al., 1996; Teerawichitchainan et al., 2019; Visaria & Dommaraju, 2019). Based on the gender-role socialisation theory, many activities related to household management and family care are gendered and mainly performed by women (J. H. Kim, 2019; Miller & Cafasso, 1992; Penning & Wu, 2016).

The education variable was uncorrelated with paid job engagement after considering the province differences. The results may contrast to some studies conducted in the US (S. Kim, 2020; Morrow-Howell et al., 2014), indicating a positive relationship between education and paid jobs. However, there was limited evidence of education in predicting work decisions among older adults, especially in Asia-related studies (J. H. Kim, 2019; Ko & Yeung, 2018; Ling & Chi, 2008). There is also inconsistent associations between

educational level and participation in a paid job in India and some southeast countries (Teerawichitchainan et al., 2019; Visaria & Dommaraju, 2019). Furthermore, the studies also revealed that education level was not associated with unpaid productive engagement. Accordingly, these findings may reflect that many older adults in developing countries did not attend formal education. This cohort of older adults experienced the Chinese Civil War (1927-1937; 1946-1949) and Second Sino-Japanese War (1937-1945). During this period, China was among some of the most backward nations in education, as 80% of the population was illiterate (Chandra, 1987). In the future, however, many of those who are becoming older will have higher education. Thus, educated older adults will be expected to contribute to their families and society from a productive engagement perspective.

On the other hand, pre-retirement employment status as a worker or farmer was not related to the likelihood to be involved in a paid job and unpaid productive engagement after including provincial effects. A study conducted in German had similar findings (Grünwald et al., 2021). Human capital in the form of education and occupation did not apply to this cohort of older adults.

6.4.6 Contextual Variable

This study provided evidence to support ecological system theory finding that the between-province GDP per capita and not within-province GDP per capita impact paid job engagement (Model 5). This study implied that older adults residing in provinces with less economic development were more likely to involve themselves in paid jobs. This finding contradicts the work of Ko and Yeung (2018) that better economic development areas could provide more job opportunities for older adults. However, Ko and Yeung (2018) further clarified that involvement in agricultural activities was also correlated with the developing economy in China, particularly when it was common for older Chinese to

participate in agricultural activities. Urbanisation, industrialisation, and modernisation may shift from an agricultural to a service-based economy and transform labour-intensive work into sedentary occupations (Monda et al., 2007; Muntner et al., 2005; S. W. Ng et al., 2009; W. Zhu et al., 2016). Using the China Health and Nutrition Survey (CHNS) (1991–2006), Monda et al.'s study (2007) indicated that the income level of counties in China was associated negatively with work-related physical activity. Based on the same CHNS data, S.W. Ng et al. (2009) found that involvement in occupational activities and overall activities for Chinese men and women were associated negatively with expanded and improved community infrastructures, such as higher educational institutions (HEIs), housing complexes, sanitation facilities, and economic well-being in the community. As China continues to urbanise, more people will undoubtedly be involved in higher-income sedentary work; more people will also be spending more time in sedentary behaviours (M. Zhang et al., 2014; W. Zhu et al., 2016). Likewise, the increase in television ownership and new entertainment from TV programmes, the internet, and movies are tempting older persons to become increasingly sedentary (Q. Feng et al., 2011). A study found that older adults in Shanghai had become more sedentary over time as opposed to general trends in western countries (Q. Feng et al., 2011). The sedentary behaviours and habits may continue after retiring and discourage older people from involvement in productive activities. Indeed, the research on the concept of productive ageing in China was still at an early stage in the 2010s (Lum, 2013). The market-driven interpretation of productive engagement limited the development of China's productive ageing public policy (Lum, 2013), allowing older adults to retire, spend time on sedentary activities, and do nothing. Poor participation and an "idle" mind may slowly confine older adults to their homes and "eradicate" the interest to participate in productive activities, whether paid or unpaid (S. T. Ng et al., 2005).

On the other hand, the findings of this study showed that provincial GDP per capita has no impact on unpaid productive activities. Ko and Yeung (2018) revealed that the effect of economic development on unpaid productive engagement like grandparenting disappears when the indicators from the institutional and sociodemographic environment are included (Ko & Yeung, 2018). This study's findings might indicate that most of the explanation for respondents' unpaid activity engagement was at the individual level.

6.5 Conclusion

Using longitudinal data from a survey across 22 provinces in China revealed that older adults were actively involved in paid and unpaid productive engagement. The results from Model 5 (Three-Level Random Intercept Multilevel Multinomial Logits Model with Person-Mean Centring Approach) indicated that older people with specific characteristics were more likely to have a paid job. These represented the older people with better human capital, such as those who had better between-person and within-person self-rated health in addition to between-person and within-person MMSE and were IADL independent. The lifestyle factors that influence acquiring a paid job include drinking and exercising habits and active participation in social activities. Personal characteristics associated with a paid job included currently married, living alone, financially insufficient, staying in rural areas, and being younger. Thus, the health variables related to human capital except for chronic diseases, behavioural variables under the WHO active ageing framework except smoking, and the "affluence or leisure preference" hypothesis were supported in this study. On the other hand, the variables related to social capital, social-location contexts under the life course perspective, human capital, such as pre-retirement occupation and education status, and the ecological system theory were partially supported.

The results were mostly similar to those obtained for the two-level models. However, the three-level models showed that residing in a province with lower PGDP per capita increased the likelihood of involvement in a paid job. Model 6 (Three-Level Random Intercept Multilevel Multinomial Logits Model with Grand-Mean Centring Approach) had similar results to Model 5 except for participation in social activities, gender, pre-retirement occupation, and educational level.

Model 5 further revealed that the impact of self-rated health and MMSE was from individual differences and intra-individual differences variation. However, the effect of participation in social activities resulted from intra-individual differences. The impact of PGDP per capita on participation in a paid job was attributed to between-province differences. This result offers empirical support for the use of the three-level models. Table 6.3 below presents a summary of the results for the three-level random-intercept multilevel multinomial logit models.

Table 6.3: Summary of the Results for the Three-Level Random-Intercept Multilevel Multinomial Logit Models

Determinants/Variables	**Paid Job vs Less Active Group**				**Unpaid productive engagement versus Less Active Group**			
	Model 5 PM-3L		**Model 6 GM-3L**		**Model 5 PM-3L**		**Model 6 GM-3L**	
Fixed Effects	**OR**	**Sig.**	**OR**	**Sig.**	**OR**	**Sig.**	**OR**	**Sig.**
Intercept	**1.646**	**	**2.113**	***	**4.058**	***	**4.876**	***
Between person self-rated health	**1.538**	***			**1.394**	***		
Within person self-rated health	**1.272**	***			**1.174**	***		
Grand mean self-rated health			**1.382**	***			**1.271**	***
One chronic disease (ref. well)	0.879		0.886		0.949		0.958	
Two chronic diseases and above (ref. well)	0.798		0.787		0.935		0.925	
Between person MMSE	**1.109**	***			**1.120**	**		
Within person MMSE	**1.093**	***			**1.095**	***		
Grand mean MMSE			**1.102**	***			**1.107**	***
IADI (ref. dependence)	**5.115**	***	**5.209**	***	**2.696**	***	**2.755**	***

Table 6.3, continued

Determinants/Variables	Paid Job vs Less Active Group				Unpaid productive engagement versus Less Active Group			
	Model 5 PM-3L		Model 6 GM-3L		Model 5 PM-3L		Model 6 GM-3L	
Fixed Effects	**OR**	**Sig.**	**OR**	**Sig.**	**OR**	**Sig.**	**OR**	**Sig.**
Smoking (ref. no smoking)	0.983		0.978		0.999		1.001	
Drinking (ref. no drinking)	**1.934**	***	**1.953**	***	**1.300**	**	**1.313**	**
Exercising (ref. no exercise)	**1.906**	***	**1.918**	***	**3.244**	***	**3.274**	***
Between person social activities	0.952				**1.125**	**		
Within person social activities	**1.143**	*			**1.138**	**		
Grand mean social activities			1.048				**1.138**	***
Marital status (ref. others)	**2.132**	***	**2.147**	***	1.175		1.187	
Living arrangement: (ref. alone)	**0.213**	***	**0.213**	***	**0.289**	***	**0.289**	***
Financial sufficiency (ref. financial insufficiency)	**0.731**	***	**0.748**	**	0.879		0.903	
Rural (ref. city/town)	**1.568**	***	**1.575**	***	0.958		0.949	
Age at wave 2002	**0.908**	***	**0.907**	***	0.982		0.980	
Female (ref. male)	1.368		**1.372**	***	**2.613**	**	**2.601**	***
Professional or governmental (ref. housemaker & others)	0.875		0.841		0.883		0.879	
Worker or farmer (ref. housemaker and others)	1.360		1.343		1.022		1.009	
Education (Years of Schooling) (ref. unschooled)	0.819		0.805		0.866		0.879	
Between Provincial GDP per Capita	**0.494**	***			**0.790**	**		
Within Provincial GDP per Capita	0.772				1.019			
Grand Mean Provincial GDP per Capita			**4.876**	***			0.876	
Random Effects	**CE**	**Sig.**	**CE**	**Sig.**	**CE**	**Sig.**	**CE**	**Sig.**
Random Effect Block 1	**0.120**	**	**0.136**	**	**0.093**	**	**0.083**	**
Random Effect Block 2	**0.528**	***	**0.526**	***	**0.106**	*	**0.104**	*
Intraclass correlation (ICC) Level 2	3.0%		3.4%		2.7%		2.4%	
Intraclass correlation (ICC) Level 3	13.4%		13.3%		3.0%		3.0%	

Note: Note: ***p<0.01, **p<0.05, *p<0.10; OR = Odds Ratio; PM = Personal-Mean Centring; GM = Grand-Mean Centring; 2L = Two-Level Modelling; 3L = Three-Level Modelling; CE = coefficient.

CHAPTER 7: CONCLUSION

7.1 Introduction

This chapter summarises the main findings of this study, discusses their implications, and puts forth recommendations for policy interventions before discussing the limitations and future research of this study.

This study examined the factors affecting the participation of older adults in productive engagement using longitudinal data from the Chinese Longitudinal Healthy Longevity Survey (CLHLS). These factors were physical, cognitive, and functional health, behaviours and lifestyle, social, economic, physical environment, and demographic variables. The contextual effects of GDP per capita of each province were examined using multilevel modelling. The longitudinal data consisted of respondents from 22 provinces in China aged between 65 to 74 during the 2002 wave of CLHLS and traced them across the three subsequent waves of the survey in 2005, 2008, and 2011. The three engagement groups were categorised as less active, unpaid productive engagement, and paid job groups.

This study aimed to add to the literature on active and productive ageing by addressing the following questions: Does productive engagement of older adults change over time? What are the impacts of the health, personal, behavioural, social, economic, physical environment, and demographic factors on productive engagement? Does the provincial contextual variable affect productive engagement? The objectives of this study are to:

1. examine the changes in the productive engagement of older adults over time;

2. investigate the impacts of health, personal, behavioural, social, economic, physical environment, and demographic factors on the productive engagement of older adults, and
3. analyse the provincial effects on productive engagement.

The research design was a longitudinal panel study based on a three-level multilevel model. As productive engagement is a multi-categorical variable, this study employed mixed-effects models developed from a random intercept three-level multinomial logit model for longitudinal data. Mixed-effects models are flexible methods that can handle problems in dealing with longitudinal data; such as missing data; by using all the available data provided that the missing data is missing at random (MAR) (Garcia & Marder, 2017; Little & Rubin, 2019). As most of the existing studies focused on paid productive engagement, this study highlighted the economic value of unpaid productive engagement.

7.2 Summary of Findings

This study's first objective revealed that older adults were actively involved in paid and unpaid productive engagements over time. In wave 2002, about 6%, 48%, and 46% of the older adults were in the less active group, unpaid productive engagement, and paid jobs, respectively. Nine years later, those in the less active and unpaid groups increased to 16% and 59%, respectively, while those engaged in a paid job decreased to 25%. These findings indicate that the majority of older adults participated in the paid or unpaid productive engagements even at an advanced age. However, it should be noted that the proportion of the less active group increased over time. A bivariate analysis indicated that health, exercising behaviour, and active social participation were particularly significant in explaining changes over time.

The characteristics of the three groups, name the less active group, unpaid productive engagement, and paid job group, were also represented in the first objective. As the less active group represented the most vulnerable of the older adults, this group may not achieve the "active ageing" target of the WHO. They were also more likely to reside with their spouses or other household members, exercise less, participate less in social activities, have poorer physical and cognitive health, and had more physical limitations than their counterparts. Due to the lack of health resources in the less active group, there is a need to prepare policies and resources that assist them. Therefore, the government should allocate more resources to provide adequate healthcare and social services for the rapidly increasing number of older adults.

The respondents in the unpaid productive engagement group represented the "active and productive retirement" model. Individuals in this group were more likely to be female, having good physical and cognitive health, and better IADL independence. Despite suffering from some physical limitations, this group still actively engaged in exercises and social activities. Furthermore, these individuals had other health and social resources that enabled them to engage in unpaid productive activities despite suffering from chronic diseases, even in provinces that lagged in economic development.

The respondents in the paid productive engagement group were more likely to be younger, currently married, and reside in rural areas. It is noteworthy that the determinants of participation of this group included better self-rated health as well as physical and cognitive health. In this group, individuals who were financially insufficient were also more likely to engage paid jobs. As these older adults may need to work for money, it affected their participation in the exercise as compared with the unpaid productive engagement group. Nevertheless, there is a need to formulate and implement

sound policies that protect the labour rights of this older generations and ensure that the social welfare systems can sustainably tackle issues faced by ageing workers.

Two-level multilevel modelling (Models 2 and 3) was used to address the second objective; while three-level multilevel modelling (Model 5 and 6) was used to address the third objective. As Models 1 and 4 were the unconditional models for the two-level and three-level multilevel analyses, respectively, their results provided statistical justifications with which to develop the two-level and three-level multilevel models, respectively. The intraclass correlations (ICCs) of Model 4 showed that about 2.6% and 16.2% variabilities in the paid job were related to between persons and between provinces, respectively. Meanwhile, the intraclass correlations (ICCs) of Model 4 revealed that about 2.2% and 7.4% variabilities in unpaid productive engagement were linked to between persons and between provinces, respectively.

A summary of the results is presented in Table 7.1. The findings of Model 2 (two-level modelling based on person-mean centring) indicated that older adults with specific characteristics were more likely to continue working. These included better physical, functional, and cognitive health, no multi-morbidities, the habit of exercising and drinking, participation in social activities, currently married, living alone, financially insufficient, residing in rural areas, and being younger, female, and previously worked as labourers or farmers before retirement. It also found that certain factors correlated with unpaid productive engagement. These included better physical, functional, and cognitive health, the habit of exercising and drinking, participation in social activities, currently married, living alone, financially insufficient, and being female. It is interesting to note that chronic diseases, advanced age, and lack of education did not pose a barrier to active

Table 7.1: Summary of the Results

Determinants/Variables	Paid Job vs Less Active Group								Unpaid productive engagement versus Less Active Group							
	Model 2 PM-2L		Model 3 GM-2L		Model 5 PM-3L		Model 6 GM-3L		Model 2 PM-2L		Model 3 GM-2L		Model 5 PM-3L		Model 6 GM-3L	
Fixed Effects	**OR**	**Sig.**	**OR**	**Sig.**	**OR**	**Sig.**	**OR**	**Sig.**	**OR**	**Sig.**	**OR**	**Sig.**	**OR**	**Sig.**	**OR**	**Sig.**
Intercept	**1.575**	*	**1.961**	***	**1.646**	**	**2.113**	***	**3.486**	***	**4.220**	***	**4.058**	***	**4.876**	***
Between person self-rated health	**1.380**	***			**1.538**	***			**1.341**	***			**1.394**	***		
Within person self-rated health	**1.314**	***			**1.272**	***			**1.196**	***			**1.174**	***		
Grand mean self-rated health			**1.343**	***			**1.382**	***			**1.258**	***			**1.271**	***
One chronic disease (ref. well)	0.903		0.900		0.879		0.886		0.968		0.965		0.949		0.958	
Two chronic diseases and above (ref. well)	**0.759**	***	**0.754**	***	0.798		0.787		0.928		0.916		0.935		0.925	
Between person MMSE	**1.104**	***			**1.109**	***			**1.119**	***			**1.120**	**		
Within person MMSE	**1.116**	***			**1.093**	***			**1.105**	***			**1.095**	***		
Grand mean MMSE			**1.112**	***			**1.102**	***			**1.111**	***			**1.107**	***
IADI (ref. dependence)	**5.717**	***	**5.712**	***	**5.115**	***	**5.209**	***	**2.757**	***	**2.774**	***	**2.696**	***	**2.755**	***
Smoking (ref. no smoking)	1.000		0.993		0.983		0.978		1.004		1.001		0.999		1.001	
Drinking (ref. no drinking)	**1.992**	***	**1.992**	***	**1.934**	***	**1.953**	***	**1.263**	***	**1.269**	**	**1.300**	**	**1.313**	**
Exercising (ref. no exercise)	**1.754**	***	**1.753**	***	**1.906**	***	**1.918**	***	**3.286**	***	**3.304**	***	**3.244**	***	**3.274**	***
Between person social activities	0.952				0.952				1.076				**1.125**	**		
Within person social activities	**1.178**	**			**1.143**	*			**1.166**	**			**1.138**	**		
Grand mean social activities			1.050				1.048				**1.117**	**			**1.138**	***
Marital status (ref. others)	**2.202**	***	**2.179**	***	**2.132**	***	**2.147**	***	**1.182**	*	**1.176**	*	1.175		1.187	
Living arrangement: (ref. alone)	**0.229**	***	**0.230**	***	**0.213**	***	**0.213**	***	**0.304**	***	**0.305**	***	**0.289**	***	**0.289**	***
Financial sufficiency (ref. financial insufficiency)	**0.696**	***	**0.692**	***	**0.731**	***	**0.748**	**	**0.822**	**	**0.828**	*	0.879		0.903	

Table 7.1, continued

Determinants/Variables	Paid Job vs Less Active Group								Unpaid productive engagement versus Less Active Group							
	Model 2 PM-2L		Model 3 GM-2L		Model 5 PM-3L		Model 6 GM-3L		Model 2 PM-2L		Model 3 GM-2L		Model 5 PM-3L		Model 6 GM-3L	
Fixed Effects	**OR**	**Sig.**	**OR**	**Sig.**	**OR**	**Sig.**	**OR**	**Sig.**	**OR**	**Sig.**	**OR**	**Sig.**	**OR**	**Sig.**	**OR**	**Sig.**
Rural (ref. city/town)	**1.716**	***	**1.752**	***	**1.568**	***	**1.575**	***	0.989		0.990		0.958		0.949	
Age at wave 2002	**0.920**	***	**0.920**	***	**0.908**	***	**0.907**	***	0.986		0.984		0.982		0.980	
Female (ref. male)	**1.477**	***	**1.489**	***	1.368		**1.372**	***	**2.669**	***	**2.661**	***	**2.613**	**	**2.601**	***
Professional or governmental (ref. housemaker & others)	0.961		0.925		0.875		0.841		0.998		0.987		0.883		0.879	
Worker or farmer (ref. housemaker and others)	**1.430**	**	**1.439**	**	1.360		1.343		1.098		1.094		1.022		1.009	
Education (Years of Schooling) (ref. unschooled)	0.851		**0.818**	*	0.819		0.805		0.913		0.912		0.866		0.879	
Between Provincial GDP per Capita					**0.494**	***							**0.790**	**		
Within Provincial GDP per Capita					0.772								1.019			
Grand Mean Provincial GDP per Capita							**4.876**	***							0.876	
Random Effects	**CE**	**Sig.**	**CE**	**Sig.**	**CE**	**Sig.**	**CE**	**Sig.**	**CE**	**Sig.**	**CE**	**Sig.**	**CE**	**Sig.**	**CE**	**Sig.**
Random Effect Block 1	**0.456**	***	**0.457**	***	**0.120**	**	**0.136**	**	**0.165**	***	**0.162**	**	**0.093**	**	**0.083**	**
Random Effect Block 2	-		--		**0.528**	***	**0.526**	***			-		**0.106**	*	**0.104**	*
Intraclass correlation (ICC) Level 2	12.2%		12.2%		3.0%		3.4%		4.8%		4.7%		2.7%		2.4%	
Intraclass correlation (ICC) Level 3	-		-		13.4%		13.3%		-		-		3.0%		3.0%	

Note: Note: ***p<0.01, **p<0.05, *p<0.10; OR = Odds Ratio; PM = Personal-Mean Centring; GM=Grand-Mean Centring; 2L = Two-Level Modelling; 3L = Three-Level Modelling; CE = coefficient.

ageing as many were engaged in unpaid productive engagement. Model 3 (two-level modelling based on grand-mean centring) provided similar results to Model 2 except that participation in social activities and educational background also impacted productive engagement.

Models 5 and 6 incorporated the impacts of the contextual variable, PGDP per capita. Model 5 indicated that several factors contributed to the participation of older adults in paid productive engagement. These factors included better between-person and within-person self-rated health, between-person and within-person MMSE, IADL independence, the habit of exercising and drinking, participation in social activities, currently married, living alone, financially insufficient, living in a rural area, being younger, and residing in a province with lower PGDP per capita.

Model 5 showed that older adults with specific characteristics were more likely to participate in unpaid productive engagement. These factors included better between-person and within-person self-rated health, between-person and within-person MMSE, IADL independence, the habit of exercising and drinking, participation in social activities, living alone, being female, and residing in a province with lower PGDP per capita. Model 6 had similar results as Model 5 except that participation in social activities, gender, pre-retirement occupation, and PGDP per capita did not have an impact. Model 5 also revealed that the impacts of self-rated health and MMSE were due to variations in individual and intra-individual differences. However, the effect of participation in social activities on participation in paid productive engagement was from intra-individual differences while the impact of PGDP per capita was from between-province differences. The findings of Models 5 and 6 were generally consistent with

that of Models 2 and 3. It is noteworthy that the significant impact of differences between-province on productive engagement suggests that these contextual effects would have been omitted if the modelling had been conducted only on two levels. Therefore, it should be acknowledged that, apart from the within- and between-individual characteristics, regional characteristics; such as province in this case; play a role in the productive engagement of the older population.

After controlling for the provincial variation, the multivariate analyses firstly showed a strong correlation between health status; such as physical, cognitive, and functional health; and paid and unpaid productive engagement. Secondly, those who had the habit of exercising and drinking were found to participate more actively in paid and unpaid productive engagements. Thirdly, participation in social activities positively correlated with paid and unpaid productive engagement. Fourthly, there was a gender-differentiated pattern in activity engagement, with older women being more likely to participate in unpaid productive engagement than men. Fifthly, older adults in rural areas as well as those facing financial insufficiency continue working for as long as they are physically capable of doing so. Lastly, older adults residing in less developed provinces were more likely to participate in paid and unpaid productive engagements than those from more developed provinces. It is noteworthy that chronic diseases, age, pre-retirement occupation, educational background, and living in rural areas did not hinder older adults from participating in unpaid productive engagement.

In general, the person-mean centring model provided more insight than the grand-mean centring model. For example, self-rated health and MMSE in paid and unpaid productive engagement were due to within-person and between-person variations. However, the effect

of participation in social activities on paid productive engagement was due to intra-individual differences while the impact of PGDP per capita on participation was due to differences between-province.

Human capital related to physical health, cognitive health, and functional health (Hypothesis One) more likely to affect participation in paid and unpaid productive engagement over time. Furthermore, suffering from chronic diseases or multimorbidity partially impacted participation in paid productive engagement. Of the behavioural determinants stipulated in the WHO's Active Ageing Framework (Hypothesis Two), smoking was not linked to participation in productive engagements while drinking and exercising were associated with participation over time. In terms of social capital (Hypothesis Three), within changes of social activities were found to especially affect participation in productive engagements. However, social activities affected involvement in unpaid productive engagements only after provincial effects were included. Marital status affected participation in paid productive engagement while living arrangement affected participation in both paid and unpaid productive engagement over time. A summary of the results of the hypotheses is listed in Table 7.2.

The "affluence or leisure preference" hypothesis supported that financial sufficiency (Hypothesis Four) affected participation in productive engagement but not unpaid productive engagement as provincial effects had been included. Apart from that, the ecological system theory supported that place of residence; be it urban or rural; (Hypothesis Five) affected opportunities for participation in paid productive engagement but not unpaid productive engagement.

Table 7.2: Summary of the Results of the Hypotheses

No	Hypotheses	Findings (Model 2 and 3)	Findings (Model 5 and 6)
1	Hypothesis 1: Individuals with better health-related human capital (physical, cognitive, and functional health, and without chronic diseases) are more likely to involve in productive engagement a) over time and b) by including provincial effects over time.	Mainly supported except for chronic diseases.	Mainly supported except for chronic diseases.
2	Hypothesis 2: Individuals with smoking, drinking, or exercising behaviour are associated with the participation in productive engagement a) over time and b) by including provincial effects over time.	Mainly supported except for smoking behaviour.	Mainly supported except for smoking behaviour.
3	Hypothesis 3: Various social capitals (social activities, marital status, and living arrangement) are associated with the participation in productive engagement a) over time and b) by including provincial effects over time.	Partially supported.	Partially supported.
4	Hypothesis 4: Financial Sufficiency is associated with participation in productive engagement a) over time and b) by including provincial effects over time.	Supported.	Partially supported.
5	Hypothesis 5: The rural-urban environment is associated with participation in productive engagement a) over time and b) by including provincial effects over time.	Partially supported.	Partially supported.
6	Hypothesis 6: Demographic factors (age, gender, pre-retirement occupation, and education status) are associated with participation in productive engagement a) over time and b) by including provincial effects over time.	Partially supported.	Partially supported.
7	Hypothesis 7: Provincial Gross Domestic Product (GDP) per Capita is associated with participation in productive engagement over time.	-	Partially supported.

Age (Hypothesis Six) was found to affect participation in paid productive engagement but not unpaid productive engagement with women more likely to participate in unpaid productive engagement than men. Other factors of human capital; such as pre-retirement occupation and educational background; modestly affected participation in paid productive engagements in the two-level multilevel analyses only. The ecological framework and economic development; especially the differences in GDP per capita of each province (Hypothesis Seven) in China; were found to affect participation in paid and unpaid productive engagements.

From a theoretical standpoint, human capital characteristics; such as physical, cognitive, and functional health; significantly affect the participation of older adults in paid and unpaid productive engagements as better health capital enables them to engage better. Human capital characteristics; such as pre-retirement occupation and educational background; were not applicable in explaining the involvement of older adults in the paid and unpaid productive engagements. Additionally, those with social capitals, such as married or active participations in social activities were more likely to be involved in paid productive engagement as social activities enable older adults to have a closer social network and more vital support. Therefore, active older adults are more likely to remain in paid productive engagements for an extended period of time.

Of the behavioural risk factors listed in the WHO's Active Ageing Framework, only drinking and exercising habits affected both paid and unpaid productive engagement. However, drinking habits must be viewed in a Chinese socio-cultural context. The habit of exercising may influence older adults to maintain and enhance the quality of their health as well as

enhance chronic disease prevention. Therefore, exercising enables older adults to be more actively involved in paid and unpaid productive engagements.

The "affluence or leisure preference" hypothesis may explain the decisions of older adults who lived alone and financially insufficient older adults as they may have to continue working as they may not have adequately prepared financially for retirement and need to work to meet their economic needs.

In this study, the ecological system theory more accurately explains the participation of older adults from rural areas and less developed provinces in paid productive engagement but not unpaid productive engagement. The findings may indicate that older adults who live in poorer economic environments still depend on agricultural activities for a living. As China continues its economic transformation and technological innovation, more people will be involved in higher income and white collar-jobs that require less physical strength. Sedentary behaviours and habits may continue after retirement and discourage older adults from involvement in productive engagements.

The social-location context of the life course perspective evidenced that the likelihood of involvement in paid productive engagement decreased with age but this was not the case with unpaid productive engagement. Many households still adhere to traditional gender roles and expect women to manage the household and perform family care.

This study sought to contribute to the existing literature by employing two and three multilevel longitudinal analyses. Therefore, a random intercept multilevel multinomial logit

model served this purpose. The GDP per capita of each province was introduced in this study to act as one of the contextual variables influencing productive engagement. Housework, personal outdoor activities, and gardening were also included to measure productive engagement to better reflect the socio-cultural context of East Asia and developing countries.

7.3 Implications of the Study and Recommendations

The findings of this study indicate that older adults in China are actively involved in paid and unpaid productive engagement. The older adults contributed to the economic wealth of the family and nation. They were also involved in taking care of and sharing their children's household work. Therefore, it is essential to adopt a long-term approach that promotes active and productive ageing by reducing barriers for older people to continue working in paid or unpaid jobs. Apart from that, policymakers need to formulate effective policies and strategies that assist and address the needs of the less active group. The following sub-sections put forth some recommendations based on the findings of this study.

7.3.1 Addressing the Needs of the Less Active Group

The Chinese government needs to ensure that less active older adults have access to affordable healthcare services. Community care centres and residential care centres can be established to improve the accessibility of health and social services to older people. There is also a need to promote physical activity and healthy and balanced diet as well as cognitive training programmes for older adults with normal and mild cognitive impairment to slow cognitive decline. Therefore, efforts must be made to collect information and consider the opinions and feedback of less active older adults to enhance the healthcare services for this group.

As less active older adults are more likely to reside with their family members, the government and NGOs must provide informal caregivers with caregiver training to mitigate and prepare them to deal with risk factors; such as physical and mental decline; that they will face when caring for less active older adults. A system of support groups can be established to provide informal caregivers with platform with which to discuss the difficult situations that they encounter. In rural areas, centres that provide caregiving services through volunteers' help; such as running errands for older adults and helping them cook and clean; may be set up.

There is a need to foster a strong social network that enables vulnerable older adults to age in place. Such a social network can be based on the Saskatchewan Seniors Mechanism, which addresses social and physical isolation among older adults by offering a wide range of activities in rural communities (Saskatchewan Seniors Mechanism, 2016). Older people can also play an essential role in running such social networks. In France, local governments task postmen with visiting isolated older adults to strengthen their social network while the Lincolnshire County Council, England, initiated a localised bus and "Call-Connected" services to link isolated and remote rural areas to their main transportation network in order to serve older adults with mobility issues (United Nations Economic Commission for Europe (UNECE), 2017).

The Chinese government can also develop initiatives that encourage older adults to assist their neighbours. This can be accomplished by forming public-private partnerships between local organisations and the community to train and equip older volunteers with the necessary

information and skills to meet the needs of other older adults. Furthermore, older volunteers could provide other older adults with information and advice. Good examples of this would be the Seniors for Seniors Program by the Slovenian Federation of Pensioners' Organisations and the "Self-Determined in Old Age! Support in Taking Precautions" project in Germany (UNECE, 2013).

7.3.2 Promoting Unpaid Productive Engagement

Policymakers must acknowledge the contribution of housework, caretaking, and planting vegetables as productivity engagement as these activities have an economic value and foster productive engagement among older adults.

As housework remains strongly gendered even after retirement, this engagement should be fostered among both genders, especially to promote male participation. There are findings that those older persons involved in housework are associated with better health (Adjei & Brand, 2018; Study et al., 2013; Yu et al., 2013).

Grandparenting is another common productive engagement and a natural extension of the Asian culture of traditional families. Therefore, policymakers should provide grandparents with more child care options and support services (day-care services) to alleviate their stress and burden. They should also be provided with formal and informal support groups as well as training programmes to equip them with the necessary information and skills. Therefore, to safeguard the welfare and health of grandparents, the government should study, plan, and prepare more proactive child care public policies and programmes while taking to consideration rural and urban differences.

Another common productive engagement among Asian cultures, gardening and personal outdoor activities; such as growing vegetables and other fieldwork; can be associated with better physical and mental wellbeing in older adults. During the COVID-19 pandemic, some governments encouraged their citizens to participate in home gardening (J. Lee, 2020). Likewise, the Chinese government could encourage home gardening activities; such as planting vegetables and other edible plants. Some initiatives, for example, provide free seeds to those interested in gardening as well as help set up informal support and sharing groups and provide them with access to classes, training, and information to foster home gardening among older adults. However, proper guidelines and suggestions need to be provided to safeguard the health of older adults and prevent injury.

7.3.3 Enhancing the Existing Work System for Older Workers

There is a need to enhance the existing work system for older Chinese workers. The work-life continuum approach enables older workers to continue working in a healthy, safe, and flexible work environment. Furthermore, the government and private sector should consider raising the retirement age to retain workers in the workforce and encourage active participation among older adults which would only benefit the country. For instance, a study by PricewaterhouseCoopers (PwC) (2018) estimated that the OECD economies could generate a potential long-term GDP gain of USD 3.5 trillion if they prolonged the work-life of their older adults.

Moreover, China may want to set the statutory retirement age according to the rising life expectancy. One suggestion is to progressively raise the current retirement age of 60 for men

and 50 or 55 for women to 65 for both genders. Ultimately, the government should replace mandatory retirement with reviewing pension eligibility to promote active and productive ageing.

The participation of older adults in paid and unpaid productive engagements not only expands the workforce but increases its quality. Furthermore, active and productive ageing can help maintain cognitive function among older adults, improve the solvency of the national pension account, and support China's current pension reform to establish "the third pillar" (Dong & Yao, 2017). Hence, the government should continue to reform pension systems and offer other financial and non-financial incentives to promote active and productive ageing. To that end, the government should consider providing guaranteed pensions as a component of old-age pensions and basic coverage for those with a low or no income-based pensions.

A policy should also be developed to address flexible retirement, bridge employment, and re-employment. It should promote continued or re-employment options for older workers, provide bridge employment, part-time or temporary jobs, offer partial retirement options, encourage women to re-enter the workforce, and offer tax or other incentives to employers who employ older adults. Such a policy could promote flexible work arrangements, pensions, and retirement age by adopting various incentives that increase job opportunities among older adults. A qualitative study by Carolan et al. (2020) indicated that promoting flexible work arrangements and retraining older adults promotes healthier working lives and benefits older adults who have low-incomes but suffer from chronic health conditions.

There is currently an urgent need to provide older adults with training to equip them with competitive skills. For instance, Germany has launched an innovative programme; "Initiative 50 Plus"; to increase the involvement of older workers in its labour force. The programme not only offers training and lifelong learning to older workers but temporary benefits to compensate older workers that accept lower-paying positions (Spross, 2010). Countries, such as Japan and the United States have also implemented salary reduction and part-time jobs for older adults through public-private partnerships. Although, under a "continuous employment" policy, Japanese companies lower the salaries of reemployed older adults by about 25% (Higo & Klassen, 2017; Ujikane et al., 2016), many older Japanese workers continue to work past the mandatory retirement age of 60 despite this economic disincentive. Although a salary reduction scheme is not an ideal solution, at the very least it enables older adults to extend their working lives. In the United States, retirees can seek part-time jobs through a public-private partnership platform or Silver Centre Workshops; a programme that offers low-skilled part-time jobs; such as house-cleaning, gardening, bicycle repair etc; at the rate of USD400 to USD500 per month (Jaffe, 2016).

Many countries have utilised tax policies to support older workers and make them more attractive to employers. For example, Japan has the lowest implicit tax rates (direct taxes) and adopts policies that extend the work-life of older adults to help them cope with inflation. As such, 75% of adults aged between 60 to 64 years old remain in the workforce (The Gerontological Society of America, 2018). Australia has also introduced several tax incentives; such as a work bonus; to incentivise older adults to prolong their working lives. Meanwhile, Sweden has implemented seniority with performance clauses in public-sector wage arrangements (Manyika et al., 2017). Therefore, the Chinese government should look

at implementing tax laws that help older adults continue working and to encourage employers to implement age-friendly policies.

A comprehensive policy package is very much needed to bring about effective reforms in the retirement system. One of the main areas of concern is ageism and the social stereotype of older adults. For instance, many employers have negative perceptions of older workers as they underestimate their productivity, pay them lower wages, and do not provide them with health insurance (Q. Feng et al., 2019; Manyika et al., 2017). Furthermore, the needs and rights of vulnerable sub-populations in the labour market; such as women, rural workers, and those in labour-intensive sectors; should be prioritised. Therefore, educational awareness campaigns against ageism are an essential developmental policy solution.

Measures are also needed to assist older adults in rural areas with lifelong learning, to create an age-friendly environment, and to arrange flexible work options in order to provide older adults with financial security throughout retirement. As women play a significant role in unpaid productive engagements; such as housework, caregiving, grandparenting; the government should provide extra pension allowances to these women and older adults in rural areas to help them attain minimum living standards.

7.3.4 Establishing the Social Enterprises and Social Entrepreneurship

A social enterprise is another viable option to foster productive engagement. A social enterprise can be characterised as a "hybrid organisation that mixes for-profit elements with a social mission; such as creating employment opportunities for disadvantaged groups in a community" (Leung et al., 2019, p. 158) to offer innovative local solutions to social

challenges (Henderson et al., 2018, 2019). Therefore, the government should encourage the setup of social enterprises that utilise older adults as human capital. It could also recruit local social enterprises that are run by and for residents to provide the energy services, broadband, transportation services, and other necessities of the local people. Henderson et al. (2019) found that social enterprises positively affected the health and well-being, social support, connectedness, and inclusion of older adults and provided them with a sense of purpose. There is also an innovative project in China in the form of a social enterprise for rural education named InterBoxes which utilises the space and place to improve physical school conditions and resolve other rural education issues (Chow et al., 2019). The village community shop in Idestrup, Denmark, is another example of a social enterprise that addresses the needs of rural communities (European Commission, 2012).

The government should also encourage collaborations between the public and private sectors, especially for social enterprises, in order to diversify the local economy of a rural area beyond agriculture and increase its economic attractiveness to spur economic development as well as encourage in-migration, especially from the younger generation. Countries, such as Poland, Netherlands, and other European countries use Care Farms; which combinate agriculture and social care; to promote the diversification of their rural economies and generate new income and employment sources for farmers (UNECE, 2017). In this way, people with social care needs can participate in farm work with farmers while the farmers receive some monetary incentives.

7.3.5 Accelerating Healthcare Reform and Promoting Prevention-Based Healthy Ageing

Given the primacy of health in fostering active and productive ageing, the government should accelerate its healthcare reform; which calls for implementing and enforcing the Healthy China 2030 plan to promote public health and disease prevention; by aligning its healthcare policies, systems, and strategies to meet the healthcare needs of its ageing population. Therefore, healthcare providers should integrate preventive health care and chronic disease prevention measures into the healthcare systems. The government should also promote programmes that raise awareness about healthy and balanced nutrition; such as consuming more fruits, vegetables, and other fresh foods; to reduce the risk of developing chronic illnesses. Good examples of such programmes are the United States' "Evidence-based Disease and Disability Prevention Program (EBDDP)" and the United Kingdom's "5 A DAY programme" (UNECE, 2010).

As China faces challenges in enhancing the effectiveness of health promotion programmes; such as limited resources with which to train health professionals, insufficient preventative services, inadequate support for evidence-based health promotion programmes, and a lack of customised disease prevention interventions; policymakers need to focus on the four main vulnerable groups; women as well as individuals with low-incomes, and those living in rural, Central, and Western regions. Furthermore, heterogeneity among older adults across gender, ethnicity, culture, health, disability, and socioeconomic status should be considered when promoting healthy and active ageing.

Policies that reduce health inequalities must be implemented to ensure that older adults have better access to healthcare services; such as mental health and emergency care. One possible solution to challenges in recruiting and retaining healthcare personnel in rural areas is to offer scholarships to youths. Furthermore, short-term urban/rural exchange schemes could provide individual healthcare providers with an opportunity to serve in under-served areas. Cost-effective mobile services; such as a retrofitted bus equipped with doctors, nurses, and telemedicine facilities; could provide easy-to-access medical services to all. Good examples of this type of service are Finland's 'Mallu does the rounds' project (eksote, 2020) and Albania's mobile mammography units (UNECE, 2017). Apart from that, provisions for mental health services need to be incorporated into the community health services. There is also a need to improve emergency and ambulance services in rural areas. As such, ambulances should be equipped with the "BeiDou" navigation satellite system or global positioning system to enable drivers to respond to emergencies faster. Furthermore, the locals; especially community volunteers; need to be trained to handle patients or victims while waiting for the arrival of the ambulance.

Older adults need to be physically active, have balanced nutrition, participate in social and leisure activities as well as brain training games to delay the adverse effects of age-related cognitive decline. Therefore, the government needs to prepare and expand healthcare services to prevent and treat age-related mental disorders; such as dementia and delirium.

As prevention-focused medical policies could improve health and cognition as well as delay the ageing process among older adults, medical insurance plans should cover the prevention, screening, and treatment of chronic diseases. In order to enhance disease prevention and

health promotion strategies, health insurance programmes should also improve the reimbursement rate of the Urban Residential-based Medical Insurance (URBMI) and the New Rural Cooperative Medical Insurance (NRCMI) as well as offer additional financial incentives and benefits to primary care practitioners (Coll & Fortinsky, 2019; P. Du et al., 2016).

7.3.6 Promoting Regular Exercise and Physical Activity Among Older Adults

This study found that participation in physical activities and exercises positively fosters active and productive engagement among older people. Moreover, involvement in exercise will delay the ageing process and lengthen older adults' participation in productive engagement. Therefore, the government and the community should encourage active older adults to continue exercising regularly and motivate inactive older adults to join an exercise programme of their choice. Regular exercise has been shown to retain and sustain cardiovascular and lung functions, insulin sensitivity, strength, and pain relief (Benton, 2015). There is also an urgent need to introduce various exercises to enhance strength, endurance, flexibility, and balance as these four aspects of exercises will provide different benefits to older adults (Panton & Artese, 2015). Tai chi is one of the most potent ways with which to improve physical, functional, and mental health. Recent studies show that tai chi can improve balance, flexibility, and muscle tone to relieve pain, especially in the back and neck; as well as pain from arthritis and fibromyalgia (Benton, 2015). Practising tai-chi has also been found to help strengthen one’s heart, reduce age-related cognitive decline, improve mood, and reduce stress while fostering calmness and clarity of thought. Studies also encourage sedentary individuals to target walking 2,700 steps a day (I. Lee et al., 2019).

Therefore, policymakers, community organisations, and healthcare providers should encourage older adults to incorporate walking into their daily routine.

Community-based programmes, peer-based strategies, and social initiatives are also needed to promote and sustain regular engagement in exercises and physical activities. Community-based programmes have been found to increase physical activity among older adults (Brach, 2015). Some studies also showed that peer-based intervention strategies facilitate and sustain behaviour changes including frequency of exercise (Ginis et al., 2013; Kullgren et al., 2014; Matz-Costa et al., 2019).

The government and non-governmental organisations need to invest in creating safe public spaces, neighbourhood parks, and green spaces equipped with sports and exercise facilities. Furthermore, local communities-built environments also require improvements in public transportation, public safety, and safety measures. As rural areas have limited public facilities, the government should build more exercise and sports facilities to promote exercise and physical activities among rural residents. Practical strategies that promote exercises and physical activities among older adults need to be implemented and integrated with current medical services and personal insurance programmes.

7.3.7 Controlling Alcohol Consumption and Preventing Alcohol Addiction among Older Adults

Alcohol consumption and addiction may affect the health of older people, thereby, preventing them from engaging actively. In China, social events, business interactions, and traditional customs promote drinking. The World Health Organization as well as many studies state that those who drink to excess carry a higher risk of cardiovascular disease, liver damage, and

mental health problems as well as carry the highest risk of all-cause mortality. Consuming no more than 100 g/week was determined to carry the lowest risk of all-cause mortality (Wood et al., 2018). Therefore, the government needs to develop programmes to control, treat, and prevent alcoholism among older adults. One good example is Switzerland's holistic and gender-specific approach to prevent alcohol abuse, prevention, and rehabilitation. Apart from that, the World Health Organization has compiled an international guideline to monitor and control drinking and alcohol consumption (WHO, 2000).

7.3.8 Developing and Utilising Technologies and Artificial Intelligence (AI)

Artificial intelligence (AI) has the potential to revolutionise productive engagement if older adults can utilise this technology advancement. As older adults will find it more and more difficult to cope with strenuous jobs as they age, they may be unable to continue working in jobs that require physical strength. Therefore, some countries have adopted new technologies; such as automations and mechanisations; that enable older people to continue working in the agriculture, manufacturing, and service industries and continue operating machinery that would otherwise require considerable physical strength. China may adopt the Asian Development Bank's framework on technology and an ageing workforce to maximise longevity and working life (Asian Development Bank, 2018).

China has progressed far in AI research. It is a more efficient and cheaper way of diagnosing diseases, developing drugs, personalising treatments, and improving gene editing. Therefore, the government could innovate and adopt new technologies to enhance the well-being of older adults as well. AI can revolutionise ageing and longevity research via deep learning algorithms in the field of biomarker development. Ageing biomarker discovery and

personalised medicine, target identification, gene therapy, regenerative medicine, small molecule drug discovery, immune-oncology, and immunosenescence are just some of the examples of AI applications in ageing research (Zhavoronkov et al., 2019).

As China is poised to be the world's largest telemedicine and telehealth market (Trinh & Zamanian, 2017), the government needs to formulate policies and invest in low-cost telemedicine services to benefit people in rural areas. Despite the devastating effects of the COVID-19 pandemic, it has made digital healthcare the new norm in China and globally. Telemedicine can improve healthcare by providing older adults with mobility issues and living in rural areas with transportation issues with remote consultations and treatment delivery for primary healthcare, follow-up on chronic diseases, rehabilitation, and in-home monitoring at a lower cost and greater ease. Nevertheless, the challenges of efficiency and cost-effectiveness of telemedicine facilities and technology acceptance among older adults needs to be addressed. Denmark and Lithuania provide excellent examples of utilising information and communication technology (ICT) for healthcare (UNECE, 2017).

There are many AI technologies, smart devices, and applications with which to serve older people and enhance their health and well-being. For example, home health monitoring, smart device assisted fall detection, smart device assisted daily living, and virtual companions play a significant role in elder care (Sanyal, 2018). Some researchers argue that, in the future, the price of technological advancements will become a more significant driver of healthcare expenditure than an ageing population (Jayawardana et al., 2019). Therefore, the government must ensure that the advancement of technology is cost-effective and introduce effective regulations to protect patient health data.

Social engagement technologies; such as email, smartphones, social networking sites, television, augmented reality (AR) and virtual reality (VR); play a crucial role in reducing physical inactivity, memory-related impairments, and financial barriers to social engagement among older adults (Bixter et al., 2018). Therefore, the involvement of older adults in designing social engagement technologies will yield more positive outcomes that meet their needs. However, informal training instruction manuals need to be developed to achieve the desired results.

7.3.9 Promoting Social Participation

This study reaffirmed the close association between social participation and engagement in paid and unpaid activities among older adults. The government should promote and foster the social participation of older adults, especially for the less active older adults. Participating in social activities and interacting with family members and friends enables older people to stay active and healthy, and prolong the older adults' involvement in productive engagement. To that end, the government should perform needs-based assessments and ascertain obstacles that prevent older adults from participating. As older adults are far from homogeneous, rewards must be designed to incentivise and encourage participation in a variety of activities. These incentives can include gift cards, birthday parties, free meals, day trips to cultural site, or awards, medals, and certificates presented at a recognition event.

Community recreational facilities help remove structural barriers and encourage social engagement among older people. For example, individual rates on public transportation and more public transportation options for older adults should be considered. Efforts should also

be made to promote and support senior or community centres where older persons can exercise, socialise, and have access to lifelong learning. Lastly, cultural activities should be organised regularly to uphold respect for older adults.

Community-based initiatives should also be developed and expanded to promote the social participation of older adults. Older adults play a vital role in recruiting their peers to get involved in social activities. For example, in the Danish village of Idestrup, a group of older adults refurbished a shop and converted it into a meeting place for the whole community, especially for older adults (European Commission, 2012). As the meeting place offers some social and economic activities as well as a wide range of services and life-long learning opportunities for older adults, it promoted more social participation, connected isolated older adults, and encouraged advanced active ageing in the village.

7.3.10 Implementing and Enhancing Sustainable Social Security System for Older Adults

As only a few older adults are entitled to a pension, a sustainable social security system needs to be developed to look after the financial needs of older adults in order for them to remain actively engaged. A multilevel and diversified support system should be established to ensure that underprivileged older adults have, at least, the minimum standards of living. Moreover, old-age insurance should be made accessible and available to all older people while the social pension level should be increased gradually. Furthermore, the social insurance system needs to invest and promote pension income coverage, particularly among the lower income groups of both rural and urban areas. Lastly, the country's present social security system for older adults should be evaluated and further strengthened.

7.3.11 Enhancing the Quality of Long-Term Care (LTC) through Community-Based Care

The findings for this study showed that those who are less active are older and with poorer physical, cognitive, and functional health. Eldercare enables older adults to age in place and safeguards their health to remain actively engaged in paid and unpaid jobs. Long-Term Care (LTC) should also pay attention to rehabilitation to enable them to be actively engaged. One of the supports that should be given is long term care through community-based care.

Community-based care can be enhanced by adopting the multi-pillar community eldercare service model as proposed by L. Zhang and Yang (2019). In this model, the zero pillar provides disadvantaged older adults in rural areas with vouchers (L. Zhang & Yang, 2019) for which limited funds are drawn from the government and public budget. In the first pillar, however, the government plans, funds, and regulates basic eldercare services while players from the private sector; such as institutional care agencies; provide free or subsidised services that are paid for by the local government or health insurance. Examples of essential elder care services include health habitation services, home-visit services, life assistance programmes, and senior activity centre facilities.

In the second pillar, private organisations provide paid services that are regulated by the government and eligible for tax incentives. The focus should be on adopting a talent policy, occupational education, training, and incentives that attract physicians, nurses, physical therapists, nutritionists, social workers, and other professional caregivers to the eldercare industry. Furthermore, health professionals are encouraged to participate in social or

volunteer organisations on a part-time basis to provide better eldercare services to the community. The role of informal care from family members should be integrated into the community eldercare system. For example, the government can consider giving subsidies to informal family caregivers from disadvantaged households and provide them as well as the community with training in older person care. Furthermore, caregivers should be provided with access to counselling and information services to adapt and deal with the stresses of caregiving and the toll on their health. Additionally, the central government should help less developed provinces establish a healthy long-term care (LTC) system by shouldering some of the fiscal responsibility. Lastly, in the event that an LTC cannot be established or is rejected by the local older adults, residential care is proposed to customise the provision of quality care.

7.3.12 Addressing Gender Inequality

This study found significant gender inequality between paid and unpaid productive engagement among older adults; with most men engaged in paid productive engagement while most women performed unpaid productive engagement. Therefore, entrepreneurships or social entrepreneurships may enable older women to utilise their skills, knowledge, and potential to earn a living. Although various stakeholders may provide the start-up fund, financial support, incentives, and training, and as well as develop policies that help older women participate in micro business, the government needs to incentivise employers to support the re-entry of older women into the labour market by providing options; such as part-time and flexible work hours. There is a need for gender-sensitised approaches for older women, especially the less active ones. Programmes that focus on healthy eating, self-

management of chronic diseases, engaging in physical activities, and social connectedness are required to engage older women in active and productive activities.

7.3.13 Promoting Participation in Training and Lifelong Learning Among Older Adults

Older workers, especially those of lower levels of education, should be provided with training, retraining, and lifelong learning opportunities to equip them with the skills needed to continue working after retirement and to remain actively engaged. Furthermore, efforts should be made to provide older adults with lifelong learning opportunities by developing classes, colleges, training centres, lifelong learning platforms etc that enhance their employability via technology. The outline, content, and curriculum for older adults may include self-care techniques, health and nutrition-related education, technology, caregiving, financial literacy, environmental study, gardening, farming, and others. There should also be classes dedicated to training older adults in the use of technologies; such as email, social media, and smartphones; so, they can take advantage of these technological advancement.

When learning new technologies, older adults may prefer to be formally trained in a group setting or informally taught by family members or friends. The lifelong learning opportunities available to women and older adults in rural areas needs to be increased to minimise the disparity between men and women as well as older adults in rural and urban areas.

The University of the Third Age (U3A) is an international movement has that contributed to active ageing in some countries, including China. Older adults participating in the U3A report improved cognitive abilities, health, physical and mental well-being, and social participation

(Formosa, 2019; X. Zhao & Chui, 2019). Nevertheless, the U3A in China needs to adjust its strategies to recruit older adults living in rural areas, older adults living in residential care, working older adults, as well as older adults with mobility and cognitive difficulties. The U3A centres should also embed e-learning strategies that cover broader, more diversified groups of older adults. Therefore, the Chinese government needs to formulate a more systematic approach in promoting late-life learning through the U3A by adopting best practices from the international community, such as Iceland.

7.3.14 Developing and Enhancing Sustainable Age-Friendly Communities

The more developed provinces can provide older adults with a better environment, facilities, and services for job opportunities that foster active and productive engagement. Therefore, these provinces should develop and enhance sustainable and age-friendly communities. When building age-friendly communities, provincial policymakers may refer to the WHO's Global Age-Friendly Cities (AFC) programme which focuses on developing "an age-friendly environment to foster healthy and active ageing by building and maintaining intrinsic capacity across the life course and enabling enhanced functional ability" (WHO, 2015, p. 225). Age-friendly cities are barrier-free cities that cater to the needs of all citizens. An age-friendly environment and community are essential to promote social engagement among older adults and foster autonomy, active and productive engagement, and well-being.

7.3.15 Developing and Enhancing Longevity Economy

Due to rapid population ageing, there is a growing group of consumers, workers, and innovators consisting of older adults. Therefore, the government needs to develop policies and strategies that tap into the older population to develop and enhance the Longevity Economy. Furthermore, the increased health expectancy presents an opportunity to turn longevity into an asset. Rather than viewing the rising number of older adults as a burden, they should be viewed as an unprecedented economic opportunity. Therefore, business entities should acknowledge and tap into the spending power of older people by developing products and services that address essential health, safety, and enhance quality of life; a growing demand among the older population. Therefore, there is an urgent need to study the consumer behaviour of older adults to better understand their needs and preferences. In the meanwhile, the government should develop a consumer policy that protects the vulnerability of many older consumers. One example is the German consumer policy for older persons (UNECE, 2009).

7.3.16 Adopting Adult Dependency Ratio Instead of Old-Age Dependency Ratio

The government should consider adopting an adult dependency ratio instead of the old-age dependency ratio to better reflect the current status of older adults. This is because many older adults over the age of 65 still actively participate in the labour force. Therefore, the conventional "old-age dependency ratio" needs to be revised. As many older adults intend to work and support their adult children by providing financial aid, grandparenting, and housework, the alternative framework; the "adult dependency ratio"; that the World Bank introduced in 2015 should be adopted to reflect the realities (Farrell, 2016; Koettl, 2015). This is because the "adult dependency ratio" measures the number of inactive versus active

person aged 15 years and above in an entire population. Therefore, this new measure will be able to better reflect changes in the longer work-life expectancy of older adults.

7.4 Limitations of the Study

Of the several limitations to this study, the first is that the primary focus of the CLHLS was on the health status of older people as they age and the median age of the respondents was 88 years old. Furthermore, the survey did not measure other types of productive engagements; such as volunteering, caring for a spouse, and providing informal help. The CLHLS also did not measure the intensity of involvement in engagements and activities. Therefore, it is impossible to distinguish between older adults who only devoted a few hours to an activity in comparison to those who devoted more time to the same activity. Apart from that, this study only used the limited social participation, economic, physical environment, and contextual variables that were available. The living arrangement needs to be interpreted cautiously as the two categories of living alone and living in a nursing home had been combined because only a small number of respondents (seven respondents) lived in a nursing home. It also did not include data from the latest 2018 CLHLS survey as that information is not yet available for public use at the time of writing.

The scope of productive engagement is defined based on the information in the survey. The older adults who were not involved in paid jobs and unpaid work were considered less active. The survey has no information on whether the less active group is idle or not. Involvement in productive engagement, especially unpaid activities, is common among the Chinese. Thus, those who are not engaged in paid or unpaid productive activities may be idle.

Another limitation was the attrition rate inherent in longitudinal research among older adults due to mortality and dropout. Therefore, mixed-effects models were used to deal with the issue of attrition and missing data (Gueorguieva & Krystal, 2004; Twisk et al., 2013). However, as mixed-effects models assume that data is missing at random, the analysis does not eliminate the possibility of data that is not missing at random (NMAR).

Furthermore, the results of this cannot be generalised for use in other developing countries. This is because China is a socialist country with unique social-cultural, economic, and political systems (Peters, 2017). Therefore, the results may not hold true in other developing countries.

Despite the longitudinal nature of the data set, the analysis does not necessarily imply a causal relationship between productive engagement and some of the determinants as it can be bi-directional. For instance, some studies found bi-directional relationships between productive engagement and self-rated health (Di Gessa & Grundy, 2014; Morrow-Howell et al., 2014), functional health (E. Choi et al., 2016), and cognitive health (Y. Luo et al., 2019).

The sixth limitation relates to the measurement of self-rated health and self-rated chronic conditions. While some studies have established the validity of using single items to measure self-rated health (DeSalvo et al., 2006; Goldberg et al., 2001; Singh-Manoux et al., 2006), others have challenged the accuracy of self-rated health as it may contradict the results of medical examinations. Furthermore, respondents were allowed to self-report chronic health conditions that may or may not be clinically confirmed by physicians. Therefore, some degree of information bias may exist as respondents may have under-reported or over-

reported chronic health conditions which will affect the findings. Nevertheless, several health surveys have validated the accuracy of self-rated chronic health conditions (Kriegsman et al., 1996; Rius et al., 2008).

Lastly, this study only utilised random-intercept multilevel multinomial logit models for longitudinal data and did not use random slope models. There is also the possibility of participant recall bias and interviewer bias which may affect the findings.

7.5 Recommendation for Future Research

As the limitations listed above call for more in-depth research, future studies may consider using longitudinal multilevel analyses to examine changes in the different types of productive engagements; paid and unpaid. This includes jobs such as housework, gardening, caregiving, providing informal help, volunteering, social engagements, lifelong learning, and civil engagements as well as various determinants and contextual variables over time to provide more compelling arguments on the cause-and-effect patterns in productive engagement. Furthermore, the length and intensity of participation in various productive engagements should be included to better quantifying the impact of productive engagement. Future longitudinal analyses on productive engagement among older adults should also extend to countries with more diverse socio-cultural contexts, including Asian and African cultures. To mitigate against reporting biases, future research may also derive physical health and chronic health information via medical examinations and objective measures.

Although multilevel longitudinal techniques provide many opportunities to examine productive engagement later in life from between and within-person perspectives by

including contextual variables, more in-depth multilevel longitudinal studies are required to add to gerontology research from theoretical and practical perspectives.

Morrow-Howell, Gonzales et al. (2017) proposed a system dynamics (SD) approach to develop a research framework on productive engagement among older adults. The model estimates "the short, intermediate, and long-term ramifications within the larger system, including changes in organisational capacity, the human capital of older adults, demand for caregiving, and attitudes and expectations about older adults" (Morrow-Howell, Gonzales, et al., 2017, p. 11).

Future studies should also examine the impact of the COVID-19 pandemic on productive and active ageing, especially among the vulnerable group of older adults. Furthermore, the societal impact that lockdown measures had on the social participation of older adults also warrants investigation.

7.6 Concluding Remarks

This study employed random intercept two and three-multilevel multinomial logit models to examine the determinants of active and productive ageing in a developing country from a longitudinal and multilevel perspective. It found that older adults in China were actively engaged in paid and unpaid activities that contributed to their families, communities, and societies. The findings of this study also supported the productive ageing concept and, particularly, the WHO's Active Ageing Framework which posits that active ageing is determined by a broad range of factors; from health to environmental. It is noteworthy that factors, such as multimorbidity, age, pre-retirement occupation, educational background, and

living in rural areas did not always hinder productive engagement, especially unpaid productive engagement. Apart from that, the person-mean centring model provided more insights than the grand-mean centring model, and that the contextual variable, PGDP per capita, affected active and productive ageing. This study also reaffirmed the primacy of health and healthy behaviours in enabling the productive engagement of older people.

Productive engagement, an activity in old age that could be promoted with the participation of various stakeholders and should be encouraged and facilitated to benefit individuals, families, societies, and the nation. The entire ecosystem to support productive engagement is increasingly important given the fact that many older persons have longer life expectancy and they may have no children or only one child to depend on in their old age.

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