

Doctoral Dissertation

Applied Dynamic Analysis on Labor and
Social Welfare:
for Predicting Condition and Environment of
Labor Market, Social Security System and
Economic Growth in China

He Du

Graduate School of Social Sciences
Hiroshima University

September 2017

Contents

Introduction	1
Chapter 1. A Survey of Chinese Labor Market	5
and Social Security	5
1.1 Overview and Problems of Chinese Labor Market	5
1.1.1 Development of Chinese Labor Market	5
1.1.2 Current Situation of Chinese Labor Market	7
1.1.3 Primary Topics of Chinese Labor Market	12
1.2 Overview and Problems in Chinese Social Security System.....	14
1.2.1 Development of Modern Social Security System	14
1.2.2 Development of Chinese Social Security System	15
1.2.3 Current Situation of Main Social Security Plans in China	16
1.2.4 The Important Issues of Social Security System in Future China	20
1.3 Conclusion and Policy Implications	23
References	24
Chapter 2. Dynamic Analysis of the Regional Differences in Japanese LTCI System	27
2.1 Introduction	27
2.2 The LTCI System in Japan; A Quick Review.	29
2.2.1 The Objective of the LTCI Care Insurance System	29
2.2.2 Application Process for the Long-Term Care Services	30
2.2.3 The Figures of the LTCI System	30
2.2.4 The Causes of Regional Differences and the 2005 Reform	31
2.3 Theoretical Model Analysis of the LTCI System	32
2.3.1 Theoretical Model Analysis	32
2.3.2 Numerical Example	39
2.3.3 Data Properties	40
2.4 Mobility Analysis of Regional User Rates' Standing Order.....	46
2.5 Mobility Analysis of Standing Order based on Residual User Rates	53
2.6 References for China	58
2.7 Conclusion.....	60
Appendix. Data Sources and Its Properties.	62
References	64
Chapter 3. Home or Market; Relative Importance of Learning Places on the Process of Economic Development	67
3.1 Introduction	67
3.2 Model.....	71
3.3 Steady State and Welfare	77
3.3.1 Steady State	77
3.3.2 Welfare at Steady States	82
3.4 Structural Stability and Bifurcation.....	83
3.4.1 Phase-diagram Analysis.....	84
3.4.2. Implication of Time Allocation for the Unified Growth Theory	89
3.5 The Implications to China	93
3.6 Conclusion.....	98

References	99
Conclusion	103
Acknowledgement	106

Introduction

This aim of this dissertation is to study the implications of labor market and social security system on the process of economic development, and to predict the future economic growth of China.

China's economy has been undergoing a rapid development during the 30-year-plus reform and opening-up period. As well documented in the economics literature, the economic growth miracle started from late 1970s is largely attributed to the so called "demographic dividend" and the "rural labor migration"¹. Cai and Zhao (2012) argue that the growth of working-age population guarantees an ample supply of labor; a continual decline in dependence ratio helps to maintain a high saving rate which is a foundation for capital formation; surplus labor moved from rural areas to urban areas improves efficiency of resource reallocation, which enhances the TFP.

Nevertheless, the impacts of demographic transition to economic development in China have exceeded far above expected although many other countries have experienced it. Particularly, in labor market, a remarkable change is the shortage of rural migrant labor and increased wages which occurred in 2004, which described as passing the Lewis turning point (Zhang et al., 2011). Du and Yang (2014) argue increased cost of labor force weakens competitiveness in labor-intensive industries and calls for the transformation of growth pattern from input-driven growth models to productivity-driven ones. The other impact comes from the population aging, evidenced by negative growth of working-age population appeared for the first time in 2011, while the population dependence ratio began to increase. The consequence is decline in labor supply and capital formation, which will reduce the potential economic growth rate (Cai and Lu, 2013).

As well as the slowdown of economic growth, demographic transition also exacerbates the problem of China's social welfare, such as the unsustainable financial guarantees institutional segregation and the low level and narrow coverage of social security system, especially the lack of long term care support for an increasing elderly people with full or

¹ For "Demographic Dividend", see <http://www.unfpa.org/demographic-dividend>

partial disabilities. The implications of social security system are not limited to ensuring the social stabilization and fairness, but also affecting the economic growth through influencing the labor supply, human capital accumulation and allocation efficiency of labor resources². Therefore, the social security itself is even regarded as a production factor³.

This study starts with a survey of labor market and social security system of China in Chapter 1. We conclude that there is an expanding labor market reflected in an increasing total number of employment. Although the China's unit labor productivity grows rapidly, the absolute level is obviously lower than the average level of the world. The relative productivity by industry presents convergent tendency. The segmentation between rural sector and urban sector prevents the labor mobility, which reduces the efficiency of labor resource reallocation and thereby decreased the TFP. Under the background of population aging, there are potential negative effects on economic growth due to the shortage of labor supply and high aging dependency ratio. Apart from relaxing the institutional regulations, improving the labor competence by investing the human capital to meet the demand of industrial optimization and upgrading should be considered.

On the other hand, in the last decade, the social security undertaking in China has developed rapidly, which embodied in the perfection of corresponding laws and the coverage expansion of beneficiary, especially the establishment of social security programs for rural area population. However, the coverage and the level of social security is relative low compared internationally. Moreover, the regional inequality of social security level, which is also brought by the institutional regulations, exacerbates the labor market segmentation and leads to negative effects on economic development. Population

² Zhang (1995) shows when bequests are positive, an unfunded social security program may simulate growth by reducing fertility and increasing the ratio of human capital investment per child to per family income by employing a theoretical framework. Allen et al. (1988) show the lower job's turnover rates of persons who are covered by pensions are strongly associated the capital loss. Zhang and Zhang (2003) suggests the enterprise pension prevents the human capital mobility, but not restricts enterprise to invest on human capital.

³ See European commission (1997). "Modernising and Improving Social Protection in the European Union".

aging generates an increasing demand of long-term care for elderly people, and the relevant social security system is absent.

To build up a nationally long-term care insurance (henceforth LTCI) system, the factor that the imbalance economic development among regions should be considered. In order to provide policy guideline for China, chapter 2 focuses on the experience of LTCI system in Japan. We give an analysis on the dynamic properties of regional differences of the Japanese LTCI system. We also investigate the effect of the government-oriented reform for the “expanding cost” problem and the “large regional differences” problem of LTCI system. First, we predict that each region’s user rate converges to a unique globally stable steady state by employing a simple theoretical model. The convergence, however, could be conditional, i.e., each region’s user rate may converge to a region-specific steady state which is determined by the region’s parameters.

We also calculated the user rates of 47 Japanese regions (prefectures) for the fiscal years between 2000 and 2012. The regional user rates seem to exhibit a tendency to conditional converge. Additionally, by using average Markov transition, we calculated the index of standing order mobility to evaluate the effects of the 2005 reform which aimed to remedy the differences in regional figures of LTCI system. It turned out that the 2005 reform, did not seem to alleviate the standing order inertia.

Moreover, the small degree of variation in the standing order suggests the existence of region-specific factors. With the help of preceding researches, we chose 3 factors {the certification rate, the late-stage (75 years or older) old age ratio, and the ordinary balance rate} to account for the regional differences in user rates, and recalculated the mobility index by using the residuals. It turned out that the degree of mobility is improved and thus the convergence is conditional. If region-specific factors were not removed, each region’s user rate would converge to region-specific steady state, and the standing order of regional user rate would be invariant. It turned out as well that the 2005 reform hardly affected the standing order mobility of residual user rates. In addition, the analysis also revealed that the improvement in the standing order variation seems small even after the regional factors are removed. Therefore, there might be factors other than our choice that could explain the regional differences.

By comparing the regional differences between Japan and China, we provide suggestions for the establishment of Chinese LTCI.

In Chapter 3, for predicting the growth trend of China, we provide theoretical framework and show that the relative importance of learning places (home or market) matters for the process of economic development by employing the ideas of “unified economic growth theory” and “family and time allocation”.

A natural framework that can deal with these issues is a two-sector model of economic growth in which a household plans time allocation between market activity and non-market (home) activity to maximize utility. Under the assumption that home technology is more labor intensive than the market technology (as presumed in many preceding researches), when market activity is more important for human capital accumulation, then multiple steady states emerge in dynamic general equilibrium. Some economies converge toward a higher growth steady state, while the others toward a lower growth steady state. Furthermore, the divergence may depend on initial condition and self-fulfilling expectation.

We also review the role of human capital on China’s economic growth process since the reform and opening-up, and discuss the applicability of our theoretical model for predicting the future of economic growth of China.

Chapter 4 concludes and points out the shortcomings and future directions for further research.

Chapter 1. A Survey of Chinese Labor Market and Social Security

In this chapter, by providing a review of the history and current situation of Chinese labor market and social security system, we conclude, the skill gap due to the industrial structure change generates labor shortage and unemployment co-existence in Chinese labor market, which could be tackled by improving the public vocational training; relaxing the family plan and regulations on labor mobility as well as improving the level and coverage of social security could counterbalance the potential negative effect brought by population aging and mobility barriers created by institutional factors on economic growth.

1.1 Overview and Problems of Chinese Labor Market

1.1.1 Development of Chinese Labor Market

From the founding of People Republic of China to the pre-reform-and-open period, Chinese labor market experienced existing, shrinking and disappearing phase. After reform and open, the labor market started to develop.

Chinese Labor Market before the Reform and Open

In the initial stage of founding of People Republic of China (1949-1953), in order to maintain social stability and recover economic development, the government took continuing policy with the confiscated old China bureaucrat capitalist enterprises staff, preserving the undeveloped labor market, which formed in few medium-and-large cities.

During the first five-year plan of planned economic system, which started from 1953, the government implement concentrate resources configuration system and the micro operation mechanism without autonomy (Lin et. al., 1995). Moreover, the government push centralized labor allocation system. Under this system, because the companies have no autonomous right on the using of labor, they cannot optimize the combination of production resources and labor; without motivation, labor degraded; without labor flow, resources were wasted.

Chinese Labor Market after Reform and Open

After reform and open, Chinese economic system gradually transferred to market economy system, and the labor market started to work. The development of economy can be divided into four stages as following.

The first stage (1979 - 1983): the Chinese rural area tried economic system reform, “the rural responsibility system of production”, while in Chinese city area, because of the development of collective economy, individual economy and other economic system, the government tried another way to solve unemployment problem – the government used “three-in-one combination”, which is the labor department job placement, resources allocation job placement, and self-employment job placement, to replace the original mode, “centralized labor allocation system”. Meanwhile, the government still employed the original labor distribution model on the state-owned enterprises within the planned economic system.

The second stage (1984 – 1992): as Chinese activated the urban economic system reform, state-owned enterprises within the planned economic system was granted more autonomous right on labor using. The reform of planned economic system facilitated the outflow of labor within the system. During the same period, the rural management system was full swing, and the farmers gained more autonomy to the labor force, stimulating the transfer of peasant labor to non-agricultural industries.

The third stage (1993 – 1997): in the “Decision of the Central Committee of the Communist Party of China on the Establishment of a Socialist Market Economic System” in 1993, the Chinese government clearly presented that the government would cultivate and develop the labor market for the first time. During this period, non-state economy developed rapidly, especially the foreign enterprises in the coastal open areas, attracting the mainland labor force. At the same time, the competitiveness of labor force in state-owned enterprises declined, and thus rising unemployment problem and inadequate employment problem.

The fourth stage (1998 – now): in 1998, China established the labor market in full swing. First of all, the problem of laid-off workers, former state-owned enterprises’ workers, was solved through the establishment of the "re-employment service center", leading the

outflow of the labor within the economic system. In addition, the government strengthened the management of occupational intermediary, standardize the order of the labor market, and established labor service network, which aimed of public occupation introduction supplemented by private occupation intermediary, covering both urban and rural area. From 2011, the ministry of labor and social security (now the ministry of human resources and social security) released “the Analysis of Labor Market Supply and Demand of Some Cities” to control the supply and demand of labor under market economy, providing the basis for employment guidance and training. However, because of the existence of policies based on household registration, so far, there is no unified labor market for industries in China.

1.1.2 Current Situation of Chinese Labor Market

Basic Situation of Economy

After open and reform, Chinese economy experienced rapid growth; from 1979 to 2011, the actual average annual growth rate is 9.8%; to be more specific, the actual annual growth rate of the first 10 years of 21st century is 10.5%, while the growth rate slowed down from 2012; the rate declined from 9.5% in 2012 to 7.4% in 2014, and further decreased to 6.7% in 2016⁴. Moreover, according to “Global Economic Prospects 2017”, released by World Bank, Chinese economic growth rate will continue decline to 6.3% in 2019⁵.

Labor Supply

Due to the fertility policy and extension of the average life expectancy, China becoming an aging society with few children. By the end of 2014, the working age population (aged 15 ~ 64) of China was 100,469,000, account for 73.4% of total population, falling from 2010. Meanwhile, the total population dependency ratio increased from 34.2% in 2010 to

⁴ Data of 2016 comes from “National Economic and Social Development Statistical Bulletin 2016”, released by CNBS, http://www.stats.gov.cn/tjsj/zxfb/201702/t20170228_1467424.html, February 28th, 2017; Other data comes from “National Database”, released by CNBS, <http://data.stats.gov.cn/>

⁵ “Global Economic Prospects 2017” <http://pubdocs.worldbank.org/en/216941493655495719/Global-Economic-Prospects-June-2017-Global-Outlook.pdf>

37% in 2015, which was composed with an increasing aged-dependency ratio and a declining child-age dependency ratio. Furthermore, according to the population outlook report of United Nations, the proportion of working age population in China is expected to fall to 68% in 2030, and to 58.9% in 2050, and the total population dependency ratio will growth from 48% in 2030 and 63.6% in 2050⁶ ⁷.

From the perspective of educational level and the OECD report of 2015, 24% of the main working population in China have high school degree or above, far below the average level, 80%, of the 35 member-countries of OECD.⁸

During the same period, according to “Investigation Report on Migrant Workers”, published by CNBS, the total number of migrant workers increased from 252,780,000 to 277,470,000, and the growth rate declined from 4.4% to 1.3% for 4 consecutive years⁹.

Employment Scale and Structure

Since 2010, China’s overall employment scale has been expanding, i.e. at the end of 2016, the total number of employees reached 776,030,000, increased 1.96% compare with the number in 2010; specifically, the number of urban employment increased from 346,870,000 to 414,280,000, increased 19.5% compare with the number in 2010 (see Table 1.1).

⁶ United Nations, Department of Economic and Social Affairs, Population Division (2015). World Population Prospects: The 2015 Revision, custom data acquired via website.

⁷ In general, the working-age is 15-60 year-old or 15-65 year-old people. According to the “minimum employment age convention”, approved by the international labor organization in 1973, the lower limit of working-age is 15-year-old. Whereas, whether the upper limit of working-age is 60 or 65 years old depends on the different expectancy of average life in different countries. In 1998, China joined the “the minimum age for employment” of international labor organization, requiring the lower limit of working-age is 16-year-old in China. However, there is no clear provision on the upper limit of working. Therefore, the statistical data on the working-age population is relative confusion in China. This paper employs “China Statistical Yearbook”, and uses 16-64 years old as the working age.

⁸ OECD (2015), Education at a Glance 2015: OECD Indicators, OECD Publishing, Paris. DOI: <http://dx.doi.org/10.1787/eag-2015-en> page 39

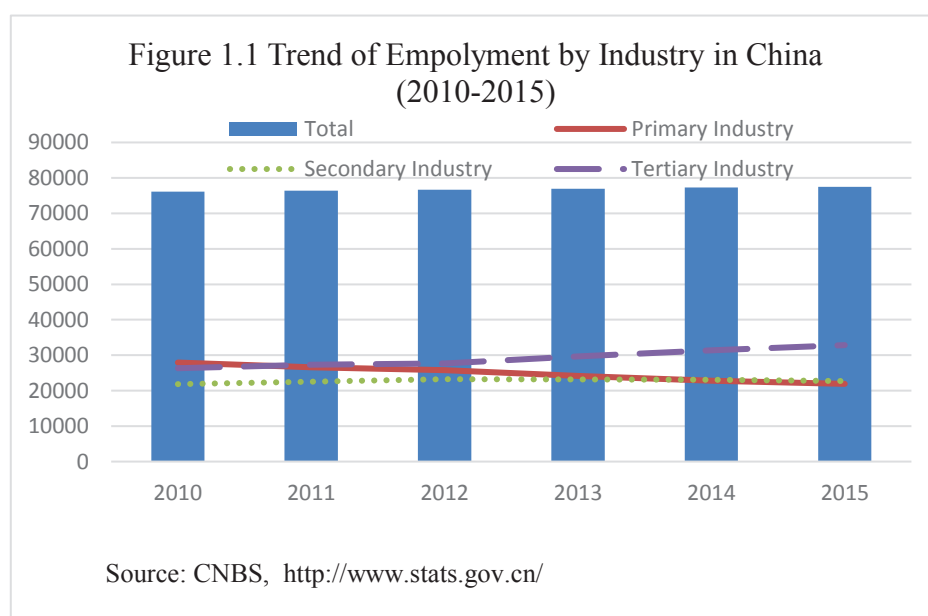
⁹ China Migrant Workers Monitoring Report 2015, http://www.stats.gov.cn/tjsj/zxfb/201604/t20160428_1349713.html

Table 1.1 Trend of Employment by Urban and Rural in China 2010-2015

	2010	2011	2012	2013	2014	2015
Total	76105	76420	76704	76977	77253	77451
Urban Sector	34687	35914	37102	38240	39310	40410
Rural Sector	41418	40506	39602	38737	37943	37041

Source: CNBS, <http://www.stats.gov.cn/>

On one hand, with the acceleration of Chinese industrial structure adjustment, the employment proportion of the three industries sector experienced significant changes. From 2010 to 2015, the primary industry employment proportion declined from 36.7% to 28.3%; that of secondary industry changed little, remained at around 29%; however, that of tertiary industrial increased from 34.6% to 42.4% (see Figure 1.1).



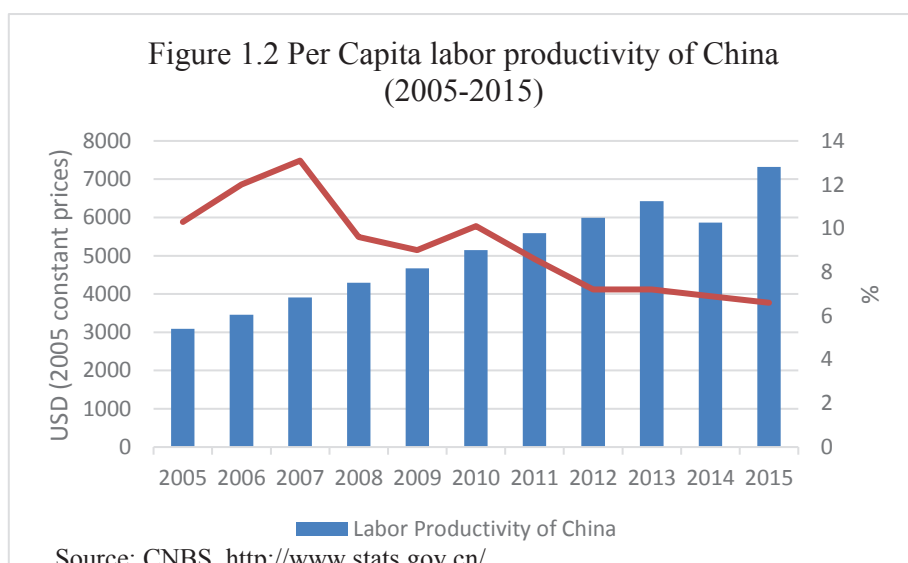
On the other hand, from the employment distribution, the proportion of rural migrant workers engaged in manufacturing industry decreased from 36 % in 2011 to 31.1 % in 2015, while that of other industries, such as wholesale and retail industry, rose.

Quality of Labor

Overall, Chinese labor productivity grow fast; the average education level of employment of Chinese improved year by year, however, unlike developed countries,

China remains a significant gap.

From 2005 to 2015, in China, the unit labor productivity had an average rise of 9.1%, from \$3,088 to \$7,318; to be more specific, from 2005 to 2010, the unit labor productivity had an average rise of 10.6%, whereas it declined to 7.3% from 2010 to 2015 (see Figure 1.2).



Meanwhile, compare to other major economies all over the world, although the increasing of China’s unit labor productivity is relative fast, the output level is obviously lower than the average level of the whole world, especially when compare with America, Japan and Eurozone (see Table 1.2).

Table 1.2 International Comparison of Labor Productivity in 2015
(Constant 2005 USD)

	China	U.S.	EU	Japan	India	World
Growth Rate	6.6	0.9	0.6	0.9	5.6	1.1
Productivity	7318	98990	68631	76068	3559	18487

Source: ILO Databases <http://www.ilo.org/global/statistics-and-databases/lang--en/index.htm>

From the perspective of relative labor productivity among industries, labor productivity

ratio of the primary, secondary, and tertiary industry (i.e., the proportion of the added value/ the employment rate) was 0.26: 1.45: 1.22 in 2010, while was 0.31: 1.39: 1.18 in 2015, indicating the labor productivity in all three industries in gradually convergence (See Table 1.3).

Table 1.3 Relative Labor Productivity by Industry

	Employment Ratio			Added Value			Relative labor Productivity		
	Primary	Secondary	Tertiary	Primary	Secondary	Tertiary	Primary	Secondary	Tertiary
2010	36.7	28.7	34.6	9.5	46.4	44.1	0.26	1.62	1.27
2011	34.8	29.5	35.7	9.4	46.4	44.2	0.27	1.57	1.24
2012	33.6	30.3	36.1	9.4	45.3	45.3	0.28	1.49	1.25
2013	31.4	30.1	38.5	9.3	44	46.7	0.29	1.46	1.21
2014	29.5	29.9	40.6	9.1	43.1	47.8	0.31	1.44	1.18
2015	28.3	29.3	42.4	8.9	40.9	50.2	0.31	1.39	1.18

Source: Calculated by the author in accordance with the industrial added value and employment ratio found in China Statistical Yearbook 2016, published by CNBS.

From the perspective of overall education level of labor, according to relevant data of “Chinese Labor Statistics Yearbook”, from 2001 to 2014, the average education level of Chinese labor increased by years, from 8.18 years to 9.93 years. At the same time, the composition of the educational level of the employees also changed significantly. In 2001, there were 40,770,000 people hold junior college or higher degree, which was 5.6% of national employment; there were 98,280,000 people hold high school degree, which was 13.5% of national employment; there were 578,970,000 people hold junior high school or lower degree, which was 81.0% of national employment. However, in 2014, those numbers changed to 124,470,000 and 16.1%, 133,090,000 and 17.2%, and 514,960,000 and 66.7% respectively. In addition, by the end of 2014, the number of people with bachelor of master degree was 52,480,000, only 6.8% of the total national employment. The above data shows that the level of human capital is still low.

From the perspective of education level of labor in different industries, “Skills Shortage in Chinese Labor Market”, which was completed by Tsinghua University and Fudan University and supported by JP Morgan, shows that by the end of 2010, there was a

significant gap among the education level of labor in different industries. Never educated, primary school educated and junior high school educated labor mainly worked in the primary industry sector, and the proportion was 88%, 75% and 50% respectively. People with high school degree, junior college degree, bachelor or higher degree can be found in tertiary industry sector, and the proportion was 47%, 70% and 79% respectively. Furthermore, from 1990 to 2010, as the adjustment of industrial structure, the proportions of labor with different education level in three industry sectors are different: labor with different education level can be found in the primary industry sector and tertiary sector in declining and rising trend; and in the secondary industry sector labor with lower and higher education level shows increasing and decreasing trend¹⁰.

1.1.3 Primary Topics of Chinese Labor Market

The mismatch of employment structure

Thanks for “demographic dividend”, Chinese economy experienced rapid growth after open and reform. “Demographic dividend” refers to the positive effect on a country’s economic development, affected by high labor force participation rate, high savings rate and high investment rate, which were brought by the advantage of age structure during the process of population transition (Cai and Wang, 2004, Cai and Lu, 2013). However, in recent years, the aging of labor market and the sharp decreasing of surplus labor of rural area led to the rapid increasing of labor cost and rapid declining of savings rate, indicating the gradual disappearance of demographic dividend, and therefore making it impossible for the export-and-investment-oriented economy to continuous grow.

On the one hand, because of the reduction of labor supply, the labor cost rapidly increased. Once the increase rate of labor cost higher than the increase rate of labor production, the comparative advantage of labor-intensive industries of China drops, pressuring the transformation and promotion of Chinese economy, in turn raising the requirement on labor quality. On the other hand, the increase of labor wage, caused by

¹⁰<https://www.jpmorganchase.com/corporate/Corporate-Responsibility/document/skillsgap-in-chineselabor-market-exec-summary.pdf>. In “Skills Shortage in Chinese Labor Market”, there is no definition on higher or lower education level in this paper, but in my opinion, “higher education level” in this paper means high school or higher educated level, while “lower education level” means lower than high school educated level.

the decrease of labor supply, causes the increase of human capital investment cost, deepening the contradictions of employment problems, which caused by the imbalance between labor demand and labor supply.

Problems of Human Capital Accumulation

In addition to the contribution of the demographic dividend, the Chinese education effectively helped the development of economy by accumulating human capital over the past 30 years since open and reform. However, although China achieved nine-year compulsory education and the popularized higher education in the 21st century¹¹, the difference of the proportion of higher educated main labor between China and developed countries is remarkable; especially in China's poor rural areas, the high school entrance rate was less than 40% in 2013 due to the relatively high tuition fees, increased opportunity costs and weak teachers (Shi et al., 2015). Since the labor force in rural areas will become the main source of labor supply in China, Chinese government has to think about whether to extend the compulsory education.

Furthermore, under the background of transformation and upgrading of China's industries, and the increasing of job skills requirements, the in-service staff face the demand pressure of skills upgrading. According to the analysis of "the Gap of Chinese Labor Skills Report", the private enterprises skill training and public vocational skilling training are weak, while enterprises and individuals have a great demand for public training with low ability of paying. This situation reflects another contradiction of the employment structure of China: supply surplus of low-end labor makes the workers actively seek training to improve their skills; and employers can choose employees from rich labor resources, lowering their training willingness. At the same time, since China has not formed life-long learning, the education level of most people was determined by 30-year-school education before career; while vocational training is another way for China to accumulate human capital, and how to improve vocational training supply is an important way to solve the contradiction of employment in China.

¹¹ About China's nine-year compulsory education, more details can be found at: <http://www.china.org.cn/english/education/184879.html>.

The Existence of Labor Market Segmentation

In the Chinese labor market, the urban-and-rural-segmentation is still the primary form. The segmentation of Chinese labor market started from planned economy era. The government focus on the development of industry and related employment system, allocation and management system and household registration system, leading to the urban-and-rural-segmentation, which can be found only in China. Even though the regulation of household registration became loose, “left-behind children”, “left-behind elderly” problems etc. rose¹². The reason is that in order to solve the employment problems of local labor some local governments, especially in big cities, set up barriers to block live, work, education, health and social insurance of migrant workers. Besides, under the background of the aging population, the urbanization of urban and rural areas increases the migration cost of the rural labor to urban, leading to the further contraction of the labor supply in China.

1.2 Overview and Problems in Chinese Social Security System

1.2.1 Development of Modern Social Security System

Modern social security system started from the English Poor Law in 1601, but it was developed and established with the development of industrial revolution. In general, Workers’ Sickness Insurance Law, Workmen Compensation, and Old Age and Disability Insurance, issued by German Bismarck government, marked the birth of modern social security system (Pampel, 1998). After German’s issuance, British, Japan, America, and Australia established their own social security system; especially in 1935, Roosevelt government passed the first social security act, promoting the social security system worldwide¹³.

After 1945, with the introduction of “general welfare” and “welfare state”, the development of social security system entered the mature stage; especially in British, sir

¹² Left-behind children refers to the children who are left at home or lodged in relatives' homes for a long time because their parents one or both work outside their hometown. Information about the current situation of Chinese left-behind children, please check: <http://www.scmp.com/news/china/society/article/1951469/chinas-left-behind-children-higher-risk-life-crime-study-finds>

¹³ For detail of the history of American social security act: Martin and Weaver (2005)

Beveridge began to the postwar British social security plan during the Second World War, and proposed “Social Insurance and Allied Services” (known as the Beveridge report) in 1942¹⁴. According to this report, in order to achieve full employment and social welfare program the British government passed the National Insurance Act (1946), Pensions Act (1947) and a series of related acts. During this period, with the improvement of social productivity, social security strengthened the economy and social life, and its content is constantly being expanded.

However, since 1980s, because of the aging population social security expenditure was too large; meanwhile, because of the influence of liberalism many developed countries began to tighten social security policies, such as the Reagan administration and the Thatcher government. Specifically, the Reagan administration signed a series of social security programs to reduce the social security plans in 1983; and the Thatcher government promoted the privatization of pension funds. During this period, many countries gradually introduced market mechanism into social security system, emphasizing the responsibility of individuals and families.

Recently, due to the global financial crisis and the European sovereign debt crisis, some European welfare countries, such as Germany and France, adopted some policies, for instance, improves the pension contribution rate, the payment period and tax, to reduce the social security expenditure, and in turn to lessen the fiscal deficit. In contrast, some middle-income countries begin to increase the input in social security, for example, the Chinese government increased the expenditures in health, education, and pension to solve the imbalance income problems between regions in the "Twelfth Five Year Plan (2010-2015)".

1.2.2 Development of Chinese Social Security System

After the founding of new China, Chinese government immediately began to establish the new China’s social security system; but a serious urban-and-rural segmentation was formed by the heavy industrialization strategy, almost all the system set the city as the foothold (Lin, 1998). In 1951-1955, the State Council promulgated and implemented the

¹⁴ The original report:
http://news.bbc.co.uk/2/shared/bsp/hi/pdfs/19_07_05_beveridge.pdf

"People's Republic of China Labor Insurance Regulations", includes the retirement, resignation, and sick of civil servicers, marking the beginning of the social security system in China. With the establishment of the socialist system, China government introduced a number of social security systems, such as "several issues of state organ staff's retirement and working years", "the Interim Provisions of the treatment of voluntary retired workers issued by State Council", from 1956; these provisions made detailed regulation on retirement, resignation and other aspects. However, in 1966, which is the beginning of the cultural revolution, China entered the ten years' turmoil, almost stagnated the social security system.

After the reform and open, the construction of social security system started again. In the late 1980s, with the expansion of the reform of state-owned enterprises, the reform of the social security system also started, and the establishment of the system continuous works. With the establishment of protection of laid-off workers, the unemployment insurance system, the pension system and social assistance system were established. In 1993 the third Plenary Session of the 14th CPC Central Committee cleared the target of establishing multi-level social security system for the first time; and from 1997 to 1999 the basic pension system, the minimum life guarantee system of city, city workers' basic medical insurance system, the unemployment insurance system and a series of social security system were formulated.

Subsequently, the sixteenth CPC Central Committee (2002) stated the goal of building a socialist harmonious society, accelerating the establishment of social security system. "The new rural cooperative medical system pilot" in 2003 and "the pilot of rural minimum living security system" in 2007 marked the new stage of China's social security, which is the overall development of urban and rural areas and institutional innovation¹⁵. With the promulgation and implementation of the social insurance law in 2011, the framework of China's social security system was basically established.

1.2.3 Current Situation of Main Social Security Plans in China

China's current social security system consists of social security system, including social

¹⁵ For more information of "The new rural cooperative medical system pilot", please refer http://china.org.cn/china/2012-09/17/content_26545922.htm

assistance, social welfare and social charity. Social insurance system includes endowment insurance system, medical insurance system, unemployment insurance system, work-related injury insurance system and maternity insurance system. Pension insurance system can be divided into urban staff pension insurance system and urban-and-rural residents pension insurance system, categorized by coverage.

Old-age Insurance System for Urban Workers

Before 1997, the endowment insurance and medical insurance of urban workers are mainly borne by enterprises; in other words, people without work do not have insurance. In 1997, the state Council formally proposed the establishment of pension system that unifies social and personal account for urban employees. The basic pension is composed of social pooling fund and individual account; the current basic pension insurance premium is 20 % of the total employee salary, including in social pooling fund, and the individual pay 8% of their average salary of last year, including in individual account. People who reaches the legal retirement age (60 years male, and 55 years female) and pays the insurance monthly for more than 15 years can receive a basic pension from the personal account and the social pooling fund until death.

From 2010 to 2014, the number of insured people increased from 257,070,000 to 341,240,000, in which the number of in-service people was 255,310,000 and the number of retirement people was 85,930,000. On the other hand, because of the rapid increase of the number of basic pension insurance of urban workers and the increase of contribution base, the pension fund increased from RMB 2,397.5 billion in 2010 to RMB 4,706.5 billion in 2014, with an average annual growth rate of 18.3%; specifically, the total fund income increased from RMB 1,342 billion in 2010 to RMB 2,531 billion in 2014, with the growth rate of 17.2 %; the total fund expenditure increased from RMB 1,055.5 billion in 2010 to RMB 2,175.5 billion in 2014, with an average annual growth rate of 19.8 %; the total amount was RMB 3180 billion.

Pension Insurance for Urban and Rural Residents

The pension insurance of urban and rural residents is a combination of the new rural cooperative medical system (NRCMs) started from 2009 and new urban residents pension

insurance spread from 2011, formed in February, 2014¹⁶. The insurance fund is consisted of individual account and basic pension; there are 12 criteria for individual payment, ranging from RMB 100 to RMB 1,200, so that people can choose their own payment criterion; one can get more if he or she pays more. On the other hand, the basic pension subsidized by the government; for middle west and east region, central government subsidizes all and 50% of the insurance respectively¹⁷. When insured individual makes the payment for 15 years and is 60 years old, the people can withdrawal pension from government. From 2015, the government cleared that the basic pension changed to RMB 70 per month from RMB 55 per month.

The Basic Medical Insurance System for Urban Employees

Like the basic endowment insurance for urban workers, the basic medical insurance fund consists of personal account and pooling fund. The insured individual pays 2% of one's wage to personal account, and the employer pays about 6% of the employee's wage; about 30 % of the insurance are included in employee personal account, and rest of that are included in pooling fund. From 1999 to 2014, the number of insured employees in cities increased from 20,650,000 to 210,410,000, and insured retirement people rose from 5,560,000 to 72,550,000.

Basic Medical Insurance for City Residents

The basic medical insurance of urban residents mainly covers the urban minor and non-working residents, and it focuses on hospitalization and outpatient expenditure. It was first introduced to the public in 2007, and matured in 2010, covering the whole city residents gradually. Until 2015, the number of participants reached 314,510,000. Family pays most of this insurance, and the government subsidies according to the criteria. From 2007 to 2015, the allowance increased from RMB 70 per person to RMB 280 per person.

¹⁶ The insured people of the new rural cooperative medical system is rural residents, while that of new urban residents pension insurance is city residents.

¹⁷ The middle-western of China includes more than 20 provinces, autonomous regions and municipality directly under the central government, such as Shanxi province, the Nei Monggol Autonomous Region, Chongqing and etc.; the eastern of China includes over 10 autonomous regions and municipality directly under the central government, such as Beijing, Shanghai, Jiangsu province and so on.

New Rural Cooperative Medical System

The new rural cooperative medical system (“NRCMs”) refers to the medical mutual assistance system of farmers that funded by the government, voluntary participated farmers and personal. NRCMs raises funds by personal payment, collective support and government allowance. In 2004, the government allowance for NRCMs reached RMB 320 per person, in which the central government pays RMB 120, and subsidizes the western and middle areas 80% and 60% respectively. Personal payment per year is approximately RMB 90. By the end of 2013, the number of participants of NRCMs was 8,020 million with the participant rate of 99% and the number of beneficiaries of 1.942 billion.

Unemployment Insurance System

China's unemployment insurance system was formed with the development of the labor market after the reform and opening in the 1980s. In order to guarantee the basic life of the unemployed workers, the state promulgated “the provisional regulations on unemployment workers in state-owned enterprises”, and “the regulations on unemployment insurance” as the legal basis of national unemployment insurance in 1999. The current unemployment insurance system aimed at protecting the basic life and promoting reemployment of the unemployed, covering the employees of urban enterprises. The insurance fund is funded by the individual, the employing companies and the local government subsidized, among which the premium rate paid by individual is no more than 1 % of the wage, and the company did no more than 2% of the wage. The expenditures of the fund are mainly the payment of insurance benefits and occupational introduction subsidies. The amount of unemployment insurance is between the local minimum wage and minimum living standard. The insured person is required to have a consecutive premium of more than one year, and not personally wish to lose his or her job and register unemployment to get insurance payment. The number of insured persons in 2014 was 170,430,000.

Employment Injury and Maternity Insurance System

In addition to the pension, medical and unemployment insurance system, Chinese social insurance also includes work-related injury insurance system and maternity insurance

system; more specifically, work-related injury insurance refers to a social insurance system that workers or their survivors will obtain material assistance temporarily or permanently after accidental injury or occupational disease from the state and society; and maternity insurance refers to a social policy that pregnant and childbirth women can get help from the state through legislation, including maternity allowances, medical services and maternity leave, and its purpose is to help those women to recover their labor capacity and return to work.

Social Assistance Scheme

Furthermore, the social assistance system is a crucial part of Chinese social security system. Unlike other insurance system, the social assistance system focuses on the people who earned low income, people who suffered the natural and man-made disasters, and people who cannot live by themselves because of other specific reasons (Zheng, 2015). Based on “the Interim Measures on Social Assistance” issued by the State Council in 2014, the social assistance system includes the minimum living security, support for disaster victims, medical assistance, housing assistance, career relief, temporary assistance and so on¹⁸. According to the report of the China development and reform Commission, the total social assistance financial expenditure of urban and rural residents was RMB 395.59 billion, in which the expenditure of minimum living security was RMB 153.86 billion¹⁹.

1.2.4 The Important Issues of Social Security System in Future China

Relatively Low Level of Social Security Expenditure

From 2008 to 2014, the absolute scale of social security expenditure and medical expenditure continuous increased, from 956.1 billion RMB to 5,614.4 billion RMB, but through the observation on the fiscal expenditure ratio and the ratio of GDP, it is easy to find that the relative security expenditure is not significantly increased (see table 1.4). In addition, compared with other countries in the world, the level of social security spending

¹⁸ See China state Council decree 649:

http://www.gov.cn/zwqk/2014-02/27/content_2622770.htm

¹⁹ See China development and reform Commission social relief, January 2015:

http://www.sdpc.gov.cn/fzgggz/jyysr/zhd/201501/t20150130_662741.html

in China is far lower than the average level in OECD countries (see table 1.5).

Table 1. 4 Trend of Expenditure of Social Security and Medical in China (2008-2014)

	Expenditure of Social Security and Medical (RMB)	Fiscal Expenditure (RMB)	GDP (RMB)	Expenditure of Social Security and Medical/Fiscal Expenditure (%)	Expenditure of Social Security and Medical/GDP (%)
2008	9561	62592	300670	15.2	3.1
2009	11600	76299	345629	15.2	3.3
2010	13934	89874	408903	15.5	3.4
2011	17538	109247	484123	16.1	3.6
2012	19830	125952	534123	15.7	3.7
2013	23269	140212	588018	16.6	3.9
2014	26144	151785	636138	17.2	4.1

Source: CNBS, <http://www.stats.gov.cn/>

Table 1. 5 Comparison of Expenditure on Social Security (/GDP)

	2008	2009	2010	2011	2012	2013	2014
Canada	16.3	18.04	17.55	17.04	17.09	16.88	16.82
France	28.2	30.54	30.66	30.47	31.03	31.49	31.94
Germany	24.22	26.67	25.92	24.66	24.56	24.76	24.85
Japan	19.59	21.89	22.07	23.12	22.94	23.06	23.87
United States	16.53	18.58	19.33	19.07	18.78	18.88	18.81
Chile	9.74	11.04	10.47	10.02	10.12	10	10.52
OECD-Total	19.02	21.18	21.07	20.75	20.97	21.12	21.07
China	3.18	3.35	3.41	3.62	3.71	3.95	4.11

Source: OECD data-social spending, <https://data.oecd.org/socialexp/social-spending.htm>

The Gaps Between Urban and Rural and Among Regions

Although Chinese government focused on the economic development of urban and rural integration, driving agriculture by industry and issuing a series of documents to accelerate the construction of rural social security, the social security gap between urban and rural

is still significant²⁰. Because Chinese government did not split the statistics of expenditure of social security between urban and rural (Chen, 2014), it used the transfer income of urban residents and rural residents as the surrogate variables of urban and rural social security expenditure and found that the proportion of rural-to-urban migrants in China decreased from 40.5 in 1999 to 9.2 in 2012; especially after the enforcement of NRCMs in 2009, the proportion of transfer income of urban and rural residents decreased significantly. However, the proportion of rural residents remains low in the social security expenditure.

In the same time, the social security gaps among provinces and regions are obvious. Because the level of social security in China is low and more than 90% of social security expenditure is paid by the local government, the imbalance of economic development among the provinces is the direct reason of the obvious differences in social security expenditure (Yin et al., 2016). Yin et al. (2016) also calculated the Theil Index of differences of social security expenditures among regions and found that there are significant differences among different provinces and the reason that the differences exist is that there are expenditure differences among regions in provinces.

The Lack of Long-term Care for Elderly People

The demand of long-term care for the elderly is increasing because of population aging, family function weakening and so on. On the other hand, because Chinese government took the medical insurance system, pension insurance system and the minimum living security system as the priority targets, there is no unified security system for the health of elderly, leading to the deficiency of long-term care for elder people in social security system²¹. Jiang and his colleagues summarized three types of service mode for elders who needs long-term care: institutional care, community care and family care (Jiang et al., 2013). Institutional care means that the care recipients need to register in public or private

²⁰ Central Committee No.1 in 2004: “opinions of the central Committee of the CPC central Committee on promoting farmers' income”:

http://www.moa.gov.cn/ztl/yhwj2014/wjhg/201301/t20130129_3209956.htm

²¹ “Worldwide Annual Health, Labor and Welfare Report 2015” by Ministry of Health, labor and welfare of Japan,

<http://www.mhlw.go.jp/wp/hakusyo/kaigai/16/dl/t4-02.pdf>

nursing home; however, the problems are that the demand exceeds the surplus in public nursing home, while the infrastructures in private nursing home are too old to satisfy the requirements of elders. Community care refers to household service, rehabilitation nursing, spiritual consolation etc. provided by community; however, the requirements of care recipients cannot be satisfied because of the lack of quality and quantity of caregivers. Like the situation of community care, it is hard for family care to offer professional service. In the above background, China faces lots of problems to establish a perfect long-term care for elder people, for example, the lack of professional caregivers, the short of care infrastructures, and the difficulties of raising funds etc.

1.3 Conclusion and Policy Implications

Maintain stability of Labor market is prior for China's economy which is being adjusted to a "New Normal" state with a slower but sustainable economic growth. The population aging and the exhausted rural surplus labor force leads to shortage of labor supply, hence causes contradiction between demand of supply in labor market. Furthermore, the shortage of labor supply, low capital formation rate due to the demographic transition results in a decline in potential growth rate in long term. To deal with these challenges, government should undertake effective action to complete the reform of household-registration and gradually eases its family-planning policy. Moreover, improving human capital by enhancing input in education and cultivation, especially to the low-skill labor, is necessary.

Specifically, relaxing the household-registration and narrowing the social welfare gaps, such as public education and social security system, could eliminate the labor market segmentation, thus enhance efficiency of labor resource reallocation and the TFP. Although easing the family planning will not have immediate effect, it could increase the working-age population in future, thus generate a positive impact in potential growth rate. Additionally, as Heckman and Yi (2012) point out that the returns of expanding public expenditure on education is very high, since it can generate strong external effect under the current high level of high-skill labor stock. Strengthening investment on human capital is another choice for Chinese government to deal with the problems in labor

market.

On the other hand, with the significant population aging, an increasing number of elderly people with partial or full disabilities boosts the demand of establishment of long-term care insurance system, which arises great social attention. For providing suggestions, we research the Japanese LTCI for reference to China in the following chapter.

References

[1]Allen, Steven G., Robert L. Clark, and Ann McDermed, (1988) "Why do pensions reduce mobility?." No. 2509. National Bureau of Economic Research.

[2]Cai, Fang, and Dewen, Wang, (2004) "Saving and Growth Effects of Demographic Transition: The Population Factor in the Sustainability of China's Economic Growth", *Population Research*, Vol. 28, pp.2-11. (in Chinese)

[3]Cai, Fang, and Yang Lu, (2013) "Population change and resulting slowdown in potential GDP growth in China." *China & World Economy* 21.2: 1-14.

[4]Cai, Fang, and Zhao Wen, (2012) "When demographic dividend disappears: growth sustainability of China." *The Chinese Economy*. Palgrave Macmillan UK, pp.75-90.

[5]Chen, Cheng, (2016) "China's Social Security Expenditure: Problems and Thinking", *Journal of Social Sciences*, No.7 pp.25-34. (in Chinese)

[6]Du, Yang, and Cuifen Yang, (2014) "Demographic transition and labour market changes: implications for economic development in China." *Journal of Economic Surveys* 28.4: 617-635.

[7]Jiang, Zhenhua, et al., (2013) "Analysis of Long Term Care of Elders in Mainland China", *Nursing Science*, No.2, pp.46-50. (in Chinese)

[8]Justin, Yifu, Lin, Fang, Cai, and Zhou, Li, (1995) *The China Miracle: development strategy and economic reform*, Chinese University Press(HK). (in Chinese)

[9]Heckman, James J., and Junjian Yi, (2012) "*Human capital, economic growth, and inequality in China.*" No. w18100. National Bureau of Economic Research.

[10]Patricia, P. Martin and Weaver, David A., (2005) , "Social Security: A Program and

Policy History”, *Social Security Bulletin*, Vol. 66, pp.1-15.

[11]Shi, Yaojia, et al., (2015) “Dropping Out of Rural China's Secondary Schools: A Mixed-Methods Analysis”. *The China Quarterly*, Vol. 224, pp.1048-1069.

[12]Yin, Jinpeng. Fuxing, Liu and Mo, Han, (2016) “The Regional Disparity of Convergence Analysis of Social Security in China: An Empirical Research Based on Provincial Data 1990-2013”, *Shanghai Economic Review*, No.1, pp.82-91. (in Chinese)

[13]Zhang, Xiaobo, et al., (2011) "China has reached the Lewis turning point." *China Economic Review* 22.4: 542-554.

[14]Zhang, Jie, (1995)"Social security and endogenous growth." *Journal of Public Economics* 58.2: 185-213.

[15]Zhang, Jie, and Junsen Zhang, (2003) "Long-run effects of unfunded social security with earnings-dependent benefits." *Journal of Economic Dynamics and Control*28.3: 617-641.

[16]Zheng, Gongcheng, (2013) “The Historical Logic of the Evolution of China’s Social Security History”. *Journal of Renmin University of China*, No.1, pp.2-12 (in Chinese)

[17]Zhong, Shiyong, and Kui, Li, (2009) “Study on the relation between population dividend and economic growth, *Population and Economics*”, Vol. 173, pp.55-59. (in Chinese)

[18]CNBS, *China Statistical Yearbook*, various years.

[19]CNBS, *China Migrant Workers Monitoring Report 2015*,
http://www.stats.gov.cn/tjsj/zxfb/201604/t20160428_1349713.html.

[20]The World Bank, <http://databank.worldbank.org/data/databases.aspx>.

[21]United Nations, Department of Economic and Social Affairs, Population Division (2015). *World Population Prospects: The 2015 Revision*, custom data acquired via website.

[22]OECD, *Education at a Glance (2015): OECD Indicators*, OECD Publishing, Paris. DOI: <http://dx.doi.org/10.1787/eag-2015-en> page 39.

[23] Ministry of Health, labor and welfare of Japan, “Worldwide Annual Health, Labor and Welfare Report 2015”

[24] “Skills Shortages in the Chinese Labor Market” by JPMorgan, 2016.

[25] “Modernising and Improving Social Protection in the European Union”. European commission, 1997.

Chapter 2. Dynamic Analysis of the Regional Differences in Japanese LTCI System

In this chapter, we review the Japanese LTCI system and study the problem of expanding regional differences of user rate in order to provide policy guideline for China. We find each Japanese region's user rate exhibits a conditional convergence as well as its groups of regions' user rate. Furthermore, we show the reform implemented in 2005, which is used to remedy the regional differences, seems to have had little effect. Relevant policy implication references for China are discussed.

2.1 Introduction

With the population aging and weakening of the family care function, rapid increasing demand of aged care is an important issue that has yet to be resolved for China. A pilot program of the long-term care insurance (henceforth LTCI) system was implemented by the Chinese government in 15 cities from 2016 and gradually rolled out national wide in future²². During this explorative process, it is meaningful by learning the international experiences which will help to build up a relatively sufficient and sustainable LTCI system.

Under this backdrop, numerous scholars have conducted a discussion from various points of views. Yang et al. (2016) show three models of financing of institutional implemented in 3 pilot cities of Qingdao, Nanjing and Shanghai, respectively. They find the model of Qingdao is the most desirable even a narrow definition of eligibility. Wang and Tang (2014) survey the commercial LTCI in U.S. and the social LTCI in Germany.

As Banister et al. (2012) point out that Japan is a highly relevant example for China, since Japan is experiencing exceeding population aging and they have similar East Asian culture. In order to meet the increasing demand for long-term care, Japan has launched a social LTCI system in 2000, although the Japanese LTCI has eased the problem of population aging, there appeared the “expanding cost” problem and the “large regional

²²For guiding opinions on conducting the pilot program of long-term care insurance released by MHRSS, see http://www.mohrss.gov.cn/gkml/xxgk/201607/t20160705_242951.html

differences” problem during the process of the operation. Since the regional distribution of population aging and financial condition in China is extremely uneven. For instance, according to the China Statistical Yearbook 2014, the ratio of aging in Chongqing is 13.25% and that of Tibet is 5.17% in 2013. Meanwhile, the fiscal revenue per capita in Beijing and Shanghai is 0.256 million RMB and 0.258 million RMB, whereas in Guangxi this index is 0.027. By introducing Japanese LCTI, studying the dynamic properties of its regional differences and trend of the development in this chapter, we hope to find meaningful implications for China.

There are preceding researches on the dynamic properties of LTCI system. Some of them sought elements that affect the variables of interest, such as the service cost, the number of service users, and the insurance premium, so as to predict the future trends of these variables. Others employed panel data to seek elements that explain the time and cross-sectional variations in these variables. [Suzuki (2002), Shimizutani and Noguchi (2004), Kikuchi, Tajika, and Yui (2005), and Kikuchi (2008) calculated the future trends of the long-term care insurance system. Tajika and Kikuchi (2003), Shimizutani and Inakura (2006), Ando (2008), and the annual reports by the MHLW (2005, 2007) analyzed the causes of regional differences in the system.] There are few researches, however, that take the long-term care insurance system as a system of dynamical equations, as we do in this research, so as to seek the proof of convergence (or non-convergence thereof), and to analyze the degree of mobility in the standing order of regional user rates. The analytical tools employed in this research are widely used in the field of endogenous economic growth theory. These tools are useful and powerful for analyzing the dynamic properties of time and cross-sectional differences in socio-economic system²³.

It will be shown that each region’s user rate converges to a unique and globally stable steady state. If regions have different parameter values, however, then each region converges to region-specific steady state (conditional convergence). Furthermore, it will

²³ For the concept and analytical methods of the convergence and the conditional convergence, see Barro and Sala-i-Martin (2004). For the application of Markov transition matrix analysis, see Quah (1993).

be shown that the theoretical model can replicate the motion of regional user rates observed in actual statistical data. Additionally, we construct average Markov transition matrixes to analyze each region's mobility across the standing order of regional user rates. We also evaluate if the 2005 reform made the standing order more variable because it tried to remedy regional differences in user rates. It will be shown that the 2005 reform seems to have had little effect on improving the regional mobility convergence. we try to remove region-specific elements (the rate of care need certification by municipalities, the late-stage (75 years or older) old age population rate, and the regional ordinary balance rate) from each region's user rate, and reevaluated the effects of 2005 reform on the regional mobility to prove the convergence is conditional.

This chapter is organized as follows. In section 2.2, we briefly review the structure of the public long-term care insurance system; In section 2.3, we construct a simple theoretical model of the Japanese LTCI system. Then the model is analyzed to derive dynamic properties of the system. In section 2.4, we construct average Markov transition matrixes to analyze each region's mobility across the standing order of regional user rates. In section 2.5, we prove the mobility of each region's user rate is conditional convergence reevaluated the effects of 2005 reform on the regional mobility. Section 2.6 is conclusion and reference for China. We note the remaining issues in section 2.7.

2.2 The LTCI System in Japan; A Quick Review.

2.2.1 The Objective of the LTCI Care Insurance System

The LTCI system started on April 2000. Before that, in traditional Japan, the cares for elderly people were thought to be done by family members, especially by wives. Such tradition became unsustainable because of rapidly aging demographic structure and increasing nuclear families. The increase in those who need long-term care relative to those who provide put physical and psychological pressures on many families. On the other hand, medical resources were used up by those who were not ill or sick but without enough care by family members. (The hospitalization by sociological reasons. According to the OECD health statistics, the average length of stay of Japanese inpatients is 31.2 days (2012), while the numbers are 10.1 days in France (2012), 9.2 days in Germany

(2012), 7.2 days in the United Kingdom (2012), and 6.1 days in the United States (2011).) It became inevitable that the long-term care services for elderly people go public.

The new system replaced public welfare system for elderly people with public insurance system in which municipalities take role as managers. Those who contribute to the insurance system are the primary individuals (65 years or older) and the secondary insured individuals (40~64 years old). The national average monthly insurance premium paid by a primary insured individual is ¥4972 in 2014 fiscal year. The insurance premium of the secondary insured individuals is collected as part of payroll tax. For example, in 2013 fy, it is 1.55% of the salary of those covered by the health insurance association for medium&small firms. The main beneficiaries are the primary insured individuals. The secondary insured individuals also receive benefits, but in limited cases. In 2014 fy, the total cost for the long-term care services was ¥10 trillion. The service users paid 10% user fee. (The fee varies with user's income level.) After subtracting ¥0.7 trillion user fee, the remaining ¥9.3 trillion are financed by the insurance premium contributions and the public (national and local) disbursement shared at 50:50.

2.2.2 Application Process for the Long-Term Care Services

For a primary insured individual, the application process for care services consists of the following 3 steps.

Step 1: When a primary insured individual finds herself in need for long-term care services, she applies for the certification of long-term care need by her municipality (insurer).

Step 2: The municipality, aided by committee members, decides if it grants the certification to the applicant. (Depending on the necessity, from light to the most serious, there are 7 levels of the certification.)

Step 3: If granted, the primary insured individual, aided by “care managers” about care plans, receives services where the recipient pays 10% user fee. The long-term care services are provided by private sector business entities subject to public supervision. There are in-home services, facility services, and community-based services.

2.2.3 The Figures of the LTCI System

As stated in the introduction, along with rapidly aging demographic structure, the figures

related to the public long-term care insurance system have been increasing too. The followings are some figures reported by the MHLW to grasp the magnitude.

* Total cost: ¥3.6 trillion (2000 fy) → ¥10.0 trillion (2014 fy) (+170%)

* The number of individuals certified by municipalities for long-term care need: 2.18 million (2000 fy) → 5.64 million (2013 fy) (+159%)

* The number of service users: 1.49 million (2000 fy) → 4.71 million (2013 fy) (+216%)

* The national average monthly insurance premium of primary insured individual: ¥2911 (2000 fy) → ¥4972 (2014 fy) (+71%)

Because the system is managed by municipalities, there are regional differences in the figures. For example, the monthly insurance premium at the municipal level for the 6th planning period (2015~2017 fy), the highest number is ¥8686 (Tenkawa village of Nara prefecture) which is 3.1 times higher than the lowest ¥2800 (Mishima village of Kagoshima prefecture). At the prefecture level, the highest is ¥5880 of Okinawa which is 1.3 times higher than the lowest ¥4409 of Tochigi.

2.2.4 The Causes of Regional Differences and the 2005 Reform

Many researches addressed the causes of the differences in the regional figures of LTCI system. Suzuki (2002) reported that a region with higher certification rate and the faster growth in those who need long-term care tends to have the faster growth in in-home service cost. The MHLW stated in 2007 annual report that faster increase in those who request for light support and care and faster increase in those who use in-home services cause faster increase in municipal certifications and care service users. Tajika and Kikuchi (2006) suggested that lax discipline on municipal management, incomplete task division between medical services and care services, and ineffectiveness of care services on rehabilitating users may explain the speed of increase in long-term care services. Ando (2008) found that regions with more low-income individuals and more late-stage (75 years or older) old individuals have higher long-term care service cost. Tajika and Kikuchi (2003), the MHLW annual report (2005), and Abrai (2006) found that a region with more facilities tends to have higher cost because it induces more demand for facility services (which cost more relative to in-house services). These researches suggest the importance of {shift from facility to in-home services, rigorous discipline on municipal management,

prevention against long-term care need}.

In accordance with the implications of these researches, Japanese government took the following measures to remedy the regional differences in the 2005 reform.

- *Tighter municipal discipline on the review process for certification.
- * Less biased distribution of facilities across regions by limiting the total number.
- * Induce private business entities to supply relatively more in-home services to those users with medium serious conditions.
- * Facility service users are made to pay residence and meal cost.
- * Introduce community-based services that aim to prevent elderly people from being in need for long-term care.

In the following sections, we will analyze the dynamic properties of regional differences in long-term care insurance system and the effect of the 2005 reform.

2.3 Theoretical Model Analysis of the LTCI System

As we saw in the previous section, there are wide differences in regional figures of the LTCI system. It is important to predict the future trend of the system because it helps those who have concerns in the system. For example, the prediction will help municipalities as insurers to evaluate the fiscal impact of the system, which consequently will affect insured individuals. For this purpose, we construct a theoretical model of the public long-term care insurance system and analyze dynamical properties of “user rate” which is defined as the ratio of service users among insured individuals. The theoretical model will be used to derive a convergence hypothesis with respect to regional user rates.

2.3.1 Theoretical Model Analysis

The Japanese LTCI system will be modeled as follows. There are $I = 47$ regions (prefectures). For $\{i = 1, 2, \dots, I, t = 0, 1, 2, \dots\}$, let $L_{i,t}$ be the number of primary insured individuals (65 years or older) of region i in period t . In the following, the region subscript “ i ” will be omitted unless necessary. Let n be the gross rate of change in the number of primary insured individuals, reflecting the number of those who were 64 years old in the previous period and the number of those who moved from other regions. Let δ be the “depreciation” rate of primary insured individuals, reflecting the

number of deceased and the number of those who moved to other regions. Then, the net growth of the number of primary insured individuals is expressed as follows.

$$L_{i,t+1} = (1 + n - \delta)L_{i,t}, \quad t = 0, 1, 2, \dots \quad (2.1)$$

Suppose the LTCI system is introduced at the beginning of period zero. Let X_0 be the number of service users. Under the current system, X_0 is determined through the following 4 steps.

Step 1: Let p be the probability that an insured individual find herself in need for long-term care services (need for care rate). Then at $t = 0$, among the primary insured individuals L_0 , $p \times L_0$ is the number of individuals who find themselves in need for long-term care services. $(1 - p) \times L_0$ is the number of individuals who do not.

Step 2: Let q be the probability of applying for municipal certification for long-term care need by an individual in step 1 (application rate). Then, $q \times p \times L_0$ is the number of individuals applying for the municipal certifications. $(1 - q) \times p \times L_0$ is the number of individuals not applying.

Step 3: Let r be the probability that a municipality as insurer grants certification to an applicant in step 3. Then, $r \times q \times p \times L_0$ is the number of individuals who are granted municipal certifications (certification rate). $(1 - r) \times q \times p \times L_0$ is the number of individuals who are not granted.

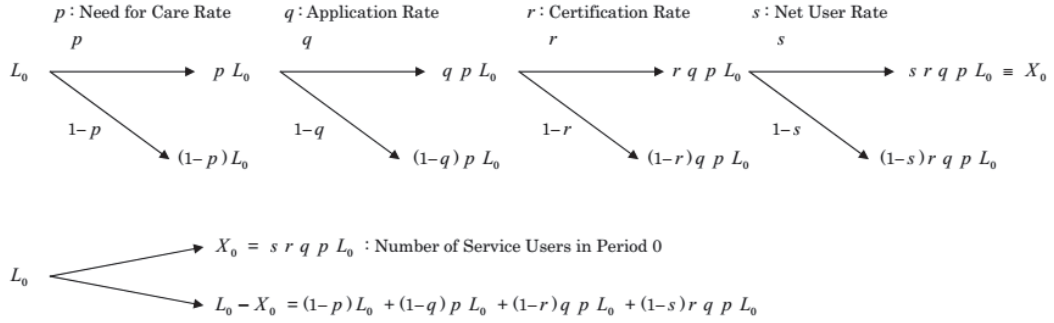
Step 4: Let s be the probability that an individual with municipal certification use public long-term care service (net user rate). Then $s \times r \times q \times p \times L_0$ is the number of those who use services. $(1 - s) \times r \times q \times p \times L_0$ is the number of those who do not.

As a result of step 1~step 4, in a region at $t = 0$, the number of individuals who use public long-term care services is

$$X_0 = pqrsl_0 \quad (2.2)$$

The rest $L_0 - X_0 = (1 - p)L_0 + (1 - q)pL_0 + (1 - r)qpL_0 + (1 - s)rqpL_0$ is the number of individuals who do not use public long-term care service. Instead, they will choose from such alternatives as private care services, public or private medical services, no services at all and stay as they are, etc. Figure 2.1 depicts the flow process that determines X_0 .

Figure 2.1



In the next period $t = 1$, the number of service users X_1 is calculated as follows. The number of primary insured individuals in L_1 is decomposed as follows.

$$L_1 = (1 + n - \delta)L_0 = nL_0 + (1 - \delta)(L_0 - X_0) + (1 - \delta)X_0 \quad (2.3)$$

In (2.3), nL_0 is the number of new primary insured individuals, $(1 - \delta)(L_0 - X_0)$ is the survivors among non-users, and $(1 - \delta)X_0$ is the survivors among service users. The logic used to derive X_0 in $t = 0$ is also applicable to derive X_1 as follows. Among the new primary insured individuals, $pqrs \times nL_0$ individuals use services in $t = 1$. Among the surviving non-users, $pqrs \times (1 - \delta)(L_0 - X_0)$ individuals use services in $t = 1$. Therefore, the number of service users X_1 is calculated as follows.

$$\begin{aligned} X_1 &= pqrs nL_0 + pqrs(1 - \delta)(L_0 - X_0) + (1 - \delta)X_0 \\ &= (1 - \delta)(1 - pqrs)X_0 + pqrs L_1 \end{aligned} \quad (2.4)$$

Equation (2.1) is used to derive the last line. (In the derivation of (2.4), we assumed that once an individual begins to use long-term care services, the individual keeps using the services in subsequent years. This assumption reflects the observation by Tajika and Kikuchi (2006) about the inability of LTCI to rehabilitate individuals under care. If insured individuals go back and forth between “under care” state and “out of care (rehabilitated)” state, then the dynamical analyses will be much more complex, and beyond the scope of this research.) Equation (2.4) holds in any year $t = 0, 1, 2, \dots$. Define the user rate x_t by

$$x_t = X_t/L_t . \quad (2.5)$$

By dividing both sides of equation (2.4) by L_t , we have the following linear first-order difference equation with respect to user rate x_t .

$$x_{t+1} = \left(\frac{(1-\delta)(1-pqrs)}{1+n-\delta} \right) x_t + pqrs \quad (2.6)$$

Equation (2.1) is used again to derive (2.6). If $\{P, q, r, s, n, \delta\}$ are constant parameters, then in (2.6), the slope is $0 < (1-\delta)(1-pqrs)/(1+n-\delta) < 1$. Therefore, the dynamical system (2.6) is globally stable. That is, for any $x_t > 1$, the sequence of user rate $\{x_t; t = 0, 1, 2, \dots\}$ monotonically converges to a unique steady state x^* where

$$x^* = pqrs/[1 - \{(1-\delta)(1-pqrs)/(1+n-\delta)\}]. \quad (2.7)$$

In addition, it can be shown that, for any two regions i and j ,

$$\text{if } x_{i,0} \begin{pmatrix} > \\ = \\ < \end{pmatrix} x_{j,0} , \text{ then } \frac{x_{i,t+1} - x_{i,t}}{x_{i,t}} \begin{pmatrix} < \\ = \\ > \end{pmatrix} \frac{x_{j,t+1} - x_{j,t}}{x_{j,t}} , t = 0, 1, 2, \dots , \quad (2.8)$$

These observations imply that the regional user rates $\{x_{i,t}; i = 1, 2, \dots, I, t = 0, 1, 2, \dots\}$ exhibit “convergence” to the same steady state x^* if all the regions have the same values of parameters $\{p, q, r, s, n, \delta\}$.

The values of parameters, however, may be different across regions. For example, the MHLW 2005 annual report documented the regional differences in municipal certification rate r . We also expect that the parameter values are region-specific because of various socio-economic reasons. If the parameter values in equation (2.6) are different across regions, then each region’s user rate $x_{i,t}$ may converge to region-specific steady state x_i^* . That is, the user rate convergence is conditional on each region’s parameter values. In the next section, we analyze the data of regional user rates to investigate the following two hypotheses;

[(Unconditional) Convergence Hypotheses] All the regional user rates $\{x_{i,t}; i = 1, 2, \dots, I, t = 0, 1, 2, \dots\}$ converges to the same steady state x^* .

[Conditional Convergence Hypotheses] Each regional user rates $\{x_{i,t}; i = 1, 2, \dots, I, t = 0, 1, 2, \dots\}$ converges to the region-specific steady state x_i^* .

We add some comments on the dynamic properties of equation (2.6). The government reviews the LTCI system and conduct major reforms at every five years. For example, the 2005 reform may have affected the dynamical system (2.6) as follows.

(□) The 2005 reform made the facility service users pay residence and meal cost. This change might have depressed the demand for long-term care services, and hence lowered the net user rate s .

(□) The 2005 reform enhanced the efforts of preventing insured individuals from being in need for long-term care services. The prevention efforts might have lowered the need for care rate p .

(□) The 2005 reform imposed more rigorous discipline on the review process for certification by municipalities. This might have lowered the certification rate r .

(□) As the number of service users increases, the LTCI system may gain wider societal recognition. As a result, those who previously regarded the public long-term care services as public welfare with some stigma will be less reluctant to apply for the services. The prevalence of the system, hence, may increase the application rate q . (The traditional view about long-term care for elderly people may change as service users increase and as people learn more about the system. In this case, the application rate q in equation (2.6) may not be a constant parameter, but dependent on user rate x_t . If it is so, then equation (2.6) is no longer a linear equation. Instead, equation (2.6) may generate a complex path for the use rate sequence $\{x_t; t = 0, 1, 2, \dots\}$).

(□) The differences in LTCI system across municipalities may induce each insured individual to seek a region with better services and lower cost. This may affect each region's net growth rate $n - \delta$ of insured individuals.

By differentiating the steady state user rate x^* (equation (2.7)) with respect to the parameters $\{p, q, r, s, n, \delta\}$, we verify the following comparative static properties.

$$x^*(\overset{+}{p}, \overset{+}{q}, \overset{+}{r}, \overset{+}{s}, \overset{-}{n}, \overset{-}{\delta}) \quad (2.9)$$

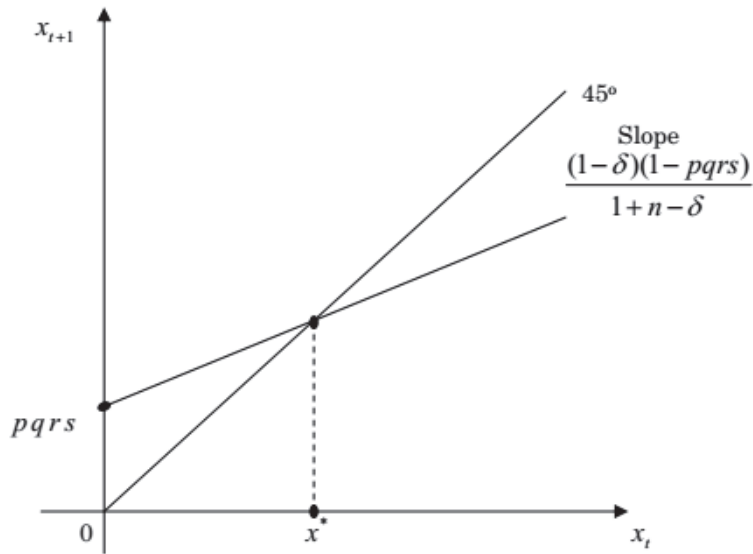
In (2.9), the “+” or “-” sign above each parameter indicates the effect of an increase in

the parameter value on the steady state user rate x^* . An increase in the need for care rate p , an increase in the application rate q , an increase in the certification rate r , or an increase in the net user rate s obviously causes the steady state user rate x^* to increase. Although the net growth rate of primary insured individuals is expressed as $n - \delta$, an increase in the gross growth rate n or an increase in the depreciation rate δ causes x^* to decrease because of the following reasons. An increase in the gross growth rate n causes the steady state value of the user rate $x_t = X_t/L_t$ to decrease simply because of the faster increase in denominator L_t . On the other hand, the increase in the depreciation rate δ has two effects on the steady state user rate x^* . While it causes the number of primary insured individuals to decrease, it also causes the number of surviving service users to decrease. The latter effect dominates the former because the latter works at the cumulative stock level while the former at the flow level.

Figure 2.2 is a phase diagram of equation (2.6). The horizontal axis measures x_t and the vertical axis measures x_{t+1} . If the parameters $\{p, q, r, s, n, \delta\}$ are constant, then the graph of (2.6) is depicted as an upward-sloping straight line with intercept $pqr s$ at the vertical axis. Because the slope is $0 < (1 - \delta)(1 - pqr s)/(1 + n - \delta) < 1$, the dynamical system (2.6) has a unique and globally stable steady state at the intersection of the graph of (2.6) and 45-degree line in figure 2.2. That is, given any initial user rate $x_0 > 0$, the sequence of user rate $\{x_t; t = 0, 1, 2, \dots\}$ generated by equation (2.6) monotonically converges to the steady state user rate x^* . Furthermore, if the initial user rate $x_{i,0}$ of region i is smaller than $x_{j,0}$ of region j , then the growth rate of region i 's user rate is larger than that of region j for all the subsequent periods, i.e.,

$$\text{if } x_{i,0} < x_{j,0}, \text{ then } \frac{x_{i,t+1} - x_{i,t}}{x_{i,t}} > \frac{x_{j,t+1} - x_{j,t}}{x_{j,t}} \quad t = 0, 1, 2, \dots, \quad (2.10)$$

Figure 2.2



The effects of changes in the value of parameters $\{p, q, r, s, n, \delta\}$ on the steady state user rate x^* can be analyzed by using figure 2.2. In the figure, an increase in the need for care rate p , an increase in the application rate q , an increase in the certification rate r , or an increase in the net user rate s causes the vertical intercept $pqrs$ to increase and the slope $(1 - \delta)(1 - pqrs)/(1 + n - \delta)$ to decrease. The combined effect is a rise in the intersection of the graph of (2.6) and 45-degree line, i.e., an increase in the steady state user rate x^* . An increase in the gross growth rate n or an increase in the depreciation rate δ does not affect the vertical intercept $pqrs$. However, it causes the slope $(1 - \delta)(1 - pqrs)/(1 + n - \delta)$ to decrease. As a result, the intersection of the graph of (2.6) and 45-degree line decreases, i.e., the steady state user rate x^* decreases. These statements are also verified by simple calculus. For example, $\partial[(1 - \delta)(1 - pqrs)/(1 + n - \delta)]/\partial\delta = -(1 - pqrs)n/((1 + n - \delta))^2 < 0$ provided $n > 0$.

Table 2.1 summarizes the effects of the 2005 reform on the steady state user rate x^* . The table suggests that the 2005 reform tried to stabilize the fiscal management of public long-term care insurance system against rapid increase in service users and service cost.

Table 2.1

Enhanced Senility Prevention Effort	$p \downarrow \Rightarrow x^* \downarrow$
Charging Residence and Meal Cost	$s \downarrow \Rightarrow x^* \downarrow$
Tightening Discipline on Municipalities	$r \downarrow \Rightarrow x^* \downarrow$
Wider Recognition of the System	$q \uparrow \Rightarrow x^* \uparrow$

$$x^*(p^+, q^+, r^+, s^+, n^-, \delta^-)$$

p : Need for Care Rate, q : Application Rate, r : Certification Rate, s : Net User Rate,
 n : Gross Growth Rate of Insured Individuals, δ : Depreciation Rate

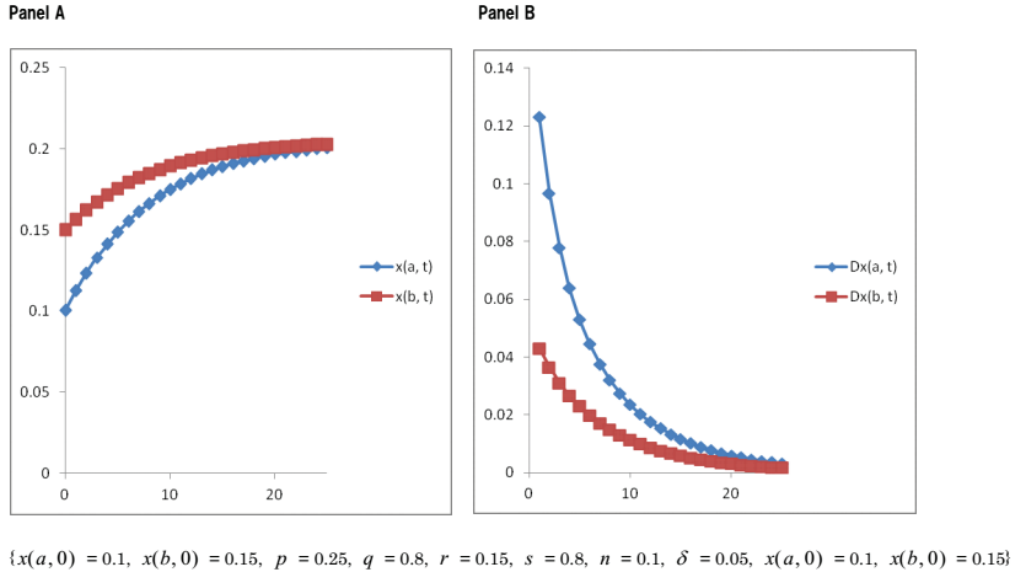
2.3.2 Numerical Example

Panel A of figure 2.3 depicts transitional paths of two regions, a and b , such that the initial user rate of region a , $x(a, 0)$, is smaller than that of region b , $x(b, 0)$. In addition, we assume that both of them are smaller than the steady state user rate x^* , i.e., $x(a, 0) < x(b, 0) < x^*$. The parameter values are same for both regions, set at $\{p = 0.25, q = 0.8, r = 0.15, s = 0.8, n = 0.1, \delta = 0.05\}$. Given these values, equation (2.7) implies the steady state user rate $x^* = 0.2052$. The initial user rates are set at $x(a, 0) = 0.1$ and $x(b, 0) = 0.15$. Panel B of figure 2.3 depicts the growth rates of two regions $\{[x(a, t + 1) - x(a, t)]/x(a, t), [x(b, t + 1) - x(b, t)]/x(b, t); t = 0, 1, 2, \dots\}$. These figures show that the transitional paths of user rates generated by the dynamical system (2.6) monotonically converge to the steady state, and the growth rate of user rate is higher (lower) for the region with lower (higher) initial user rate.

Panel A of figure 2.4 depicts the effects of a change in parameter value on the transitional path of user rates. For periods $t = 0, 1, 2, \dots, 10$, we assume the same assumptions as before, i.e., $\{p = 0.25, q = 0.8, r = 0.15, s = 0.8, n = 0.1, \delta = 0.05\}$ and $\{x(a, 0) = 0.1, x(b, 0) = 0.15\}$, hence $x^* = 0.2052$. We also assume that at $t = 11$ the application rate q increases from 0.8 to 0.9 and stays at the higher value thereafter which implies the new steady state $x^* = 0.2817$. Panel A of figure 2.4 shows that the transitional paths, at the time of shock $t = 11$, begin to converge to the new and higher steady state. As depicted by panel B of figure 2.4, the change causes a temporary increase in growth rates of both

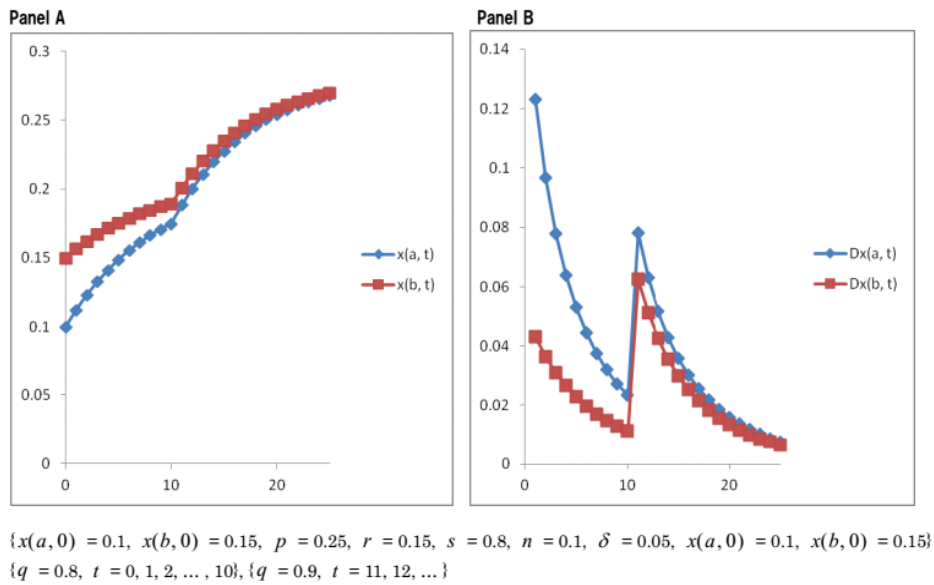
regions.

Figure 2.3



{Vertical axis: x , Horizontal axis: t }

Figure 2.4



{Vertical axis: x , Horizontal axis: t }

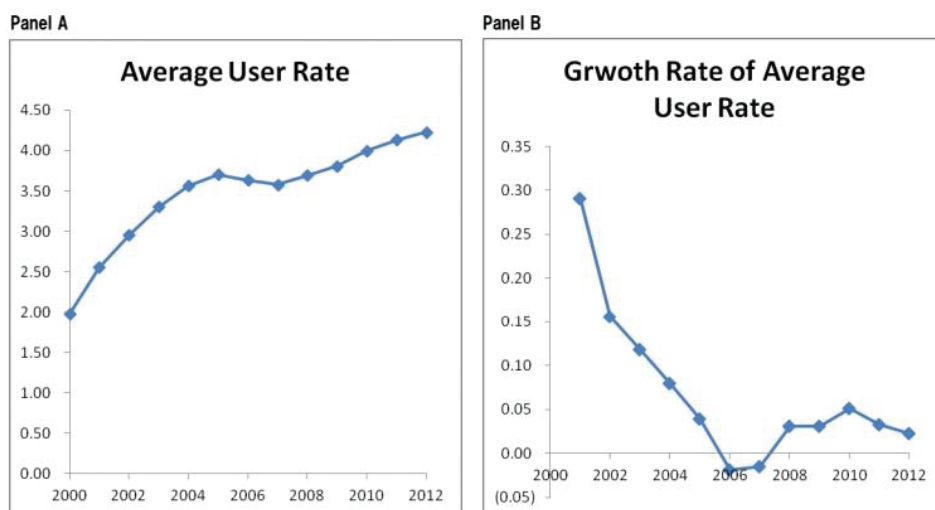
2.3.3 Data Properties

In this section, we look at the data of public long-term care insurance system for the

properties of average user rate and regional differences. For the analyses, we use the data provided by the Japan Ministry of Health, Labor, and Welfare. There are cautions on interpreting the data. See appendix at the end of paper for details.

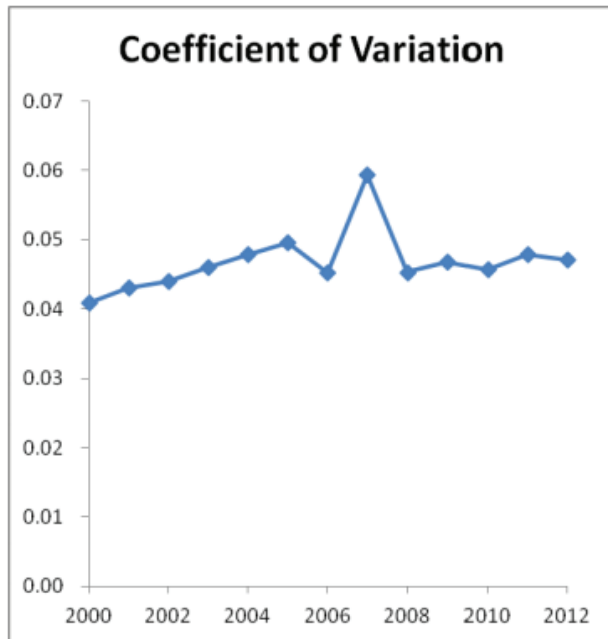
In figure 2.5, panel A depicts the graph of average user rate of 47 Japanese regions (prefectures), and panel B depicts the graph of growth rate of average user rate. These graphs show that the average user rate increased between 2000 and 2005 at diminishing growth rate. After the temporal decline in 2006 and 2007, the average user rate began to grow again, but at diminishing growth rate. There seems to be a structural change before and after the 2005 reform. Figure 2.6 is the graph of coefficient of variation of the regional user rates, and figure 2.7 is the graph of max/min ratio of the regional user rates. The coefficient of variation slightly increased between 2000 and 2005. After 2006, it did not show clear trend. The max/min ratio, on the other hand, showed declining trend throughout the data periods. (The spikes in figure 2.6 and figure 2.7 are caused by irregular movement in Niigata's user rate which plummeted in one and only one year 2007.) Figure 2.8 depicts the graph of Gini coefficient of the regional user rates. Like figure 2.7 which depicts the graph of max/min ratio, the Gini coefficient showed declining trend throughout the data periods, suggesting the diminishing regional differences in user rates.

Figure 2.5



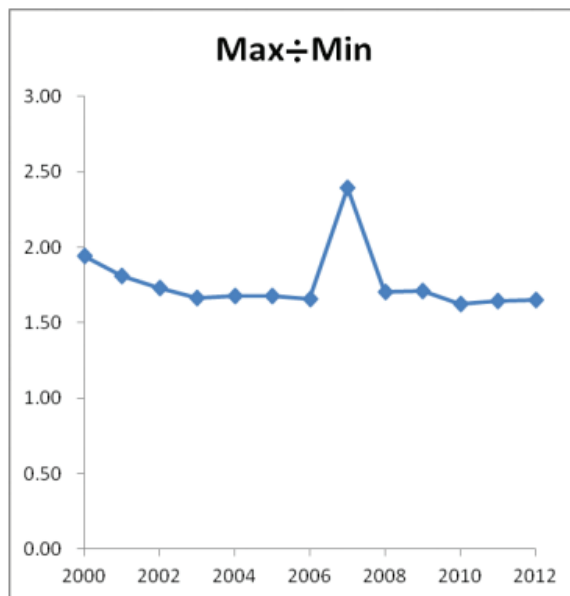
Data Source: Japan Ministry of Health, Labor, and Welfare

Figure 2.6



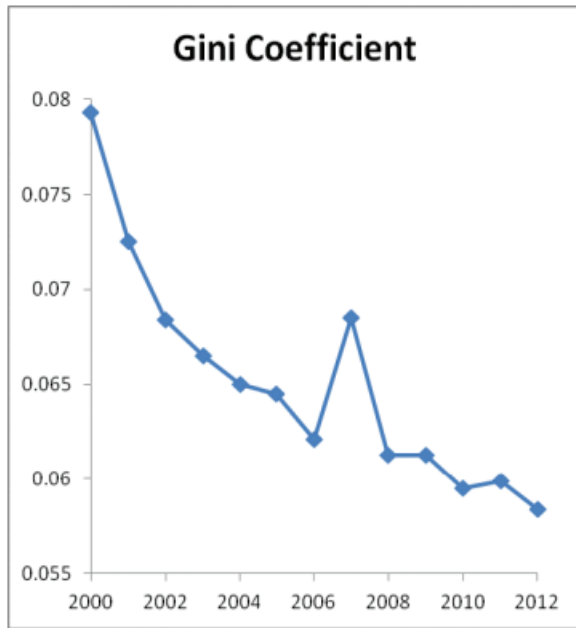
Data Source: Japan Ministry of Health, Labor, and Welfare

Figure 2.7



Data Source: Japan Ministry of Health, Labor, and Welfare

Figure 2.8



Data Source: Japan Ministry of Health, Labor, and Welfare

Next, in order to analyze the variations in the standing order (high and low) of regional user rates, we sorted the 47 regions (prefectures) according to each region's user rate, and divided them into 5 groups {I(7 regions), II(10), III(10), IV(10), V(10)}. Group I consist of 7 regions with the highest user rates, group II consists of 10 regions with second highest user rates, and so on. Group V consists of 10 regions with the lowest user rates. Then, for 2000~2012, we calculated the mean user rate and the annual rate of change for each group. The results are summarized in table 2.2. The table reveals the following properties;

(i) The movement of each group's use rate resembles the movement of the average user rate. That is, they grew but at diminishing rate between 2000 and 2005, declined temporarily in 2006 and 2007, then started to grow again after 2008 at diminishing rate. There seems to be a structural change before and after the 2005 reform.

(ii) In the first half (2000~2005),the years before the 2005 reform, the higher (lower) is a group's user rate, the slower (faster) is the subsequent growth of the group's user rate, i.e., the regional user rates seem to converge. For example, in 2000, group I's user rate is 2.43 and group V's use rate is 1.62. Between 2000 and 2001, the rate of change in group I's user rate is 0.27 while that of group V is 0.31. Between 2000 and 2005, the average

annual growth rates are higher (lower) for the groups with lower (higher) user rate. Such a convergence in regional user rates is not so obvious in the second half (2006~2012), the years after the 2005 reform, although it seems to hold for the groups with higher user rates. In figure 2.9, panel A depicts the graphs of group I's user rate and group V's user rate, and panel B depicts the graphs of growth rate of group I's user rate and that of group V's user rate. Compare and notice the resemblance between figure 2.9 (actual data) and figure 2.4 (calibrated data). The comparison of these figures seems to suggest that the convergent paths of user rates were affected by the 2005 reform. The 2005 reform might have altered the steady state, and initiated convergence to the new steady state.

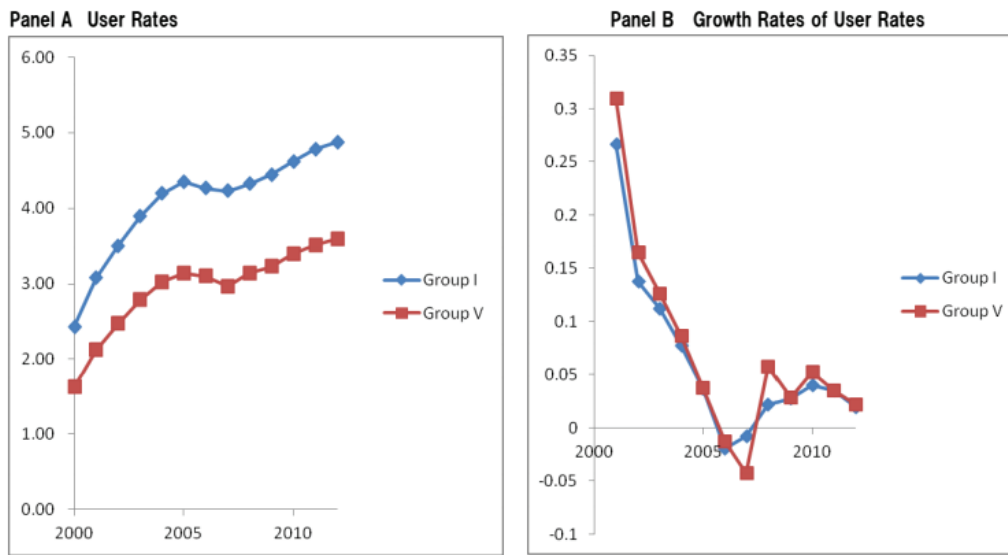
Table 2.2

Regional User Rates					
	Group I	Group II	Group III	Group IV	Group V
2000	2.428	2.180	1.971	1.841	1.619
2001	3.075	2.789	2.560	2.394	2.120
2002	3.499	3.214	2.988	2.769	2.471
2003	3.891	3.597	3.333	3.096	2.783
2004	4.193	3.879	3.571	3.356	3.024
2005	4.348	4.024	3.714	3.493	3.138
2006	4.262	3.910	3.662	3.437	3.098
2007	4.229	3.871	3.626	3.411	2.966
2008	4.321	3.955	3.724	3.518	3.138
2009	4.441	4.087	3.841	3.638	3.227
2010	4.618	4.296	4.055	3.830	3.395
2011	4.779	4.444	4.190	3.938	3.514
2012	4.873	4.521	4.289	4.061	3.590

Growth Rate of Regional User Rates					
	Group I	Group II	Group III	Group IV	Group V
2000					
2001	0.267	0.279	0.299	0.300	0.310
2002	0.138	0.152	0.167	0.157	0.165
2003	0.112	0.119	0.115	0.118	0.126
2004	0.077	0.079	0.071	0.084	0.087
2005	0.037	0.037	0.040	0.041	0.038
2006	-0.020	-0.028	-0.014	-0.016	-0.013
2007	-0.008	-0.010	-0.010	-0.008	-0.042
2008	0.022	0.022	0.027	0.031	0.058
2009	0.028	0.033	0.031	0.034	0.028
2010	0.040	0.051	0.056	0.053	0.052
2011	0.035	0.034	0.033	0.028	0.035
2012	0.020	0.017	0.023	0.031	0.022

Data Source: Japan Ministry of Health, Labor, and Welfare

Figure 2.9



Data Source: Japan Ministry of Health, Labor, and Welfare

Although the regional user rates seem to exhibit a convergence property, it might not be an unconditional convergence. As we saw in the theoretical model analysis of the user rate, if each region has different parameter values, then each region's user rate may converge to region-specific steady state. If the convergence is conditional on region-specific elements, then the standing order (high and low) of regional user rates may not be variable. In fact, as shown in table 2.3, which is a list of 5 regions (prefectures) with the higher user rates and 5 regions with the lowest between 2000 and 2012, there was a small degree of variation in the standing order. For example, Wakayama, Tokushima, and Hiroshima belonged to the top 5 regions for all but 3 years between 2000~2012. Especially, Wakayama had the highest user rate in 2003 and 2005, and for all the years in the second half (2006~2012). On the other hand, Tochigi, Ibaraki, Chiba, and Saitama, all of them are located in Kanto area, belonged to the bottom 5 regions for all the sample years.

Table 2.3

STANDING	2000	2001	2002	2003	2004	2005
1	Kagoshima	Kagoshima	Kagoshima	Wakayama	Tokushima	Wakayama
2	Aomori	Aomori	Kyoto	Kagoshima	Wakayama	Tokushima
3	Oita	Okinawa	Okinawa	Tokushima	Hiroshima	Hiroshima
4	Okinawa	Hiroshima	Hiroshima	Hiroshima	Oita	Oita
5	Hiroshima	Kyoto	Aomori	Kyoto	Kyoto	Nagasaki
43	Yamanashi	Yamanashi	Yamanashi	Hokkaido	Hokkaido	Hokkaido
44	Tochigi	Tochigi	Tochigi	Tochigi	Tochigi	Tochigi
45	Ibaraki	Chiba	Chiba	Chiba	Chiba	Chiba
46	Chiba	Saitama	Saitama	Saitama	Saitama	Saitama
47	Saitama	Ibaraki	Ibaraki	Ibaraki	Ibaraki	Ibaraki

STANDING	2006	2007	2008	2009	2010	2011	2012
1	Wakayama	Wakayama	Wakayama	Wakayama	Wakayama	Wakayama	Wakayama
2	Tokushima	Tokushima	Tokushima	Tokushima	Tokushima	Tokushima	Osaka
3	Hiroshima	Hiroshima	Shimane	Nagasaki	Nagasaki	Osaka	Tokushima
4	Aomori	Aomori	Hiroshima	Shimane	Hiroshima	Nagasaki	Shimane
5	Ehime	Ehime	Ehime	Ehime	Shimane	Shimane	Nagasaki
43	Hokkaido	Tochigi	Aichi	Aichi	Aichi	Shizuoka	Shizuoka
44	Tochigi	Chiba	Tochigi	Tochigi	Tochigi	Tochigi	Tochigi
45	Chiba	Ibaraki	Chiba	Chiba	Chiba	Chiba	Chiba
46	Saitama	Saitama	Ibaraki	Ibaraki	Ibaraki	Saitama	Saitama
47	Ibaraki	Niigata	Saitama	Saitama	Saitama	Ibaraki	Ibaraki

Data Source: Japan Ministry of Health, Labor, and Welfare

Despite the small variation in the standing order of regional user rates, the 2005 reform might have affected each region's mobility across the ladder of standing order because its objective is to remedy the regional differences. Therefore, if the reform had the implied effects, if any, we could expect the increased mobility of the standing order in the second half (2006~2012) relative to the first half (2000~2005). The objective of the next section, hence, is to evaluate if the 2005 reform did remedy the regional differences and alleviated the standing order inertia.

2.4 Mobility Analysis of Regional User Rates' Standing Order

In this section, we develop an index for measuring the degree of regions' mobility across the ladder of user rates standing order (high and low) to see if the 2005 reform had the implied effects. The index, which is based on Markov transition matrixes, is calculated by the following 4 steps.

Step 1: Let $\{x(i, t); i = 1, 2, \dots, 47, t = 2000, 2001, \dots, 2012\}$ stands for the user rate

of region i in year t . For each year t , $\{x(i, t); i = 1, 2, \dots, 47\}$ is sorted from the highest to the lowest, and divided into 5 groups $\{I(7 \text{ regions}), II(10), III(10), IV(10), V(10)\}$ as we did in 2.2.3.

Step 2: We construct a Markov transition matrix of size 5×5 from 2000 to 2001, denoted as $P_{0,1}$, as follows. The $(1, 1)$ element of the matrix, denoted as $P_{0,1}(1, 1)$, is the number of regions of group I in 2000 that remained in group I in the next year 2001 divided by the group size (7 regions). For example, among seven regions of group I in 2000, if two regions move to the other groups while five regions stay, then $P_{0,1}(1, 1) = 5/7$. The other elements $\{P_{0,1}(1, j); j = 2, 3, 4, 5\}$ of the first row of $P_{0,1}$ imply the number of regions of group I in 2000 that moved to group j in 2001 divided by group I's size. Generally, we denote $\{P_{t,t+1}(i, j); i, j = 1, 2, 3, 4, 5, t = 2000, 2001, \dots, 2011\}$ as the number of regions of group i in year t that moved to group j in year $t+1$ divided by group i 's size.

Step 3. We calculate the average Markov transition matrixes for the first half by:

$$P_A = (1/5) \sum_{t=2000}^{2004} P_{t,t+1} \quad (2.11)$$

and for the second half by

$$P_B = (1/7) \sum_{t=2005}^{2011} P_{t,t+1} \quad (2.12)$$

The average Markov transition matrixes $\{P_A, P_B\}$ have the following properties.

(i) By construction, the five elements of each row of $P_{t,t+1}$ add up to one, i.e.,

$$\sum_{j=1}^5 P_{t,t+1}(i, j) = 1 \text{ for all } i \in \{1, 2, 3, 4, 5\} \text{ and for all } t \in \{2000, 2001, \dots, 2011\}. \quad (2.13)$$

By the definition, the same property also holds for the average Markov transition matrixes $\{P_A, P_B\}$. This implies that $\{P_A, P_B\}$ are probability matrixes.

(ii) For $k = 1, 2, 3, \dots$, the k -th powered average Markov transition Matrixes $\{(P_A)^k, (P_B)^k; k = 1, 2, 3, \dots\}$ are also probability matrixes. We use the average Markov transition matrixes to evaluate the degree of variation in the standing order of regional user rates as follows. Suppose, although counter factual, there was no variation in the

standing order of regional user rates in the first half, i.e., no region moved from one group to the others in any years between 2000 and 2005. Then, each Markov transition matrix $\{P_{t,t+1}; t = 2000, 2001, \dots, 2004\}$ is a 5×5 unit matrix, so are the average matrix P_A and its k -th power $\{(P_A)^k; k = 1, 2, 3, \dots\}$. On the other hand, if there are regions that moved from one group to the others in the first half, then some of the Markov transition matrixes have non-zero non-diagonal elements, so does the average matrix P_A . In this case, each row of the k -th powered average Markov transition Matrix $(P_A)^k$, may converge to the “uniform” distribution $\{7/47, 10/47, 10/47, 10/47, 10/47\}$ as k becomes larger. For example, the first row of $(P_A)^k$, denoted as $\{(P_A)^k(1, j); j = 1, 2, 3, 4, 5\}$, expresses the hypothetical probability distribution for a region in group I’s whereabouts among 5 groups k years later if the degree of variation in the first half continues. Then, the convergence of the first row to the “uniform” distribution implies that, even if the degree of variation in the standing order of regional user rates is small in the short run, it will be variable in the long run. In which group a region will be in the long run is a random event described by the “uniform” distribution.

Step 4: The degree of variation in the long run, may be different in the first half and the second half because of the 2005 reform which aimed to remedy the regional differences in user rates. To compare the degree of variation before and after the 2005 reform, we calculated the distances between each row of the k -th powered average Markov transition matrixes $\{(P_A)^k, (P_B)^k; k = 1, 2, 3, \dots\}$ and the “uniform” distribution as follows. For $\{k = 1, 2, 3, \dots, i = 1, 2, 3, 4, 5\}$,

$$V_A(k, i) = [(P_A)^k(i, 1) - (7/47)]^2 + [(P_A)^k(i, 2) - (10/47)]^2 + \dots + [(P_A)^k(i, 5) - (10/47)]^2, \quad (2.14)$$

$$V_B(k, i) = [(P_B)^k(i, 1) - (7/47)]^2 + [(P_B)^k(i, 2) - (10/47)]^2 + \dots + [(P_B)^k(i, 5) - (10/47)]^2. \quad (2.15)$$

For example, $V_A(k, 1)$ is a distance between the first row of the k -th powered average Markov transition matrixes $(P_A)^k$ and the “uniform” distribution $\{7/47, 10/47, 10/47, 10/47, 10/47\}$. Then, the standing order convergence of regional user rates in the first half

and that in the second half may be defined as follows.

$$\lim_{k \rightarrow \infty} V_A(k, i) = 0 \text{ for all } i = 1, 2, 3, 4, 5 \quad (2.16)$$

$$\lim_{k \rightarrow \infty} V_B(k, i) = 0 \text{ for all } i = 1, 2, 3, 4, 5 \quad (2.17)$$

We expect the quicker convergence in the second half than the first half if the 2005 reform had the implied effects.

By using the MHLW data, the average Markov transition matrixes of the first half and the second half are calculated as follows.

$$P_A = \begin{pmatrix} 0.81 & 0.19 & 0 & 0 & 0 \\ 0.133 & 0.733 & 0.133 & 0 & 0 \\ 0 & 0.133 & 0.767 & 0.1 & 0 \\ 0 & 0 & 0.1 & 0.833 & 0.067 \\ 0 & 0 & 0 & 0.067 & 0.933 \end{pmatrix} \quad (2.18)$$

$$P_B = \begin{pmatrix} 0.976 & 0.024 & 0 & 0 & 0 \\ 0.017 & 0.933 & 0.05 & 0 & 0 \\ 0 & 0.033 & 0.8 & 0.15 & 0.017 \\ 0 & 0 & 0.15 & 0.733 & 0.17 \\ 0 & 0.017 & 0 & 0.1 & 0.833 \end{pmatrix} \quad (2.19)$$

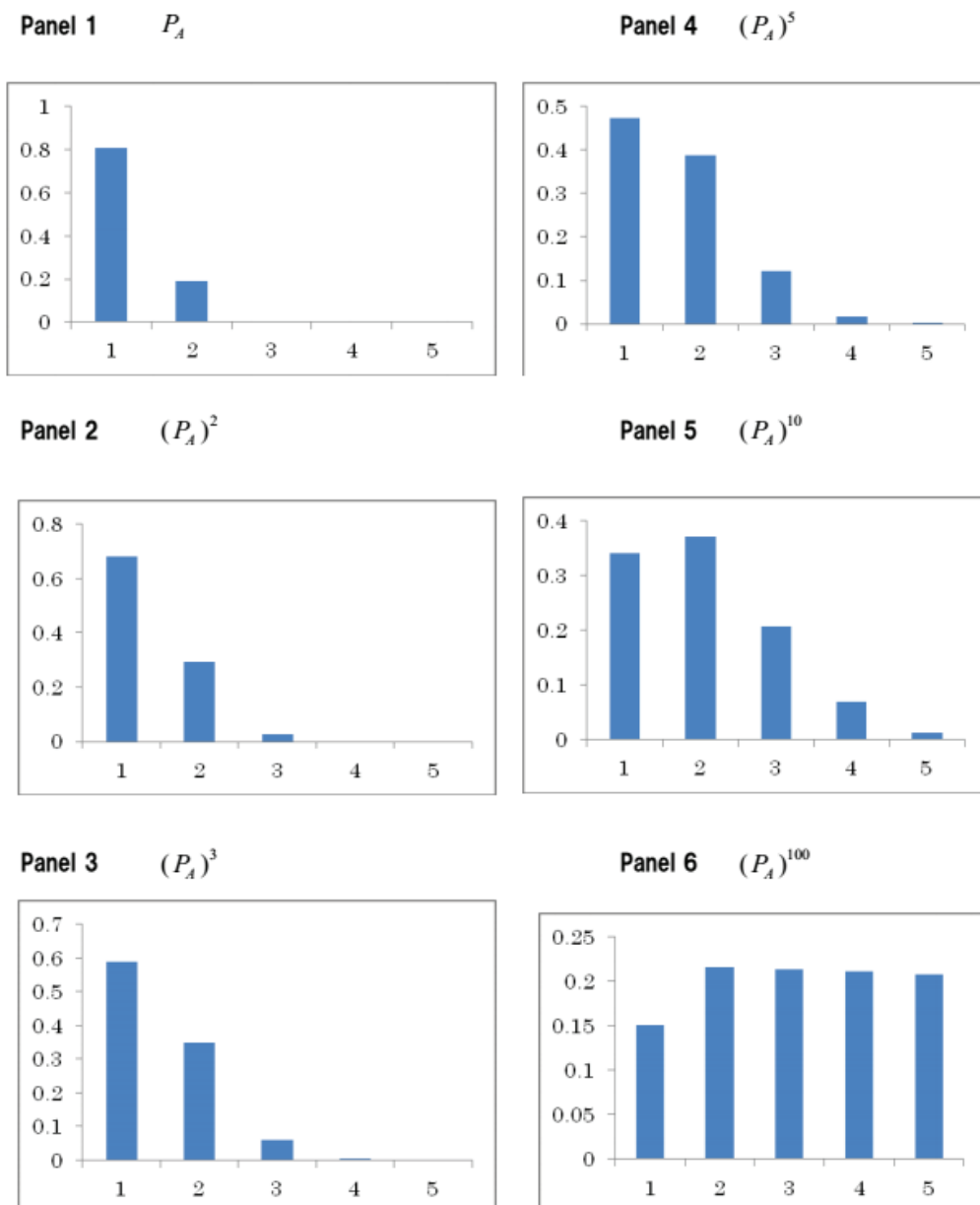
For example, the first row of P_A implies that, on average between 2000 and 2005, for a region in group I, the probability of staying in group I after one year is 0.81, the probability of moving to group II is 0.19, and the probability of moving to any other groups (III, IV, or V) is zero. The squared average Markov transition matrix of the first half is calculated as follows.

$$(P_A)^2 = \begin{pmatrix} 0.681 & 0.294 & 0.025 & 0 & 0 \\ 0.206 & 0.581 & 0.2 & 0.013 & 0 \\ 0.0178 & 0.2 & 0.616 & 0.16 & 0.007 \\ 0 & 0.013 & 0.16 & 0.709 & 0.118 \\ 0 & 0 & 0.007 & 0.118 & 0.876 \end{pmatrix} \quad (2.20)$$

The first row of $(P_A)^2$ implies that, under the degree of standing order mobility in the first half, for a region in group I, the probability of staying in group I after two years is 0.681, the probability of moving to group II is 0.294, the probability of moving to group III is 0.025, and the probability of moving to group IV or group V is zero. The six panels

of figure 2.10 show the first row of $(P_A)^k$ for $k = 1, 2, 3, 5, 10,$ and 100 . Although a region in group I tends to stay in group I for a short period of time, it may move to the other groups in the long run, and the probability distribution of being in groups I~V seems to converge to the “uniform” distribution $\{7/47, 10/47, 10/47, 10/47, 10/47\}$.

Figure 2.10



The five panels of figure 2.11 show the graphs of $\{V_A(k, i), V_B(k, i); k = 1, 2, 3, \dots, i = 1, 2, 3, 4, 5\}$. For example, panel 1 shows the graph of the distance $V_A(k, 1)$ between the first row of average Markov transition matrix $\{(P_A)^k(1, j); k = 1, 2, 3, \dots, j = 1, 2, 3, 4, 5\}$ and the “uniform” distribution $\{7/47, 10/47, 10/47, 10/47, 10/47\}$ for the first half $\{2000, 2001, \dots, 2005\}$ and the graph of $V_B(k, 1)$ for the second half $\{2006, 2007, \dots, 2012\}$ such that the horizontal axis measures the power $\{k = 1, 2, 3, \dots\}$ and the vertical axis measures $\{V_A(k, 1), V_B(k, 1)\}$. We may infer the following properties of figure 2.11.

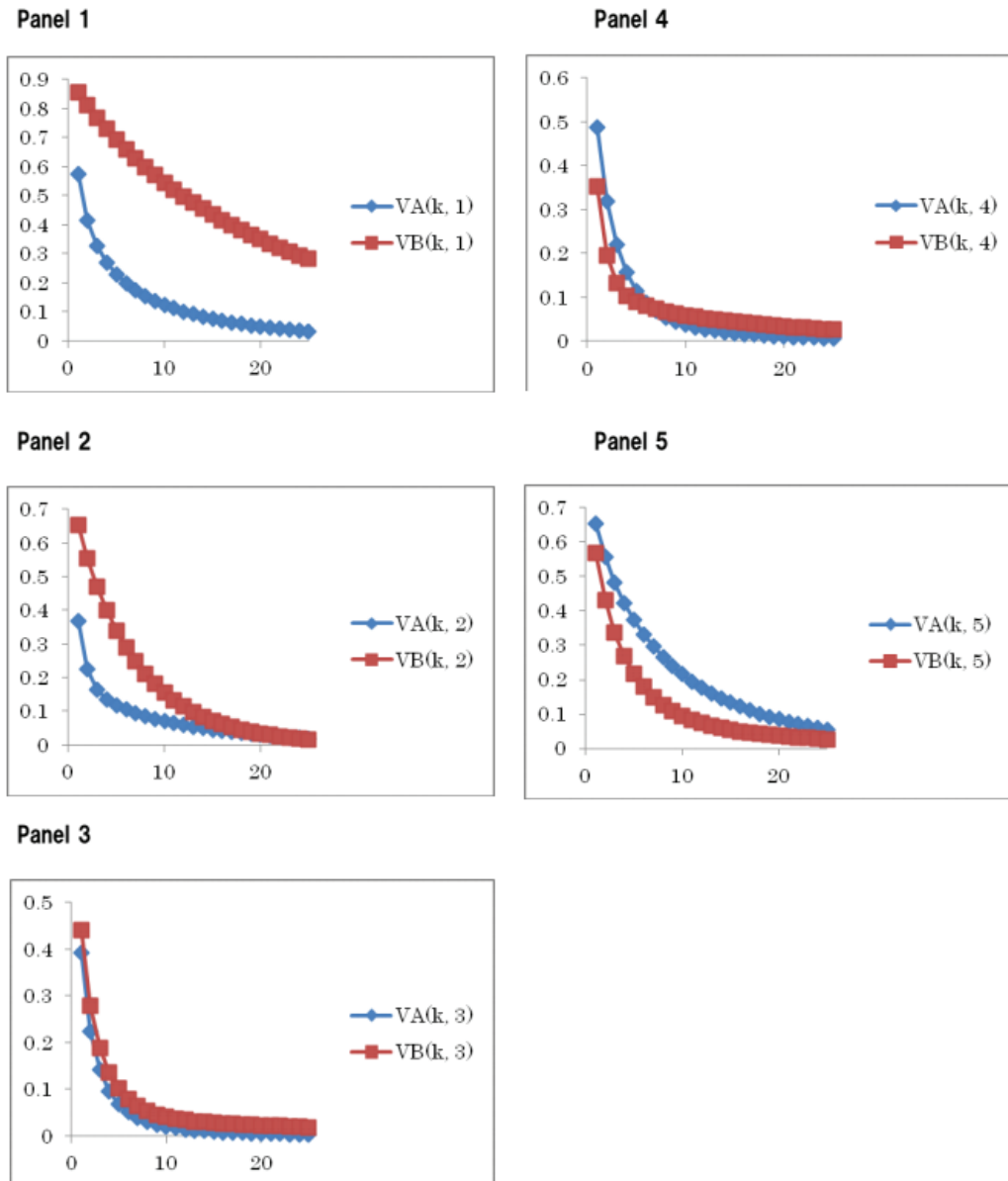
(i) For the groups of regions with higher user rates (such as group I and group II), the speed of convergence to the “uniform” distribution is faster in the first half than the second half. There is not much difference in the speed of convergence for group III. On the other hand, for the groups of regions with lower user rates (such as group IV and group V), the order seems to be reversed, i.e., the speed of convergence is quicker in the second half than the first half.

(ii) Both in the first half and in the second half, the speed of convergence is slower for the groups of regions with higher user rates and for the groups of regions with lower user rates, and faster for the groups of regions with intermediate user rates.

(iii) In the first half, group V’s speed of convergence is the slowest. It would take 7 years to close the distance by less than half, i.e., $V_A(1, 5) = 0.6533$ and $V_A(7, 5) = 0.2961 < V_A(1, 5)/2$. For the other groups, it would take 3~4 years to close the distance by less than half.

(iv) In the second half, group I’s speed of convergence is the slowest. It would take 16 years to close the distance by less than half, i.e., $V_B(1, 1) = 0.8559$ and $V_B(16, 1) = 0.4159 < V_B(1, 1)/2$. For the other groups, it would take 3~6 years to close the distance by less than half.

Figure 2.11



If the problems of public long-term care insurance system that originate from regional differences are more serious in regions with higher user rates, then the 2005 reform does not seem to be effective because the standing order mobility, measured by $\{V_A(k, i), V_B(k, i); k = 1, 2, 3, \dots, i = 1, 2, 3, 4, 5\}$, did not improve after the reform. The above analyses seem to suggest that the standing order convergence is conditional because there seem to remain persistent regional differences even after the 2005 reform. Each region's user rate may be converging to region-specific steady state, and the standing order of

regional user rates may exhibit small variation for the long periods of time. On the other hand, if we are able to remove region-specific factors from the data, then the residual user rates may converge to the same steady state, and the standing order of residual user rates may be more variable. This is what we will try to do in the next section.

2.5 Mobility Analysis of Standing Order based on Residual User

Rates

As we saw in the previous section, the standing order (high and low) of regional user rates did not seem to become variable after the 2005 reform which had aimed to alleviate the immobility. As table 2.3 suggests, some regions in group I (consisting of regions with the highest user rates) or group V (consisting of regions with the lowest user rates) do not seem to move to the other groups. Preceding researches suggest that the user rate convergence may be conditional, i.e., each region's user rate may converge to region-specific steady state if each region has different parameter values. Hence, if we are able to remove region-specific elements that cause the differences in regional user rates, the remaining (residual) use rates may converge to a common steady state. Therefore, we regress each region's user rate on the variables that might explain the regional differences, and use the regression residuals to recalculate the speed of convergence to the "uniform" distribution. If the explanatory variables are able to account for the regional differences in user rates, then the speed of convergence of residual user rates will be improved. As a preliminary attempt, we looked at preceding researches and chose the following three explanatory variables; For region (prefecture) $i = 1, 2, \dots, 47$, and for year $t = 2000, 2001, \dots, 2012$, $h_1(i, t)$ is the certification rate which may represent each region's administrative discipline, $h_2(i, t)$ is the late-stage (75 years or older) old age population rate, and $h_3(i, t)$ is the ordinary balance rate which may represent the region's fiscal flexibility and robustness. (These data are available from the MHLW and the Ministry of Internal Affairs and Communications.) For each $t = 2000, 2001, \dots, 2012$, we estimate the following model.

$$\ln x(i, t) = a_0 + a_1 \times \ln h_1(i, t) + a_2 \times \ln h_2(i, t) + a_3 \times \ln h_3(i, t) + e(i, t),$$

$$i = 1, 2, \dots, 47. \quad (2.21)$$

In (2.21), $x(i, t)$ is the user rate. After obtaining the OLS estimates of regression parameters $\{a_0, a_1, a_2, a_3\}$, we use the (exponent of) regression residuals $\{e(i, t); i = 1, 2, \dots, 47, t = 2000, 2001, \dots, 2012\}$ to calculate the speed of convergence before and after the 2005 reform as we had done in the previous section. Table 2.4 summarizes the regression results. The fitting of the statistical model (2.21) to the data is not so good. Although the three variables $\{h_1, h_2, h_3\}$ together explain 70~80% of the variation in the user rate x , the only significant variable is the certification rate h_1 . The ordinary balance rate h_2 is marginally significant. The late-stage old age population rate h_3 is insignificant.

Table 2.4

	Intercept	h1(i, t)	h2(i, t)	h3(i, t)	Adjusted R2
2000	2.975	0.875	0.129	0.077	0.827
(t Value)	11.613	11.891	1.898	2.013	
2001	2.974	0.881	0.065	0.066	0.803
(t Value)	12.038	11.744	0.981	1.788	
2002	2.892	0.858	0.034	0.057	0.795
(t Value)	12.531	11.987	0.524	1.612	
2003	3.036	0.862	0.071	0.068	0.776
(t Value)	12.041	11.560	0.919	1.690	
2004	3.088	0.919	0.030	0.069	0.791
(t Value)	14.198	12.282	0.451	2.021	
2005	3.167	0.956	0.028	0.081	0.784
(t Value)	14.792	12.042	0.421	2.327	

	Intercept	h1(i, t)	h2(i, t)	h3(i, t)	Adjusted R2
2006	3.051	0.934	0.006	0.065	0.755
(t Value)	14.101	10.747	0.094	1.823	
2007	2.792	1.011	-0.148	0.023	0.452
(t Value)	7.005	5.900	-1.118	0.358	
2008	2.984	0.948	-0.031	0.053	0.718
(t Value)	13.392	9.423	-0.397	1.504	
2009	3.038	0.967	-0.031	0.060	0.730
(t Value)	13.582	9.595	-0.383	1.652	
2010	3.039	0.954	-0.029	0.062	0.734
(t Value)	13.461	9.820	-0.363	1.653	
2011	3.078	0.988	-0.046	0.068	0.747
(t Value)	13.158	10.242	-0.548	1.711	
2012	3.028	0.985	-0.066	0.055	0.743
(t Value)	12.950	10.085	-0.764	1.405	

$h_1(i, t)$: certification rate

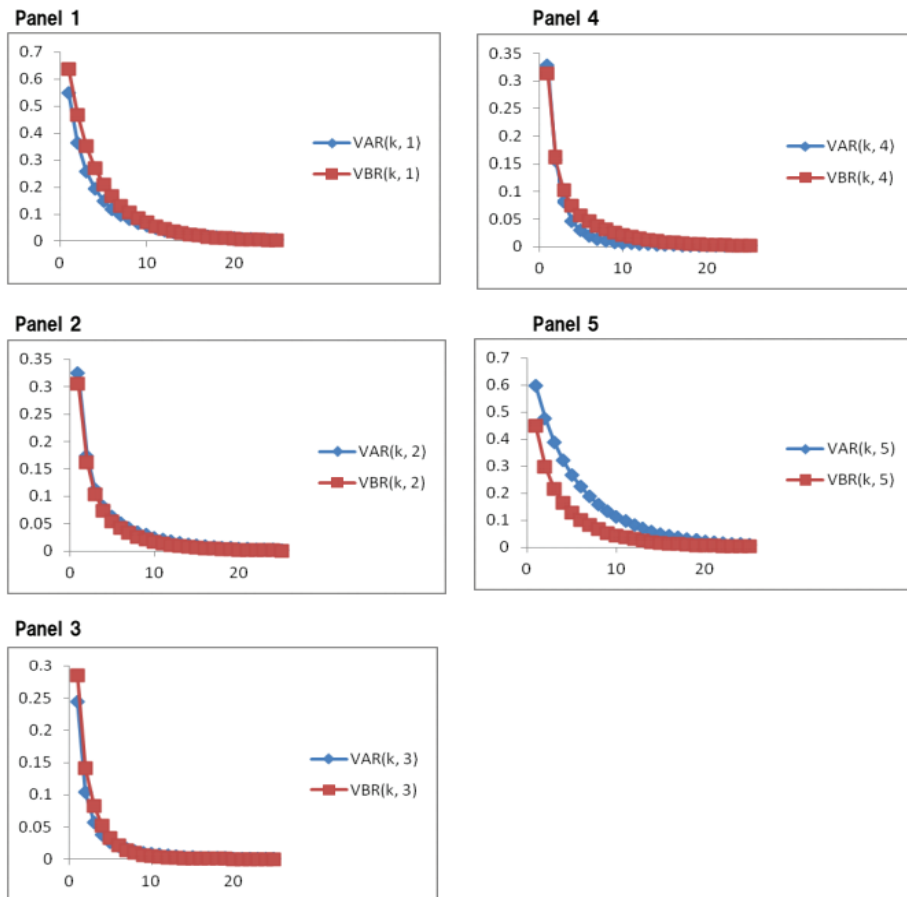
$h_2(i, t)$: late-stage (75 years or older) old age population rate

$h_3(i, t)$: ordinary balance rate

We used the regression residuals to calculate average Markov transition matrixes,

denoted as P_{AR} for the first half $\{2000, 2001, \dots, 2005\}$ and P_{BR} for the second half $\{2006, 2007, \dots, 2012\}$. Then we used $\{(P_{AR})^k, (P_{BR})^k; k = 1, 2, \dots\}$ to calculate the distances, denoted as $\{V_{AR}(k, i), V_{BR}(k, i); k = 1, 2, 3, \dots, i = 1, 2, 3, 4, 5\}$, from the “uniform” distribution $\{7/47, 10/47, 10/47, 10/47, 10/47\}$ for the first half and the second half. The five panels of figure 2.12 show the graphs of $\{V_{AR}(k, i), V_{BR}(k, i); k = 1, 2, 3, \dots, i = 1, 2, 3, 4, 5\}$. Even after adjusted for the region-specific factors, like $\{V_A(k, i), V_B(k, i)\}$ for the unadjusted user rates shown in figure 2.12, the speed of convergence of group I $V_{AR}(k, i)$ is faster in the first half than the second half $V_{BR}(k, i)$, while the order is reversed for group V.

Figure 2.12



The five panels of figure 2.13 plot and compare the adjusted distance for the first half

$V_{AR}(k, i)$ and the unadjusted distance $V_A(k, i)$ for the first half. Similarly, the five panels of figure 2.14 plot and compare the adjusted distance for the second half $V_{BR}(k, i)$ and the unadjusted distance $V_B(k, i)$ for the second half. These figures show that for the first half and the second half, and for all the 5 groups, the speed of convergence is faster after adjusted for the region-specific factors. This implies that the convergence might have been conditional, i.e., each region's user rate, if unadjusted for region-specific factors, is converging to region-specific steady state user rate.

Figure 2.13

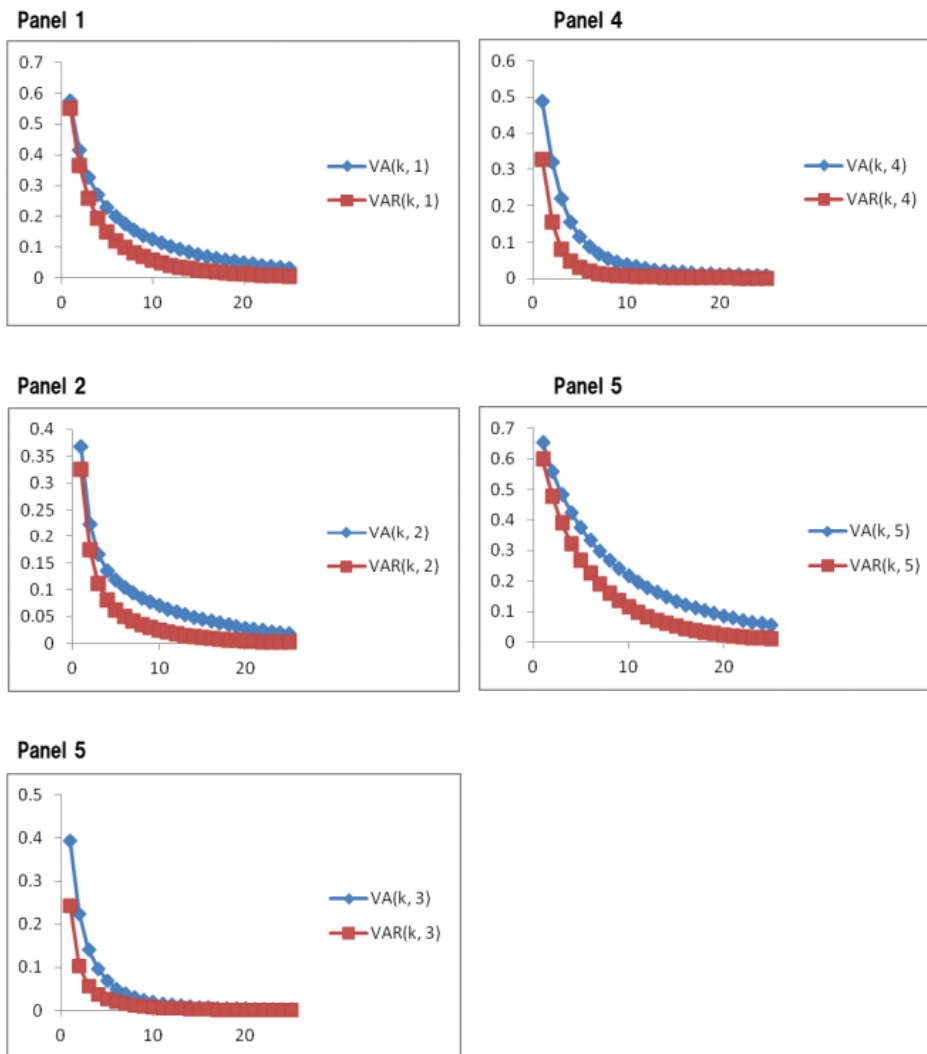
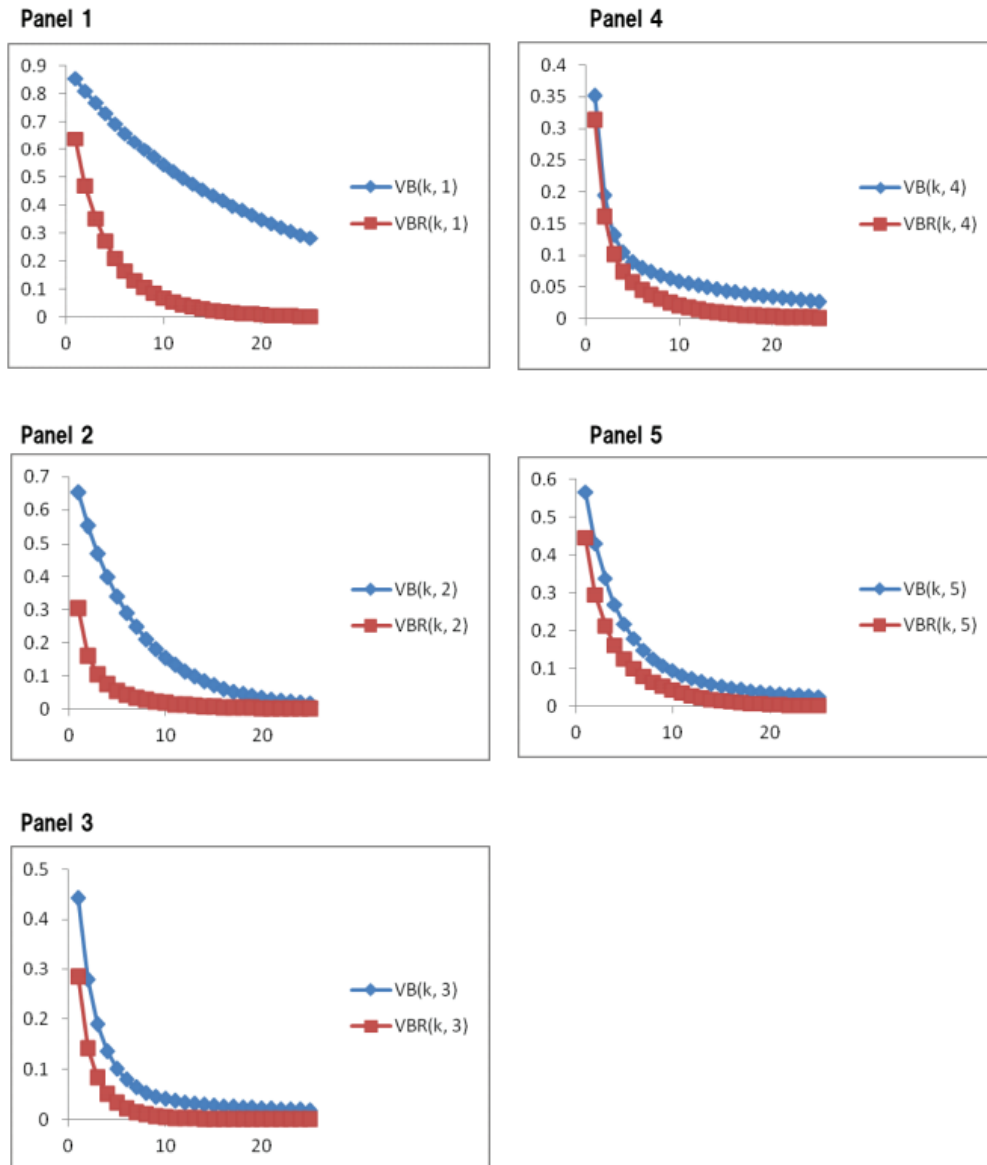


Figure 2.14



It turned out as well, however, that the standing order of regional user rates, even after being adjusted for region-specific factors, is not quite variable yet. Table 2.5 shows the 5 regions with the highest residual user rates and the 5 regions with the lowest residual user rates between 2000 and 2012. The table shows that some regions still hardly change their positions in the standing order. For example, Hokkaido stays the 47th for all the sample years but 2007, while Nagano stays the first for all but two years. These observations suggest that there are factors other than the ones we chose (the certification rate, the late-stage old age population rate, and the ordinary balance rate) that cause the regional

differences in user rates.

Table 2.5

STANDING	2000	2001	2002	2003	2004	2005
1	Shiga	Nagano	Nagano	Nagano	Nagano	Nagano
2	Aomori	Shiga	Shiga	Kyoto	Wakayama	Wakayama
3	Nagano	Aomori	Kyoto	Shiga	Kyoto	Shiga
4	Gifu	Gifu	Yamagata	Wakayama	Shiga	Kyoto
5	Kanagawa	Yamagata	Niigata	Niigata	Yamagata	Niigata
43	Fukuoka	Fukuoka	Osaka	Toyama	Mie	Ishikawa
44	Kochi	Yamaguchi	Akita	Yamaguchi	Yamaguchi	Yamaguchi
45	Yamaguchi	Kochi	Yamaguchi	Osaka	Akita	Akita
46	Akita	Akita	Kochi	Kochi	Kochi	Kochi
47	Hokkaido	Hokkaido	Hokkaido	Hokkaido	Hokkaido	Hokkaido

STANDING	2006	2007	2008	2009	2010	2011	2012
1	Wakayama	Nagano	Nagano	Nagano	Nagano	Nagano	Nagano
2	Nagano	Wakayama	Wakayama	Wakayama	Shiga	Shiga	Aomori
3	Shiga	Yamagata	Shiga	Shiga	Aomori	Aomori	Shiga
4	Kyoto	Shiga	Aomori	Aomori	Wakayama	Yamanashi	Wakayama
5	Yamagata	Aomori	Kyoto	Yamanashi	Yamanashi	Wakayama	Yamanashi
43	Ishikawa	Nagasaki	Okayama	Kagoshima	Kagoshima	Kagoshima	Kagoshima
44	Mie	Okinawa	Ibaraki	Ibaraki	Ibaraki	Ibaraki	Yamaguchi
45	Yamaguchi	Hokkaido	Yamaguchi	Yamaguchi	Yamaguchi	Yamaguchi	Ibaraki
46	Kochi	Kochi	Kochi	Kochi	Kochi	Kochi	Kochi
47	Hokkaido	Niigata	Hokkaido	Hokkaido	Hokkaido	Hokkaido	Hokkaido

2.6 References for China

By the end of 2014, the working age population (aged 15 ~ 64) of China was 100,469,000, account for 73.4% of total population, falling from 2010. During the same period, the aging population rate (ratio of population aged 65 ~ to total) grew dramatically from 8.9% to 10.1% (CNBS, 2015), and be expected to grow to 17.1% in 2030 and 26.3 in 2050 (UN, 2017).

According to the report of “Research of Long-term Care in China 2016” presented by Insurance Association of China, there are 7% of families with elderly people who needs long term care in China. And in 79.9% of these families, the care service is provided by spouses, children and relatives. Additionally, in 53% of these families, the service time spent by family members exceeds 50%.

To meet the increasing demand of long-term care, the Chinese government efforts to develop an LTCI system over the past few years. Since 2016, a 15-cities pilot program was started to implement. Based on the program’s guiding opinions, the pilot cities should

explore a LTCI system which is accustomed to each regional characteristic and a nationwide framework is aimed to accomplish in 1-2 years. As an added note, to build a nationwide LTCI, the differences of regional development should be considered. By the calculation of the Chinese provincial data, we find, during 2010 to 2015, the Gini coefficient of aging rate and per capita DPI grew from 0.11 to 0.13, 0.11 to 0.19, respectively. Meanwhile, that of per capita fiscal revenue has fell from 0.33 to 0.32²⁴(See Table 2.6). By contrast, those of Japan in 2015 are 0.05, 0.05 and 0.24, respectively. It is obvious that the Chinese regional differences are more significant than Japan. Thus, based on our preceding research, if the Chinese LCTI also take the locally conducted administration, it is reasonable to predict that these regional factors will lead to the regional disparities of the Chinese LCTI, such as user rate, premium and benefits. In reality, the primary responsibility for managing the current social security programs remains with the local government in China, which is embodied in the existence of a substantial amount of independent social security funds with various scale, various operation modes²⁵. These fragmented systems may be the potential factor that enlarges the regional differences of LCTI of China, and in turn affect the regional developmental balance.

To prevent this, the China's government should adopt a scheme that combined with market and social power. A unified social LTCI at national level ensures the supply of basic service to majority, especially for the most vulnerable groups-mid. On the other hand, demand of non-basic and diversified services can be met by commercial security. Additionally, a narrow eligibility and evaluation standards as well as the specific laws and policies for LTCI are required.

²⁴ Liu et al., (2014) provides a detail analysis on distribution of population aging in China.

²⁵ For the relationship of responsibility between central government and local government for providing social security, see Zhu (2016).

Table 2.6

	2010			2015		
	Aging Rate	Per Capita DPI	Per Capita Fiscal	Aging Rate	Per Capita DPI	Per Capita Fiscal
			Revenue			Revenue
Beijing	0.087	2.907	1.199	0.107	4.845	2.175
Tianjin	0.085	2.429	0.825	0.103	3.129	1.726
Hebei	0.082	1.623	0.185	0.101	1.812	0.356
Shanxi	0.041	1.565	0.147	0.092	1.785	0.448
Inner Mongolia	0.075	1.769	0.433	0.095	2.231	0.782
Liaoning	0.103	1.771	0.458	0.128	2.458	0.485
Jilin	0.083	1.541	0.219	0.109	1.868	0.446
Heilongjiang	0.083	1.386	0.197	0.108	1.859	0.306
Shanghai	0.101	3.194	1.248	0.039	4.987	2.028
Jiangsu	0.108	2.294	0.519	0.182	2.954	1.006
Zhejiang	0.093	2.736	0.479	0.101	3.553	0.868
Anhui	0.101	1.578	0.193	0.179	1.836	0.399
Fujian	0.078	2.178	0.312	0.09	2.541	0.662
Jiangxi	0.076	1.548	0.175	0.091	1.844	0.474
Shandong	0.098	1.944	0.496	0.117	2.271	0.561
Henan	0.083	1.563	0.147	0.099	1.712	0.318
Hubei	0.091	1.605	0.177	0.112	2.002	0.513
Hunan	0.097	1.656	0.165	0.112	1.932	0.371
Guangdong	0.067	2.389	0.433	0.078	2.786	0.863
Guangxi	0.092	1.706	0.167	0.098	1.687	0.316
Hainan	0.078	1.558	0.311	0.084	1.898	0.688
Chongqing	0.115	1.753	0.331	0.133	2.011	0.714
Sichuan	0.109	1.546	0.194	0.129	1.722	0.408
Guizhou	0.085	1.414	0.155	0.094	1.369	0.426
Yunnan	0.076	1.606	0.189	0.084	1.522	0.381
Tibet	0.051	1.498	0.12	0.057	1.225	0.423
Shanxi	0.085	1.569	0.257	0.103	1.739	0.543
Gansu	0.082	1.318	0.137	0.093	1.347	0.286
Qinghai	0.062	1.385	0.195	0.071	1.581	0.454
Ningxia	0.063	1.534	0.242	0.069	1.732	0.558
Xinjiang	0.061	1.364	0.229	0.071	1.685	0.564
National Avg.	0.076	1.645	0.309	0.092	1.997	0.604
Gini Coefficient	0.11	0.11	0.33	0.13	0.19	0.32

Source: Calculated by the author in accordance with China Statistical Yearbook 2016, published by CNBS.

2.7 Conclusion

In this chapter, we analyzed the dynamic properties of the regional differences in user rates defined as the ratio of LTCI users relative to the primary insured individuals (65 years or older). The main findings are summarized as follows.

(i) A simple theoretical model predicts that each region's user rate converges to a unique globally stable steady state. The convergence, however, could be conditional, i.e., each region's user rate may converge to a region-specific steady state which is determined by the region's parameters.

(ii) We calculated the user rates of 47 Japanese regions (prefectures) for the fiscal years between 2000 and 2012. (Data source: The Japanese Ministry of Health, Labor, and Welfare.) Then, we divided the 47 regions into 5 groups according to the standing order (high and low) of user rates. It turned out that the user rate of a group with higher (lower) user rate grows slower (faster). Hence, the regional user rates seem to exhibit a tendency to converge. The convergence, however, may be conditional. It turned out as well that the standing order of regional user rates is not quite variable.

(iii) By using average Markov transition matrixes for the first half (2000~2005) and for the second half (2006~2012), we calculated the index of standing order mobility so as to evaluate the effects of the 2005 reform which aimed to remedy the differences in regional figures of LTCI system. It turned out that the degree of mobility is greater in the first half than the second half for the group of regions with higher user rates. The 2005 reform, hence, did not seem to alleviate the standing order inertia.

(iv) The small degree of variation in the standing order suggests the existence of region-specific factors. With the help of preceding researches, we chose 3 factors {the certification rate, the late-stage (75 years or older) old age ratio, and the ordinary balance rate} to account for the regional differences in user rates, and recalculated the mobility index by using the residuals. It turned out that the degree of mobility is improved for all the 5 groups and for both before and after the 2005 reform. Thus, the convergence might have been conditional. If region-specific factors were not removed, each region's user rate would converge to region-specific steady state, and the standing order of regional user rate would be invariant. It turned out as well that the 2005 reform hardly affected the standing order mobility of residual user rates. In addition, the analysis also revealed that the improvement in the standing order variation seems small even after the regional factors are removed. Therefore, there might be factors other than our choice that could explain the regional differences.

Appendix. Data Sources and Its Properties.

For the analyses in this research, we used the data provided by the Japan Ministry of Health, Labor, and Welfare²⁶. There are some cautions on using the data;

(i) The public long-term care insurance system started on April 2000. Therefore, the data for 2000 fiscal year consists of 11 months, from April 2000 to February 2001. The data for each fiscal year between 2001 and 2012 consists of 12 months, from March of the year to the February of the next year.

(ii) In accordance with the 2005 reform, community-based services started on April 2006. The total number of long-term care services in each fiscal year between 2000 and 2005 and March 2006 is the sum of in-home services and facility services. On the other hand, the total number of services after April 2006 includes community-based services in addition to the formerly provided services.

(iii) We analyzed the data of primary insured individuals (65 years or older). The data of secondary insured individuals (40~64 years old) are excluded.

(iv) Because each primary insured individual may use in-home services, facility services, and community-based services many times in a year, the user rate, defined as the total number of services used by primary insured individuals divided by the number of primary insured individuals, may exceeds one. In the theoretical model of section 3, the user rate $x_t = X_t/L_t$ is defined as the ratio of the number of insured individuals who use services X_t to the number of insured individuals L_t . An insured individual is included in X_t if she uses at least one service. X_t does not reflect the number of services each insured individual uses. This implies $0 < x_t < 1$ in the theoretical model. Therefore, we implicitly assume that if the theoretical model is true so that the user rate x_t converges to the steady state x^* , the same force also works on the user rate calculated from the data in the manner stated above.

Because of the discontinuity, we looked at two series. Series [ALL] includes all the

²⁶ [The Reports on Long-term Care Insurance System: Annual Reports, 2000~2012 Fiscal Years] (URL <http://www.mhlw.go.jp/topics/kaigo/joukyou.html>)

services, while series [EXC] excludes the community-based services from the second half data. Table 2.7 reports the basic statistics of regional user rates [ALL]; mean, annual rate of change, variance, coefficient of variation, maximum value, minimum value, and max/min ratio. Table A1 also reports the basic statistics of regional user rates [EXC].

Table 2.7

	Mean [ALL]	GrowthRate[ALL]	Variance[ALL]	Coeff.Var[ALL]	Max[ALL]	Min[ALL]	Max/Min[ALL]
2000	1.9812		0.0809	0.0408	2.7487	1.4134	1.9448
2001	2.5566	0.2904	0.1103	0.0431	3.3282	1.8398	1.8090
2002	2.9556	0.1561	0.1301	0.0440	3.7131	2.1468	1.7296
2003	3.3046	0.1181	0.1519	0.0460	4.0299	2.4232	1.6630
2004	3.5668	0.0794	0.1706	0.0478	4.4533	2.6575	1.6757
2005	3.7049	0.0387	0.1839	0.0496	4.7039	2.8077	1.6754
2006	3.6365	-0.0185	0.1647	0.0453	4.6696	2.8181	1.6570
2007	3.5820	-0.0150	0.2127	0.0594	4.6814	1.9558	2.3936
2008	3.6935	0.0311	0.1674	0.0453	4.8177	2.8299	1.7024
2009	3.8090	0.0313	0.1783	0.0468	4.9431	2.8929	1.7087
2010	4.0018	0.0506	0.1831	0.0457	4.9355	3.0319	1.6279
2011	4.1344	0.0331	0.1979	0.0479	5.1233	3.1104	1.6472
2012	4.2280	0.0226	0.1991	0.0471	5.2352	3.1706	1.6512

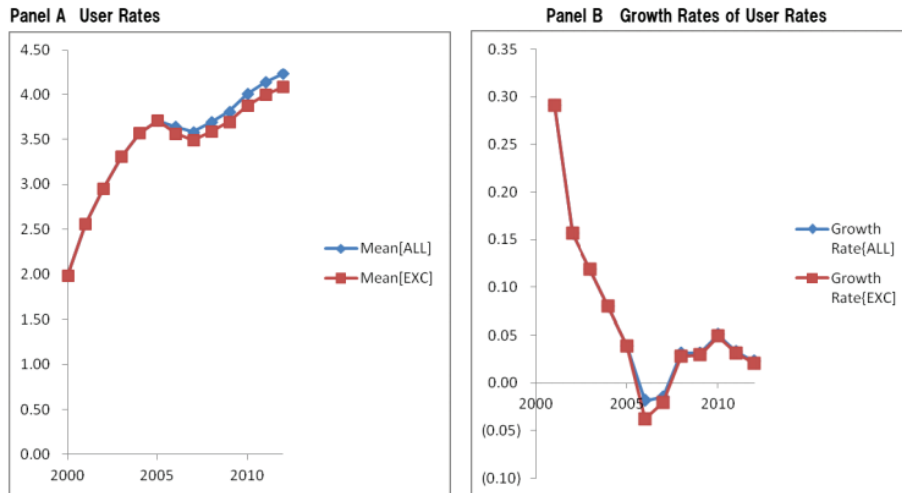
	Mean[EXC]	GrowthRate[EXC]	Variance[EXC]	Coeff.Var[EXC]	Max[EXC]	Min[EXC]	Max/Min[EXC]
2000	1.9812		0.0809	0.0408	2.7487	1.4134	1.9448
2001	2.5566	0.2904	0.1103	0.0431	3.3282	1.8398	1.8090
2002	2.9556	0.1561	0.1301	0.0440	3.7131	2.1468	1.7296
2003	3.3046	0.1181	0.1519	0.0460	4.0299	2.4232	1.6630
2004	3.5668	0.0794	0.1706	0.0478	4.4533	2.6575	1.6757
2005	3.7049	0.0387	0.1839	0.0496	4.7039	2.8077	1.6754
2006	3.6365	-0.0185	0.1647	0.0453	4.6696	2.8181	1.6570
2007	3.5820	-0.0150	0.2127	0.0594	4.6814	1.9558	2.3936
2008	3.6935	0.0311	0.1674	0.0453	4.8177	2.8299	1.7024
2009	3.8090	0.0313	0.1783	0.0468	4.9431	2.8929	1.7087
2010	4.0018	0.0506	0.1831	0.0457	4.9355	3.0319	1.6279
2011	4.1344	0.0331	0.1979	0.0479	5.1233	3.1104	1.6472
2012	4.2280	0.0226	0.1991	0.0471	5.2352	3.1706	1.6512

[ALL] Includes Community-Based Services. [EXC] Community-Based Services Excluded.

Data Source: Japan Ministry of Health, Labor, and Welfare

Panel 1 of figure 2.15 depicts the graph of average user rate [ALL] and the graph of [EXC]. Because of the introduction of community-based services in the second half, the average user rate [ALL] is higher than [EXC] in the second half. Despite the inclusion of community-based services, these graphs show the similar movements. Between 2000 and 2005, the average user rate increased, but at diminishing growth rate. After the temporary decline in 2006 and 2007, the average user rate began to increase again. The speed of the growth diminished for the last two years, 2011 and 2012. We can reconfirm these properties in panel 2 of figure 2.15 which depicts the growth rate of the user rate [ALL] and that of [EXC]. Since both user rates [ALL] and [EXC] show similar movements, in this research we focus on the analyses of user rate [ALL] that includes the community-based services in the second half.

Figure 2.15



Data Source: Japan Ministry of Health, Labor, and Welfare

References

- [1]Banister J, Bloom DE, Rosenberg L, (2012)“Population aging and economic growth in China,” in Masahiko Aoki and Jinglian Wu, eds. *The Chinese Economy: A New Transition*. Basingstoke: Palgrave Macmillan.
- [2]Barro, Robert J., and Xavier Sala-i-Martin (2004) *Economic Growth*, 2nd ed., MIT Press.
- [3]Ljungqvist, Lars, and Thomas J. Sargent (2004) *Recursive Macroeconomic Theory*, 2nd ed., MIT Press.
- [4]Quah, Danny (1993) “Galton’s Fallacy and Tests of the Convergence Hypothesis” *Scandinavian Journal of Economics*, Vol. 95, No. 4, pp.427-443.
- [5]Stokey, Nancy L., and Robert E. Lucas, Jr. (with Edward C. Prescott) (1989) *Recursive Methods in Economic Dynamics*, Harvard University Press.
- [6]Ando, Michihito (2008) “An Empirical Analysis of Regional Differences in Provision and Premiums of Long-term Care Insurance: An Analysis of Japanese Municipality-level Data” *The Quarterly of Social Security Research*, Vol. 44, No. 1, pp.94-109. (In Japanese)
- [7]Kikuchi, Jun (2008) “The sustainability of the long-term care insurance in Japan: from the viewpoint of institutional care services” *The Quarterly of Social Security*

Research, Vol. 43, No. 4, pp.365-379. (In Japanese)

[8]Kikuchi, Jun, Eiji Tajika, and Yuji Yui (2005) “The Present State and Sustainability of Long-Term Care Insurance” in Eiji Tajika and Motohiro Sato (eds.), *Intergenerational Differences in Medical and Long-Term Care: Current Situation and Issues*, Toyo Keizai Inc. (In Japanese)

[9]Luo, Meng (2017) “Long-Term Care System in Taiwan and Its Implications” *Scientific Research on Aging*, Vol.5, No.3 pp.52-60. (In Chinese)

[10]Huajun, L., Liwei, H., & Qian, Y. (2014). “Spatial Inequality and Distributional Dynamics of Population Ageing in China, 1989-2011” *Population Research*, 2, 006. (In Chinese)

[11]Shimizutani, Satoshi, and Noriko Inakura (2006) “Japan’s Public Long-term Care Insurance and the Financial Condition of Insurers: Evidence from Municipality-Level Data” *Government Auditing Review*, No. 34, pp.83-95. (In Japanese)

[12]Shimizutani, Satoshi, and Haruko Noguchi (2004) *An Economic Analysis on the Elderly and Child Care in Japan: Micro-level Investigation with Policy Implication*, Toyo Keizai Inc. (In Japanese)

[13]Suzuki, Wataru (2002) “Kaigo Service Juyou Zouka no Youin Bunseki” *Japanese Journal of Labour Studies*, No. 502, pp.6-17. (In Japanese)

[14]Tajika, Eiji, and Jun Kikuchi (2003) “The Long-Term Care Insurance in Japan: Why is Its Financing so Difficult?” *The Quarterly of Social Security Research*, Vol. 39, No. 2, pp.174-188. (In Japanese)

[15]Tajika, Eiji, and Jun Kikuchi (2006) “What are the problems with nursing insurance?: study on the process of system creation and its effects on improving states of nursing requirement” *Financial Review*, Vol. 80, pp.157-186. (In Japanese)

[16]Yui, Yuji (2006) “Analysis of Long-term Care Insurance using Municipal Data: The Case of Aomori Prefecture” *Financial Review*, Vol. 80, pp.187-203. (In Japanese)

[17]Wei, Wang and Yongchun Tang(2014) “The International Comparative Study of Long-Term Care Insurance System” *International Journal of Business and Social Science* Vol. 5, No. 2, pp.239-244.

[18]Yang, Wei, et al. (2016) "Financing institutional long-term care for the elderly in China: a policy evaluation of new models." *Health policy and planning* 31.10: 1391-1401.

- [19]Wang, W., & Tang, Y. (2014). The International Comparative Study of Long-Term Care Insurance System. *International Journal of Business and Social Science*, 5(2).
- [20]Japan Ministry of Health, Labor, and Welfare White Paper 2005 Fiscal Year (2005).
- [21]Japan Ministry of Health, Labor, and Welfare White Paper 2007 Fiscal Year (2007).
- [22]Data and Statistics Sources
- [23]Japan Ministry of Health, Labor, and Welfare
- [24]Japan Ministry of Internal Affairs and Communications Statistics Bureau
- [25]OECD Health Statistics 2015

Chapter 3. Home or Market; Relative Importance of Learning Places on the Process of Economic Development

In this chapter, we provide a theoretical economic growth model with home production sector and market production sector to show the relative importance of learning places in the process of economic development. We assume the home production technology is more intensive and show when market activity is more important for human capital accumulation, multiple steady states may emerge. This result may help to explain the divergence of economic growth among economies. The implications to China are discussed.

3.1 Introduction

At the frontier of macroeconomic analysis to date, the “unified economic growth theory” and the “family and time allocation” are two major fields of researches. Galor (2011) proposed an initiative to construct unified economic growth theory which can explain (i) transition from stagnant phase to growth phase, and (ii) divergence between high growth group and low growth group in single framework. On the other hand, the macroeconomic implication of family and time allocation attracts renewed interest among researchers. [See, for example, Doepke and Tertilt (2016), and Aguiar and Hurst (2016).] In this chapter, we provide a framework which combines these two fields and show that the relative importance of learning places (home or market) matters for the process of economic development.

A natural framework that can deal with these issues is a two-sector model of economic growth in which a household plans time allocation between market activity and non-market (home) activity to maximize utility. Under the assumption that home technology is more labor intensive than the market technology (as presumed in many preceding researches), we show it is necessary that activity at market is more important for human capital accumulation than activity at home for steady state multiplicity. When activity at market is more important for human capital accumulation than activity at home, multiple steady states may emerge in dynamic general equilibrium. Some economies converge

toward a higher growth steady state, while the others toward a lower growth steady state. Furthermore, the divergence may depend on initial condition and self-fulfilling expectation. We also derive some testable implications.

The intuitive reason behind these observations are explained as follows. Suppose the model economy is on a steady state where the ratio of physical capital to human capital is constant, the resource allocation between two sectors is optimal, and the aggregate variables grow at the rate of human capital accumulation. Then, a shock that destroys physical capital, while leaves human capital intact, causes an upward jump in the share of physical capital employed by market sector because market sector is more physical capital intensive than home sector. The shock also causes an upward jump in the share of human capital employed by market sector so as to keep the temporal optimal condition with respect to sectoral resource allocation invariant. If activity at home is relatively more important for human capital accumulation than activity at market, then the shock decreases the speed of human capital accumulation. As a result, the ratio of physical capital to human capital increases, and the process continues until the economy moves back to the same steady state. On the other hand, if activity at market is relatively more important for human capital accumulation than activity at home, then the shock increases the speed of human capital accumulation so that the ratio of physical capital to human capital decreases furthermore until the economy reaches another steady state, if any, where the ratio of physical capital to human capital is lower and the speed of human capital accumulation is faster than the initial steady state.

This chapter is related to the following researches. In many optimal growth models, external effects are introduced as the Marshallian externality.²⁷ Boldrin and Rustichini (1994) showed that in optimal growth models with one state variable (physical capital), while a negative externality generates an indeterminate steady state, a positive externality does not under mild conditions. Benhabib and Farmer (1994), and Farmer and Guo (1994) showed that an indeterminate steady state could emerge in optimal growth models with a leisure-in-utility function. Perli (1998) introduced home production, and showed by

²⁷ See Boldrin and Rustichini (1994), Schmitt-Grohe (1997), Nishimura and Sorger (1999), Benhabib and Farmer (1999) for the survey of this topic.

calibration that an indeterminate steady state could emerge. These studies introduce external effects as the Marshallian externality. In the present model, home consumption might also be interpreted as a leisure which requires both human capital and physical capital inputs, although the source of external effects is different. The "history versus expectation" phenomenon emerges in Krugman (1991), Matsuyama(1991), Futagami and Mino (1995), Gali (1994), and Greiner and Semmler (1996).²⁸

The qualitative and quantitative importance of household production is widely recognized in macroeconomic modeling. In the field of real business cycle theory, introducing the home sector to a standard model is known to improve the matching of artificial data to actual data in terms of standard deviation and co-variation with output. [c.f., Benhabib, Rogerson, and Wright (1991), Greenwood and Hercowitz (1991), Greenwood, Rogerson, and Wright (1995), McGrattan, Rogerson, and Wright (1997)] In the field of endogenous business cycle theory, the degree of increasing returns required to generate indeterminate equilibria is greatly reduced by introducing the home sector. [c.f., Perli (1998)] It is also interesting to see how home sector, through its interaction with market sector, affects the long-run growth of an economy. Greenwood and Hercowitz (1991) note that "in contrast to physical capital, important components of human capital are produced in the household sector" (p.1211), although the human capital accumulation in their model is an exogenous process. On the other hand, learning-by-doing in the market sector would play an important role in the human capital accumulation as well. Because the resources a society can spend are limited, the appropriate question might be the relative importance of each sector for human capital

²⁸ The other related research is as follows. Dynamic general equilibrium models with external effects could have multiple steady states due to the violation of global concavity. Skiba (1978), and Deckert and Nishimura (1983) characterized the solution of optimal growth models with a non-convex technology set. Ethier (1982), Howitt and McAfee (1988), Spear (1991), Boldrin and Rustichini (1994), and Benhabib and Farmer (1994) studied indeterminacy due to external effects. Benhabib and Nishimura (1979, 1998) studied the conditions for indeterminacy in multi-sector optimal growth models. Pelloni and Waldman (1998), and Mino (1999) studied the role of preference structure on the emergence of an indeterminate steady state. Chamley (1993), Bond, Wang and Yip (1996), and Ladron-De Guevara, Ortigueira and Santos (1999) studied the indeterminacy in Uzawa-Lucas type two-sector endogenous growth models. (See Uzawa (1964), and Lucas (1988).)

accumulation. If people learn more through activities at home, spending too much resource in the market may reduce the speed of human capital accumulation and (per-capita) economic growth, or vice versa. In this chapter, I incorporate this consideration into a model of economic growth driven by human capital accumulation to see the implications of home sector for the local and global dynamics of the Hamiltonian system. Benhabib et. al. (1991), and Greenwood and Hercowitz (1991) suggest that home sector might be more labor-intensive than market sector. In this case, if people learn more at home than at market, the model predicts an equilibrium path converging to a globally unique saddle-point. On the other hand, if people learn more at market than at home, multiple steady states could emerge, and the outcome might depend on both history and expectation.

This chapter is organized as follows. In section 3.2, we present a two-sector model of economic growth that will be used for our purpose. In the model, there are two inputs, physical capital and human capital, and two outputs, market output and non-market (home) output. The economic growth is driven by human capital accumulation, the speed of which is assumed to be dependent on the time allocation between market activity and non-market (home) activity. We also assume that home technology is more labor intensive than the market technology (as presumed in many preceding researches). At the end of section 3.2, we derive a system of dynamic general equilibrium (DGE) equations with respect to two variables; the ratio of physical capital to human capital and the share of physical capital employed by market sector. In section 3.3, we analyze the steady state of dynamic general equilibrium. We show that when market activity is more important for human capital accumulation, then multiple steady states may emerge. In section 3.4, we analyze the local and global stability of the steady states. We show that when there are multiple steady states, depending on the initial condition and self-fulfilling expectation, some economies converge toward a higher growth steady state, while the others toward a lower growth steady state. On the path to the higher growth steady state, the ratio of physical capital to human capital decreases (because human capital accumulation is the main engine of economic growth), and both the share of physical capital and the share of human capital employed by market sector increase. On the path to the lower growth

steady state, these variables behave the opposite. In section 3.5, we summarize and conclude the paper by proposing the lines of future research.

3.2 Model

In this section, we present a two-sector model of economic growth that will be used for the analysis of time allocation and economic growth. Consider a two-sector model of economic growth driven by human capital accumulation. The model is described as a continuous-time optimization problem of a representative agent. There are many identical agents in the economy. The population size is normalized to be one. At each moment t , a representative agent has one unit of time, $H(t)$ units of human capital, and $K(t)$ units of physical capital which has been accumulated through past investment activities. The human capital and physical capital are allocated between two types of production activities; market good production and nonmarket (home) good production. The $\lambda(t) \times 100\%$ of time is combined with human capital $H(t)$, and the $\mu(t) \times 100\%$ of physical capital is allocated to produce $A[\lambda H]^\alpha [\mu K]^{1-\alpha}$ units of market good that is used for market good consumption C_m and gross investment $\dot{K} + \delta_k K$. (Hereafter, λ is referred as the “time share of human capital”.) $A \in (0, \infty)$ is market production technology level (scale parameter), $\alpha \in [0, 1]$ is the share of human capital in market production function, and $\delta_k \in [0, 1]$ is physical capital depreciation rate. The remaining human capital and physical capital are used to produce $B[(1-\lambda)H]^\beta [(1-\mu)K]^{1-\beta}$ units of nonmarket (home) consumption good C_n . $B \in (0, \infty)$ is home production technology level, and $\beta \in [0, 1]$ is the share of human capital in home production function.

In a survey paper by Aguiar and Hurst (2016) about the macroeconomics of time allocation, time is divided between market work and nonmarket work (homework). Nonmarket work includes such activities as home production (cooking, cleaning, shopping, laundry, lawn mowing, older adults caring, etc.), child caring, and leisure (TV, theatre, videogames, socializing, exercising, sleeping, etc.). In addition, Aguiar and Hurst count such activities as job search, human capital accumulation, civic organization

participation, etc., as yet another group for time allocation. In our research, λ is share of time for market work, and $1 - \lambda$ is the share of time for all the other activities.²⁹

Preceding researches assume that home technology is relatively more human capital intensive than market technology. For example, Greenwood and Hercowitz (1991) assumed $\alpha = 0.7$ and $\beta = 0.87$ in their numerical calibration analysis of real business cycle model. Therefore, in this research, we also assume the following.

Assumption 1. $\alpha < \beta$

As stated in the introduction, the rate of human capital accumulation \dot{H}/H may depend on how each individual learns at home and at market. Page (1994) compared the growth experiences of the East Asian countries and Latin American countries. Although these two regions had comparable initial states, the subsequent per-capita economic growth turned out to be much higher for the East Asian countries than Latin American countries. Page observes the differences in education system as the key factor. While Latin American countries spent resources more on secondary and higher education, whose return could be internalized through markets, the East Asian countries spent more on primary education. In fact, providing very basic skills such as reading and writing to every individual at an early stage could generate an external effect that enhances economy-wide labor-productivity. On the other hand, we often observe child-labor in the market place among low-income, stagnant economies. In this case, economies that spend too much resources in market sector may experience lower rate of growth in labor productivity than those that spend more in home sector. On the other hand, learning as by-product of market production, and network (team) externality on learning at workplace are stressed in labor economics. [c.f., Arrow(1962), Aoki(1984)] Therefore, each of these two cases will be considered in the following analysis. Specifically, we assume the following functional form for human capital accumulation.

$$\dot{H} = \phi(\lambda)H - \delta_H H \quad (3.1)$$

$\delta_H \in [0, 1]$ is human capital depreciation rate, and $\phi(\lambda) \geq 0$ is the (gross) growth rate

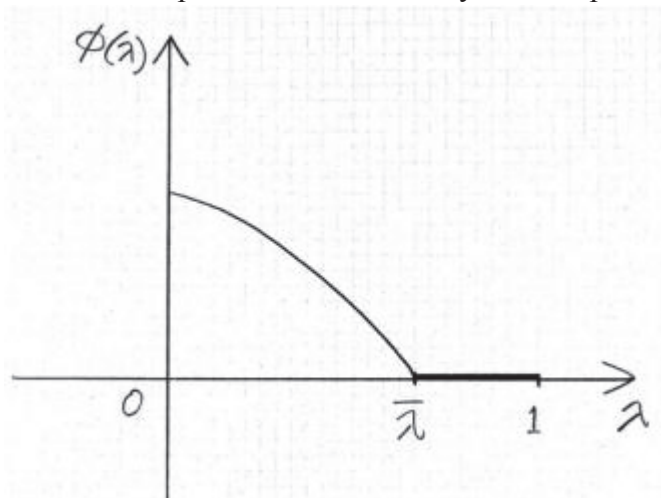
²⁹ Aguiar and Hurst (2016) and Doepke and Tertilt, (2016) report the trend of time allocation since 1960s in the US. Time share for market work of male workers has been decreasing while that of female workers increasing.

of human capital which is dependent on the time share of human capital λ employed by market sector. $\phi(\lambda)$ may be increasing in λ if people learn relatively more at market. Or, $\phi(\lambda)$ may be decreasing in λ if people learn relatively more at home. We will consider the following three cases with respect to the relationship between λ and $\phi(\lambda)$.

Case 1; Home production is relatively more important for human capital accumulation. For some $\bar{\lambda} \in [0, 1]$, $\phi(\lambda) > 0$ for all $\lambda \in [0, \bar{\lambda})$, $\phi(\lambda) < 0$ for all $\lambda \in (\bar{\lambda}, 1]$, and $\phi(\lambda) = 0$ for all $\lambda \in [\bar{\lambda}, 1]$. (See figure 3.1.) $\bar{\lambda}$ is a threshold value such that the positive effect of home production on human capital growth ceases to effect above this value.

Figure 3.1

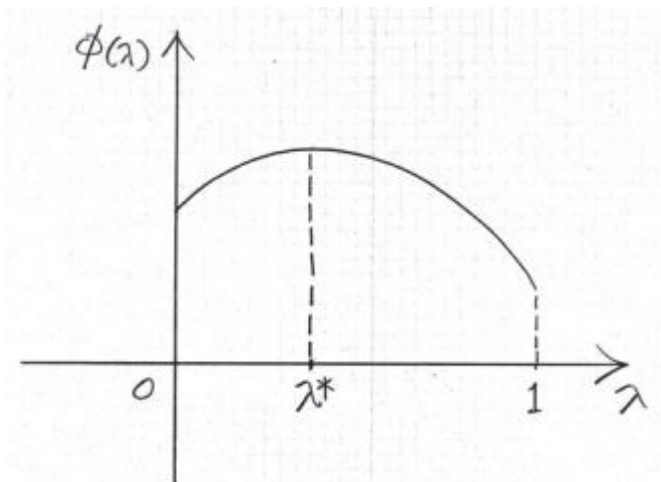
Case 1: Home production is relatively more important for human capital accumulation.



Case 2; There is an interior $\lambda^* \in [0, 1]$ which maximizes the human capital growth rate. $\phi'(\lambda^*) = 0$, $\phi'(\lambda) \geq 0$ for all $\lambda \in [0, \lambda^*)$, and $\phi'(\lambda) \leq 0$ for all $\lambda \in (\lambda^*, 1]$. (See figure 3.2.)

Figure 3.2

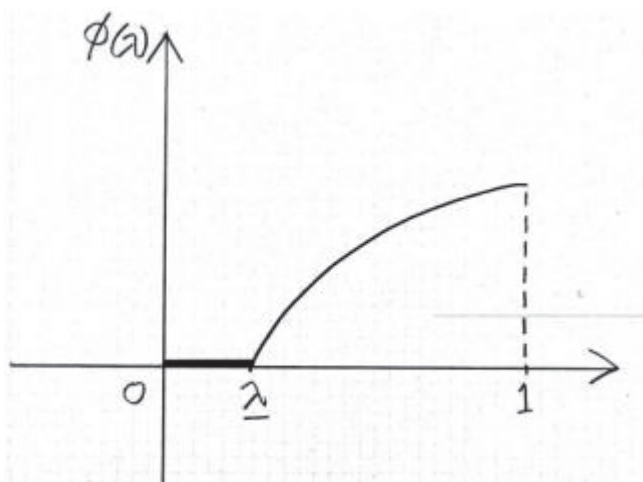
Case 2: There is an interior which maximizes the human capital accumulation.



Case 3; Market production is relatively more important for human capital accumulation. For some $\underline{\lambda} \in [0, 1]$, $\phi(\lambda) = 0$ for all $\lambda \in [0, \underline{\lambda}]$, $\phi(\lambda) > 0$ for all $\lambda \in (\underline{\lambda}, 1]$, and $\phi'(\lambda) > 0$ for all $\lambda \in (\underline{\lambda}, 1]$. (See figure 3.3.) $\underline{\lambda}$ is a threshold value such that the positive external effect of home production on human capital growth starts to effect above this value.

Figure 3.3.

Case 3: Market production is relatively more important for human capital accumulation.



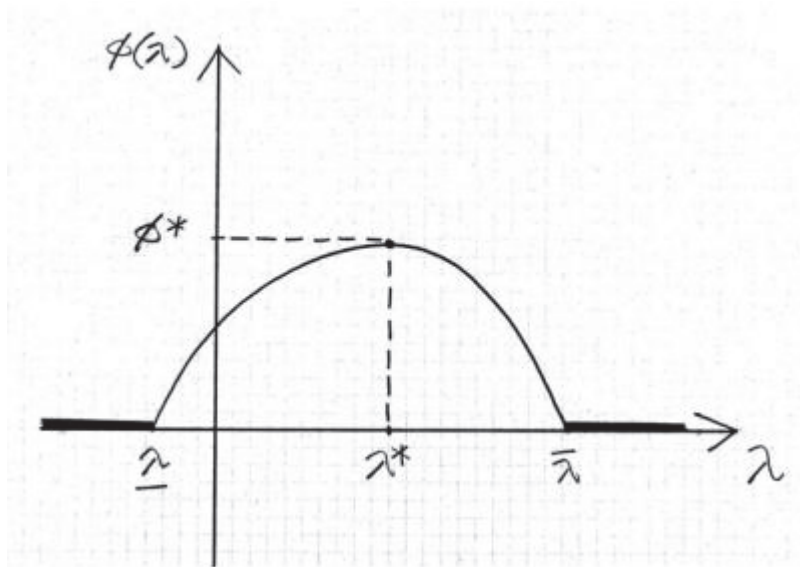
A functional example that includes these 3 cases as special cases is presented as follows.

(See figure 3.4)

$$\phi(\lambda) = \begin{cases} -\psi(|\lambda^* - \lambda|)^\varepsilon + \phi^*, & \underline{\lambda} \leq \lambda \leq \bar{\lambda} \\ 0, & \lambda \leq \underline{\lambda} \text{ or } \lambda \geq \bar{\lambda} \end{cases}, \quad \psi > 0, \varepsilon > 0, \phi^* > 0$$

(3.2)

Figure 3.4



In addition, we assume that the effect of λ on $\phi(\lambda)$ is taken as external by the representative individual in the following analysis.

Assumption 2. The effect of λ on $\phi(\lambda)$ is taken as external by the representative individual.

In case of market activity, assumption 2 may be plausible because the activity is collective. On the other hand, assumption 2 may not be plausible in case of nonmarket activity because each household internalizes the effect on human capital accumulation. Despite the implausibility, we impose assumption 2 in the following because the assumption greatly facilitates the analyses. We would like to analyze the extended model which incorporate the market and nonmarket asymmetry as a remaining issue.

The representative agent's preference over market good C_m and home good C_n is expressed by the following lifetime utility function.

$$\int_0^{\infty} u(C_m, C_n) e^{-\rho t} dt \quad (3.3)$$

In (3.3), $u(C_m, C_n)$ is an instantaneous utility function of logarithmic form described as follows.

$$u(C_m, C_n) = \gamma \ln C_m + (1 - \gamma) \ln C_n \quad (3.4)$$

In (3.3) and (3.4), $\rho \in (0, \infty)$ is subjective discount factor and $\gamma \in (0, 1)$ is the relative importance of market good C_m over home good C_n in the instantaneous utility function.

The representative agent's optimization problem at time $t = 0$ is summarized as follows.

Given $\{K(0), H(0)\}$ and $\{\phi(t) ; t \geq 0\}$, choose $\{C_m(t), C_n(t), \lambda(t), \mu(t), K(t) ; t \geq 0\}$ to maximize

$$\int_0^{\infty} u(C_m, C_n) e^{-\rho t} dt \quad (3.3)$$

subject to

$$u(C_m, C_n) = \gamma \ln C_m + (1 - \gamma) \ln C_n \quad (3.4)$$

$$C_m + \dot{K} + \delta_K K = A[\lambda H]^\alpha [\mu K]^{1-\alpha} \quad (3.5)$$

$$C_n = B[(1 - \lambda)H]^\beta [(1 - \mu)K]^{1-\beta} \quad (3.6)$$

$$\lambda \in [0, 1]$$

$$\mu \in [0, 1] \quad .$$

The solution to this optimization problem is a dynamic general equilibrium (DGE) of the model economy. The DGE is summarized by the following system of differential equations $\{(3.7), (3.8)\}$ with respect to the share of physical capital employed by market sector μ and the ratio of physical capital to human capital $k \equiv K/H$.

$$\frac{\dot{k}}{k} = A \left(\frac{\lambda}{\mu} \right)^\alpha [(1+M)\mu - M] k^{-\alpha} - \delta_K - \phi(\lambda) + \delta_H \quad (3.7)$$

$$\frac{\dot{\mu}}{\mu} = \frac{1}{\Omega(\mu)} \left[A \left(\frac{\lambda}{\mu} \right)^\alpha (1+M)(1-\alpha)(1-\mu) k^{-\alpha} - \rho - \alpha \delta_K - \alpha \phi(\lambda) + \alpha \delta_H \right] \quad (3.8)$$

In (3.7) and (3.8),

$$\lambda = a\mu / [a\mu + b(1-\mu)] \quad (3.9)$$

$a \equiv \alpha / (1-\alpha)$, $b \equiv \beta / (1-\beta)$, $M \equiv [\gamma(1-\alpha)] / [(1-\gamma)(1-\beta)]$, and

$$\Omega(\mu) \equiv \frac{-\mu}{1-\mu} \left[\frac{(1-\mu)(1-\alpha)(b-a) + a}{a\mu + b(1-\mu)} \right].$$

At each moment t , (3.9) must hold for the optimal resource allocation between market sector and home sector. In addition, the following transversality condition must hold as well.

$$\lim_{t \rightarrow \infty} e^{-\rho t} \sigma(t) k(t) = 0 \quad (3.10)$$

In (3.10), $\sigma(t)$ is the shadow price of $k(t)$.

3.3 Steady State and Welfare

3.3.1 Steady State

At a steady state $\{k_s, \mu_s\}$ of the DGE, $\dot{k}/k = 0$ and $\dot{\mu}/\mu = 0$. The steady state value of the time share of human capital employed by market sector, λ_s , is shown to be a solution to the following equation.

$$\mu(\lambda) = F(\lambda) \quad (3.11)$$

The left-hand side of (3.11) is

$$\mu(\lambda) \equiv b\lambda / [a(1-\lambda) + b\lambda] \quad (3.12)$$

by (3.9), and the right-hand side of (3.11) is

$$F(\lambda) \equiv \left[\frac{(1-\alpha)(\delta_K + \phi(\lambda) - \delta_H)}{\rho + \delta_K + \phi(\lambda) - \delta_H} + M \right] / (1+M) \quad (3.13)$$

The other steady state variables are expressed as functions of λ_s as follows.

$$\mu_s = b\lambda_s / [a(1-\lambda_s) + b\lambda_s] \quad (3.14)$$

$$k_s = \left(\frac{\lambda_s}{\mu_s} \right) \left[\frac{(1-\alpha)A}{\rho + \delta_K + \phi(\lambda_s) - \delta_H} \right]^{1/\alpha} \quad (3.15)$$

$$c_{m,s} \equiv C_m / H = M A (\lambda_s / \mu_s)^\alpha (1 - \mu_s) k_s^{1-\alpha} \quad (3.16)$$

$$c_{n,s} \equiv C_n / H = B(1-\lambda_s)^\beta [(1-\mu_s)k_s]^{1-\beta} \quad (3.17)$$

In a steady state,

$$K = k_s H, \quad C_m = c_{m,s} H, \quad \text{and} \quad C_n = c_{n,s} H. \quad (3.18)$$

Therefore, $\{K, C_m, C_n\}$ grow at the same growth rate equal to $\dot{H}/H = \phi(\lambda) - \delta_H$.

(3.12) implies

$$\mu(0) = 0, \quad \mu(1) = 1, \quad \text{and} \quad \mu'(\lambda) > 0 \quad \text{for all} \quad \lambda \in [0, 1].$$

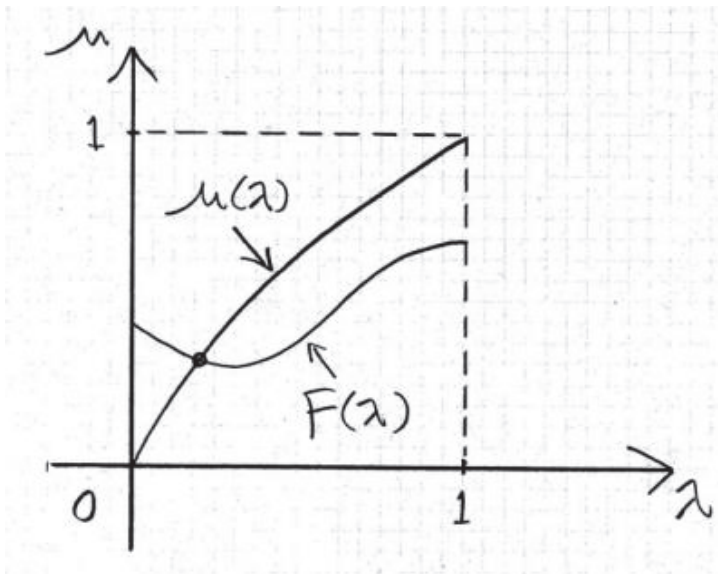
(3.19)

Assume $\delta_K + \phi(\lambda) - \delta_H \geq 0$ for all $\lambda \in [0, 1]$. Then, (3.13) implies

$$M/(1+M) \leq F(\lambda) < 1 \quad \text{for all} \quad \lambda \in [0, 1]. \quad (3.20)$$

Therefore, equation (3.11) has at least one interior solution $\lambda_s \in (0, 1)$. (See figure 3.5.)

Figure 3.5



The following theorem 1 is used for checking the existence of multiple steady states.

Theorem 1.

$$\text{sign}[F'(\lambda)] = \text{sign}[\phi'(\lambda)] \quad (3.21)$$

Proof ; $\frac{\partial}{\partial \lambda}[\ln F(\lambda)] = \left(\frac{\partial}{\partial \phi}[\ln F(\lambda)] \right) \phi'(\lambda)$. It can be shown that

$$\partial \ln F(\lambda) / \partial \phi > 0.$$

The following corollary 1 is used for comparative dynamic analysis in section 4.

Corollary 1.

$$\begin{aligned} \text{(i) } & F(\lambda; \overset{(-)}{\rho}, \overset{(+)}{\delta_K}, \overset{(-)}{\delta_H}, \overset{(-)}{\alpha}, \overset{(+)}{\beta}, \overset{(+)}{\gamma}) \\ \text{(ii) } & F'(\lambda) = 0 \text{ for } \lambda \leq \underline{\lambda} \text{ or } \lambda \geq \bar{\lambda}. \end{aligned} \quad (3.22)$$

In (3.22), “+” sign or “-” sign above each parameter implies an upward shift or a downward shift in $F(\lambda)$ caused by the change in parameter value. For example, an increase in subjective discount factor ρ of future utility causes $F(\lambda)$ to shift downward.

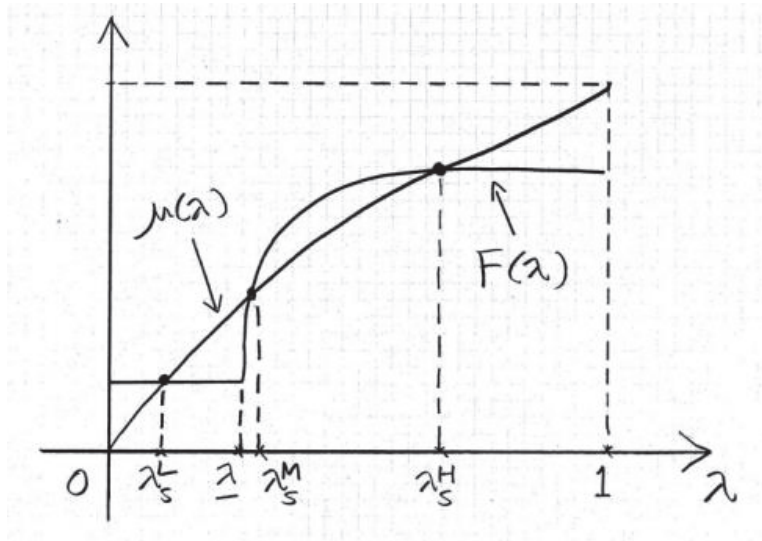
The following theorem 2 implies $\phi'(\lambda) \geq 0$ is a necessary condition for (3.11) to have multiple solutions.

Theorem 2. There is a unique steady state λ_s in case 1.

Proof; A steady state λ_s is a solution to (3.11). In case 1, $F'(\lambda) \leq 0$ for all $\lambda \in [0, 1]$. On the other hand, $\mu'(\lambda) > 0$ for all $\lambda \in [0, 1]$. Therefore, there cannot be more than one intersection between $\mu(\lambda)$ and $F(\lambda)$.

On the other hand, multiple steady states may emerge in case 3. Figure 3.6 shows one possible case in which there are three steady states λ_s

Figure 3.6

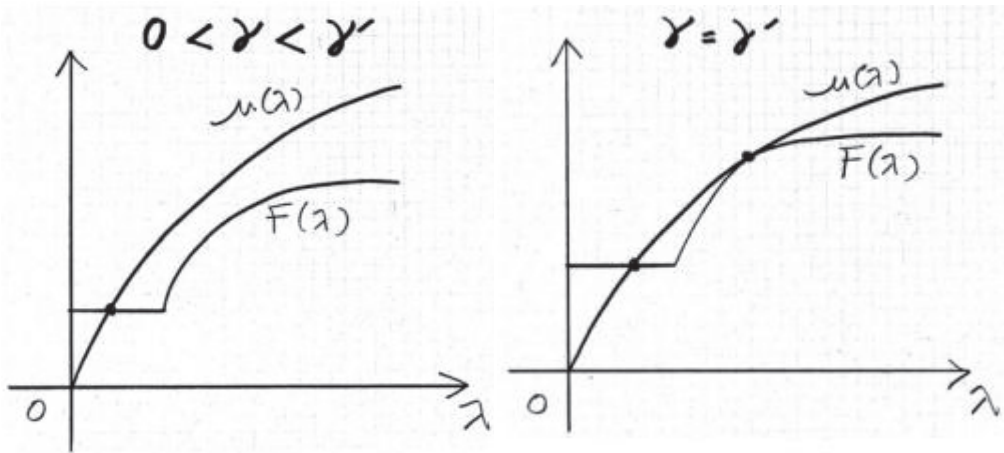


Five panels of figure 3.7 shows the effect of a change in parameter γ (importance of market consumption relative to home consumption in utility function) on the number of steady states λ_s . An increase in γ causes $F(\lambda)$ to shift upward. When γ is small, there is one steady state λ_s (panel 3.7.A). At the steady state, there is no growth in human capital ($\phi(\lambda_s) = 0$) because $\lambda_s < \underline{\lambda}$. As γ gets larger, three steady states $\{\lambda_s^L < \lambda_s^M < \lambda_s^H\}$ emerge (panel 3.7.C which is same as figure 3.6). The corresponding human capital growth rates are $0 = \phi(\lambda_s^L) < \phi(\lambda_s^M) < \phi(\lambda_s^H)$. As γ gets ever larger, the number of steady states is reduced back to one (panel 3.7.E). The human capital growth rate increases along with γ

Figure 3.7

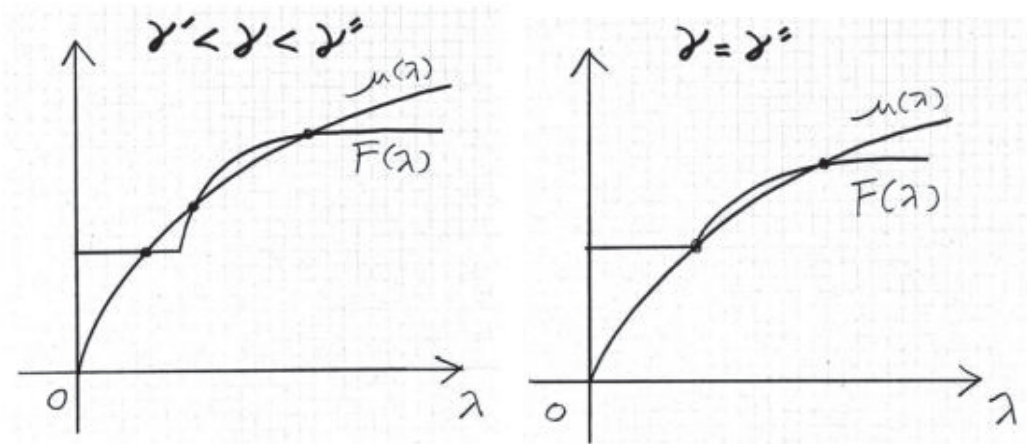
Panel 3.7.a

Panel 3.7.b



Panel 3.7.c

Panel 3.7.d



Panel 3.7.e

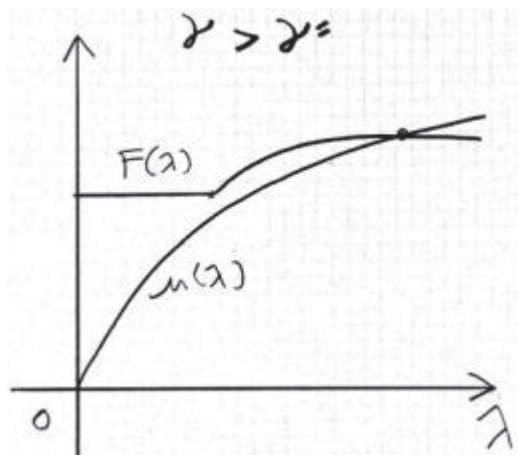
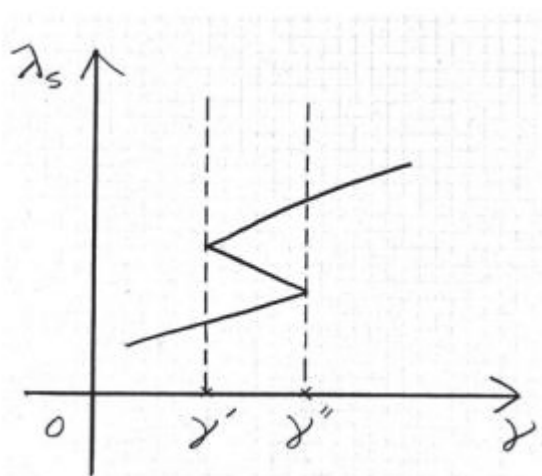


Figure 3.8 displays the relationship between γ and the number of steady states λ_s that are solutions to equation (3.11). As stated above, there are two critical values of γ , γ' and γ'' , such that for $\gamma \in [0, \gamma')$, (3.11) has a unique solution λ_s , at $\gamma = \gamma'$, (3.11) has two solutions, for $\gamma \in (\gamma', \gamma'')$, (3.11) has three solutions, at $\gamma = \gamma''$, (3.1) has two solutions, and for $\gamma \in (\gamma'', \infty)$, (3.11) has a unique solution.

Figure 3.8.



The following theorem 3 states that the number of steady states of the dynamical system $\{(3.7), (3.8)\}$ is same as the number of steady states λ_s .

Theorem 3. k_s is a monotone function of λ_s .

Proof ; It can be shown that

$$\frac{d \ln k}{d \mu} \begin{cases} < \\ = \\ > \end{cases} 0 \Leftrightarrow \alpha \begin{cases} > \\ = \\ < \end{cases} \beta \quad \text{and} \quad \mu'(\lambda) > 0 \text{ for all } \lambda \in [0, 1].$$

3.3.2 Welfare at Steady States

When there are multiple steady states, it is interesting to compare the welfare level of each steady state. At a steady state λ_s , the growth rate of human capital is

$$\dot{H}/H = \phi(\lambda) - \delta_H \tag{3.23}$$

The solution to this differential equation is

$$H(t) = H(0)\exp[(\phi(\lambda_s) - \delta_H)t]. \quad (3.24)$$

At the steady state, the lifetime utility W_s of representative agent is calculated as follows.

$$\begin{aligned} W_s &= \int_0^{\infty} [\gamma \ln(c_{m,s} H(t)) + (1-\gamma) \ln(c_{n,s} H(t))] e^{-\rho t} dt \\ &= (1/\rho)[\gamma \ln c_{m,s} + (1-\gamma) \ln c_{n,s}] + (1/\rho) \ln H(0) + (1/\rho^2)(\phi(\lambda_s) - \delta_H) \end{aligned} \quad (3.25)$$

The first term of the right-hand side of (3.25) is "level effect", the second term is initial human capital, and the third term is "growth effect". Suppose there are three steady states $\{\lambda_s^L < \lambda_s^M < \lambda_s^H\}$ as depicted by panel 3.7.C of figure 3.7. The corresponding human capital growth rates are $0 = \phi(\lambda_s^L) < \phi(\lambda_s^M) < \phi(\lambda_s^H)$. Although the "level effect" may be larger for the steady state with smaller λ_s , we expect the lifetime utility is larger for the steady state with larger λ_s because the time preference factor $\rho < 1$ implies that, while the level effect is discounted by $1/\rho$, the growth effect is discounted by $1/\rho^2$.

3.4 Structural Stability and Bifurcation

In this section, we analyze the local and global stability of the steady states, and explore the implication of the time allocation for the unified economic growth theory.

In general, when a dynamic system has multiple steady states, the local stability of each steady state alternates its property. In the following, attention is paid to the possibility that the equilibrium path is indeterminate. Given the initial value of the ratio of physical capital to human capital $k(0) = K(0)/H(0)$, the equilibrium path is said to be indeterminate if there are multiple $\mu(0)$ such that $\{k(t), \mu(t); t \geq 0\}$ satisfies the system of differential equations, (3.7) and (3.8), and the transversality condition (3.10). The local multiplicity of $\mu(0)$ at a steady state is uncountable if the dynamic system has a locally stable manifold of dimension two at the steady state. On the other hand, the multiplicity of $\mu(0)$ may be countable if the dynamic system has a stable manifold of

dimension zero and an "overlap" at one of the multiple steady states [c.f., Krugman (1991), Matsuyama (1991)]. For example, a steady state might have expanding spiral paths converging toward other steady states. In this case, for a given initial value of the ratio of physical capital to human capital $k(0)$ in some neighborhood of the steady state, there are countably many $\mu(0)$ such that $\{k(t), \mu(t); t \geq 0\}$ satisfies (3.7), (3.8), and the transversality condition (3.10).

3.4.1 Phase-diagram Analysis

The stability of each steady state is analyzed by phase-diagrams. The following theorem 4 will be used for the analysis.

Theorem 4. If $\phi(\lambda)$ is constant, then the dynamical system $\{(3.7), (3.8)\}$ has a unique steady state $\{k_s, \mu_s\}$ which is a globally stable saddle point.

Proof ; The assumption implies $\phi'(\lambda) = 0$. By theorem 2 and theorem 3, the dynamical system $\{(3.7), (3.8)\}$ has a unique steady state $\{k_s, \mu_s\}$. In $\{k, \mu\}$ plane where $k \in [0, \infty)$ and $\mu \in [0, 1]$, the graph of $\dot{k}/k = 0$ locus is described as follows.

By (3.7), $\dot{k}/k = 0$ implies

$$k = \frac{\lambda}{\mu} \left[\frac{A(1+M)\mu - M}{\delta_K + \phi(\lambda) - \delta_H} \right]^{1/\alpha}. \quad (3.26)$$

At $k=0$, $\mu = M/[A(1+M)]$. At $k = [\{A(1+M) - M\}/\{\delta_K + \phi(\lambda) - \delta_H\}]^{1/\alpha}$, $\mu = 1$. In the $\{k, \mu\}$ plane, it can be shown that $\dot{k}/k > 0$ above the $\dot{k}/k = 0$ locus (4.1), and $\dot{k}/k < 0$ below the $\dot{k}/k = 0$ locus. In addition, $\dot{k}/k = 0$ locus (3.26) is shown to be monotone in the $\{k, \mu\}$ plane. Similarly, by (3.8), $\dot{\mu}/\mu = 0$ locus is given by

$$k = \frac{\lambda}{\mu} \left[\frac{A(1+M)(1-\alpha)(1-\mu)}{\rho + \alpha\delta_K + \alpha\phi(\lambda) - \alpha\delta_H} \right]^{1/\alpha}. \quad (3.27)$$

When $\mu = 1$, $\lambda/\mu = 1$ and $k = 0$. When $\mu = 0$, $\lambda/\mu = a/b$ and

$$k = \frac{a}{b} \left[\frac{A(1+M)(1-\alpha)}{\rho + \alpha\delta_K + \alpha\phi(\lambda) - \alpha\delta_H} \right]^{1/\alpha}. \quad (3.28)$$

(3.27) also implies that μ and k have monotone relationship on the $\dot{\mu}/\mu = 0$ locus.

In addition, $\dot{\mu}/\mu > 0$ above the $\dot{\mu}/\mu = 0$ locus, and $\dot{\mu}/\mu < 0$ below the $\dot{\mu}/\mu = 0$ locus.

Based on these observations, phase-diagram analysis establishes the claim of the theorem.

In case 1 ($\phi'(\lambda) \leq 0$ for all $\lambda \in [0, 1]$), theorem 2 states that there is a unique steady state. By phase-diagram analysis like the one employed for the proof of theorem 4, this steady state $\{k_s, \mu_s\}$ is shown to be a globally stable saddle point.

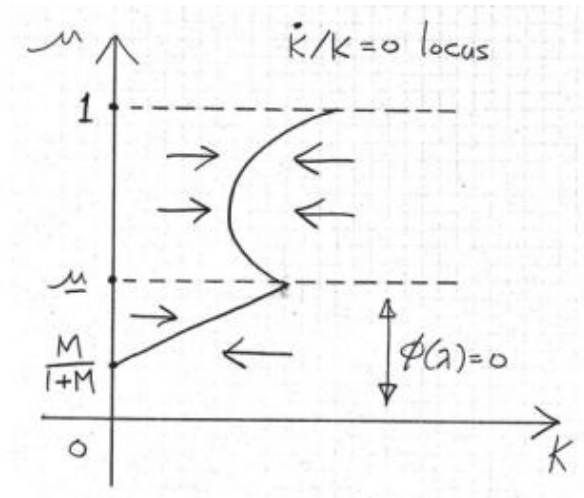
In the following, we conduct phase-diagram analysis so as to describe the properties of dynamical system $\{(3.7), (3.8)\}$ for case 3. In case 3, $\phi'(\lambda) > 0$ for $\lambda \in (\underline{\lambda}, 1]$, and $\phi(\lambda) = 0$ for $\lambda \in [0, \underline{\lambda}]$. The $\dot{k}/k = 0$ locus in $\{k, \mu\} \in \{[0, \infty), [0, 1]\}$ plane is constructed as follows. By (3.7), $\dot{k}/k = 0$ implies

$$A \left(\frac{\lambda}{\mu} \right)^\alpha [(1+M)\mu - M] = [\delta_K + \phi(\lambda) - \delta_H] k^\varepsilon. \quad (3.29)$$

In (3.29), $\lambda/\mu = a/[a\mu + b(1-\mu)]$, $a \equiv \alpha/(1-\alpha)$, $b \equiv \beta/(1-\beta)$, and $M \equiv [\gamma(1-\alpha)]/[(1-\gamma)(1-\beta)]$. (3.29) has the following properties; (i) the left-hand side is increasing in μ , (ii) $\phi(\lambda) \in [0, \phi^*]$, and (iii) $\lambda/\mu \in [a/b, 1]$ because $a\mu + b(1-\mu) \in [a, b]$. Therefore, when $\mu = M/(1+M)$, k must be zero. On the other hand, when k is large, μ must be large. Define $\underline{\mu} \equiv \mu(\underline{\lambda})$. Then, $\mu \in [0, \underline{\mu}]$ corresponds to $\lambda \in [0, \underline{\lambda}]$ and $\phi(\lambda) = 0$ in this region. In (3.29), an increase in μ causes the left-hand side to increase. Then, k must increase so as to equate the right-hand side and the left-hand side. For $\mu \in (\underline{\mu}, 1]$, such a monotone

relationship between μ and k may not be necessary for (3.29) to hold because an increase in μ causes not only an increase in λ but also an increase in $\phi(\lambda)$ in the right-hand side of (3.29). This non-monotonic relationship between μ and k may generate multiple steady states. Figure 3.9 depicts a possible graph of $\dot{k}/k = 0$ locus which displays non-monotonic relationship between μ and k .

Figure 3.9



It can be shown that $\dot{k}/k > 0$ on the left-hand side of $\dot{k}/k = 0$ locus in $\{k, \mu\}$ plane, while $\dot{k}/k < 0$ on the right-hand side of $\dot{k}/k = 0$ locus.

Similarly, the $\dot{\mu}/\mu = 0$ locus in $\{k, \mu\} \in \{[0, \infty), [0, 1]\}$ plane for case 3 is constructed as follows. By (3.8), $\dot{\mu}/\mu = 0$ implies

$$A \left(\frac{\lambda}{\mu} \right)^\alpha (1+M)(1-\alpha)(1-\mu) = [\rho + \alpha(\delta_K + \phi(\lambda) - \delta_H)] k^\alpha \quad (3.30)$$

(3.30) has the following properties; (i) the left-hand side is decreasing in μ , (ii) $\phi(\lambda) \in [0, \phi^*]$, and (iii) $\lambda/\mu \in [a/b, 1]$. Therefore, $\mu = 1$ when $k = 0$. On the other hand, when k is large, μ must be small. As before, define $\underline{\mu} \equiv \mu(\underline{\lambda})$. It can be shown that for both regions $\mu \in [0, \underline{\mu}]$ and $\mu \in (\underline{\mu}, 1]$, an increase in μ

must be associated with a decrease in k for (3.30) to hold. Figure 3.10 depicts a possible graph of $\dot{\mu}/\mu = 0$ locus. Notice in figure 3.10, for $\mu \in [0, \underline{\mu}]$, $\lambda \in [0, \underline{\lambda}]$ and $\phi(\lambda) = 0$. It can be shown that $\dot{\mu}/\mu > 0$ above the $\dot{\mu}/\mu = 0$ locus in $\{k, \mu\}$ plane, while $\dot{\mu}/\mu < 0$ below the $\dot{\mu}/\mu = 0$ locus.

Figure 3.10

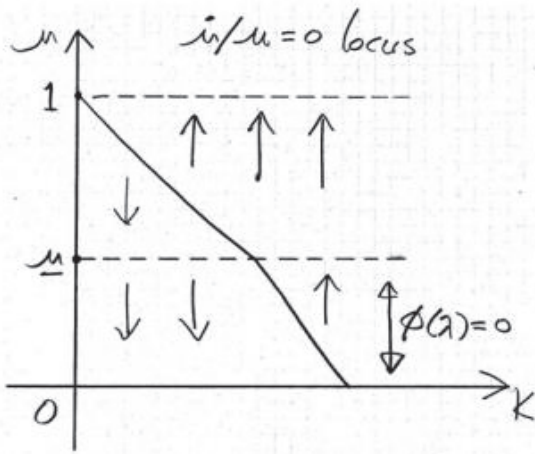
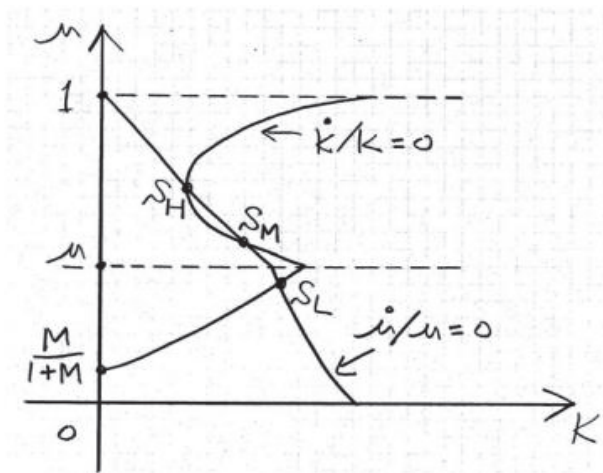


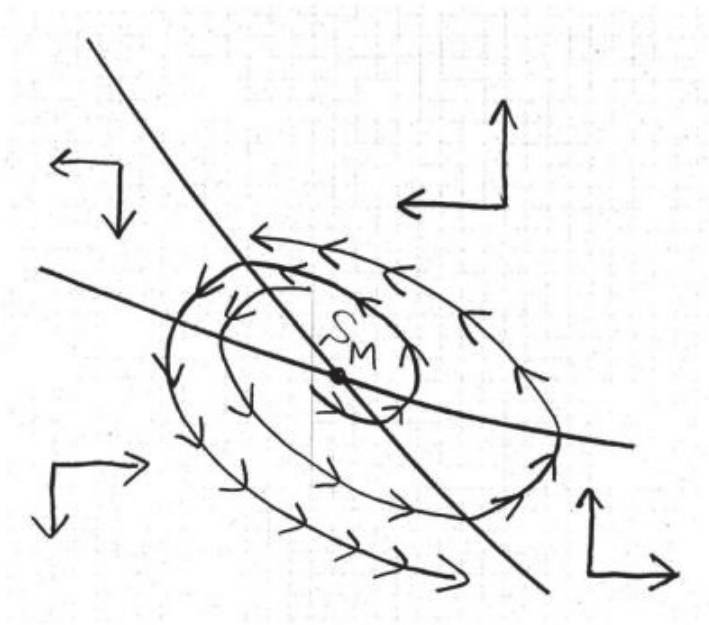
Figure 3.11 depicts a situation in which there are three steady states $\{S^H \equiv \{k_s^H, \mu_s^H\}\}$, $S^M \equiv \{k_s^M, \mu_s^M\}$, $S^L \equiv \{k_s^L, \mu_s^L\}$ in case 3 such that $k_s^H < k_s^M < k_s^L$ and $\mu_s^H > \mu_s^M > \mu_s^L$.

Figure 3.11



The corresponding time share of human capital employed by market sector, $\lambda_s^H > \lambda_s^M > \lambda_s^L$, implies $\phi(\lambda_s^H) > \phi(\lambda_s^M) > \phi(\lambda_s^L) = 0$ (because $\lambda_s^L < \underline{\lambda}$). The above analysis implies that $\{k_s^H, \mu_s^H\}$ and $\{k_s^L, \mu_s^L\}$ are saddle points. Depending on parameter values, the middle steady state $\{k_s^M, \mu_s^M\}$ might be either a source or a sink with limit cycle. Figure 3.12 depicts two possible trajectories of $\{k(t), \mu(t)\}$ satisfying the dynamical system $\{(3.7), (3.8)\}$. There are two expanding spirals emanating from the middle steady state $\{k_s^M, \mu_s^M\}$ such that one is converging toward $\{k_s^H, \mu_s^H\}$ while the other is converging toward $\{k_s^L, \mu_s^L\}$.

Figure 3.12



Under the assumption that home technology is more labor intensive than the market technology, we saw it is necessary that market activity is more important for human capital accumulation than nonmarket activity for the steady state multiplicity. When market activity is more important for human capital accumulation than nonmarket activity, multiple steady states may emerge in dynamic general equilibrium. Some economies converge toward a higher growth steady state, while the others toward a lower growth

steady state. Furthermore, the divergence may depend on initial condition and self-fulfilling expectation. The intuitive reason behind these observations is explained as follows. Suppose up to some moment $t \in [-\infty, 0)$ the model economy is on a steady state where the ratio of physical capital to human capital k is constant, the resource allocation between two sectors $\{\mu, \lambda\}$ is optimal, and the aggregate variables grow at the rate of human capital accumulation $\dot{H}/H = \phi(\lambda) - \delta_H$. Suppose at moment $t = 0$, there is a shock that destroys physical capital while leaves human capital intact. The shock causes an upward jump in the share $\mu(0)$ of physical capital employed by market sector because market sector is more physical capital intensive than home sector. The shock also causes an upward jump in the time share $\lambda(0)$ of human capital employed by market sector so as to keep the temporal optimality condition with respect to sectoral resource allocation intact. If nonmarket activity is relatively more important for human capital accumulation than market activity ($\phi'(\lambda) \leq 0$, case 1), then the shock decreases the speed of human capital accumulation. As a result, the ratio of physical capital to human capital increases, and the process continues until the economy moves back to the same initial steady state. On the other hand, if market activity is relatively more important for human capital accumulation than nonmarket activity ($\phi'(\lambda) \geq 0$, case 3), then the shock increases the speed of human capital accumulation so that the ratio of physical capital to human capital decreases furthermore until the economy reaches another steady state, if any, where the ratio of physical capital to human capital is lower and the speed of human capital accumulation is faster than the initial steady state.

3.4.2. Implication of Time Allocation for the Unified Growth Theory

This model can shed light on the implication of time allocation between market activity and nonmarket activity for the two phases of economic growth ; (i) From stagnation to growth, and (ii) divergence between group of economies with high growth rate and those with low growth rate. In the following, we provide two scenarios which may be capable for explaining the two phases of economic growth.

Scenario 1. Consider an increase in preference parameter γ which measures the relative importance of market consumption C_m to home consumption C_n in utility function. Five panels {(3.7.A), (3.7.B), (3.7.C), (3.7.D), (3.7.E)} of figure 3.7 depict the appearance and disappearance of multiple steady state as follows.

(3.7.A) $0 < \gamma < \gamma'$. There is a unique steady state $\lambda_s < \underline{\lambda}$ where human capital growth rate is $\phi(\lambda_s) = 0$.

(3.7.B) $\gamma = \gamma'$. Second steady state appears.

(3.7.C) $\gamma' < \gamma < \gamma''$. There are three steady states $\lambda_s^H > \lambda_s^M > \lambda_s^L$.

(3.7.D) $\gamma = \gamma''$. There are two steady states.

(3.7.E) $\gamma > \gamma''$. There is a unique steady state where human capital growth rate is $\phi(\lambda_s) > 0$.

The five panels {(3.13.A), (3.13.B), (3.13.C), (3.13.D), (3.13.E)} of figure 3.13 depicts the phase-diagrams corresponding to the five panels of figure 3.7.

(3.13.A) $0 < \gamma < \gamma'$. There is a unique steady state $\{k_s, \mu_s\}$ which is a globally stable saddle point where human capital growth rate is $\phi(\lambda_s) = 0$ because $\lambda_s < \underline{\lambda}$.

(3.13.B) $\gamma = \gamma'$. There are two steady states. One is a globally stable saddle point without human capital growth, and the other is unstable.

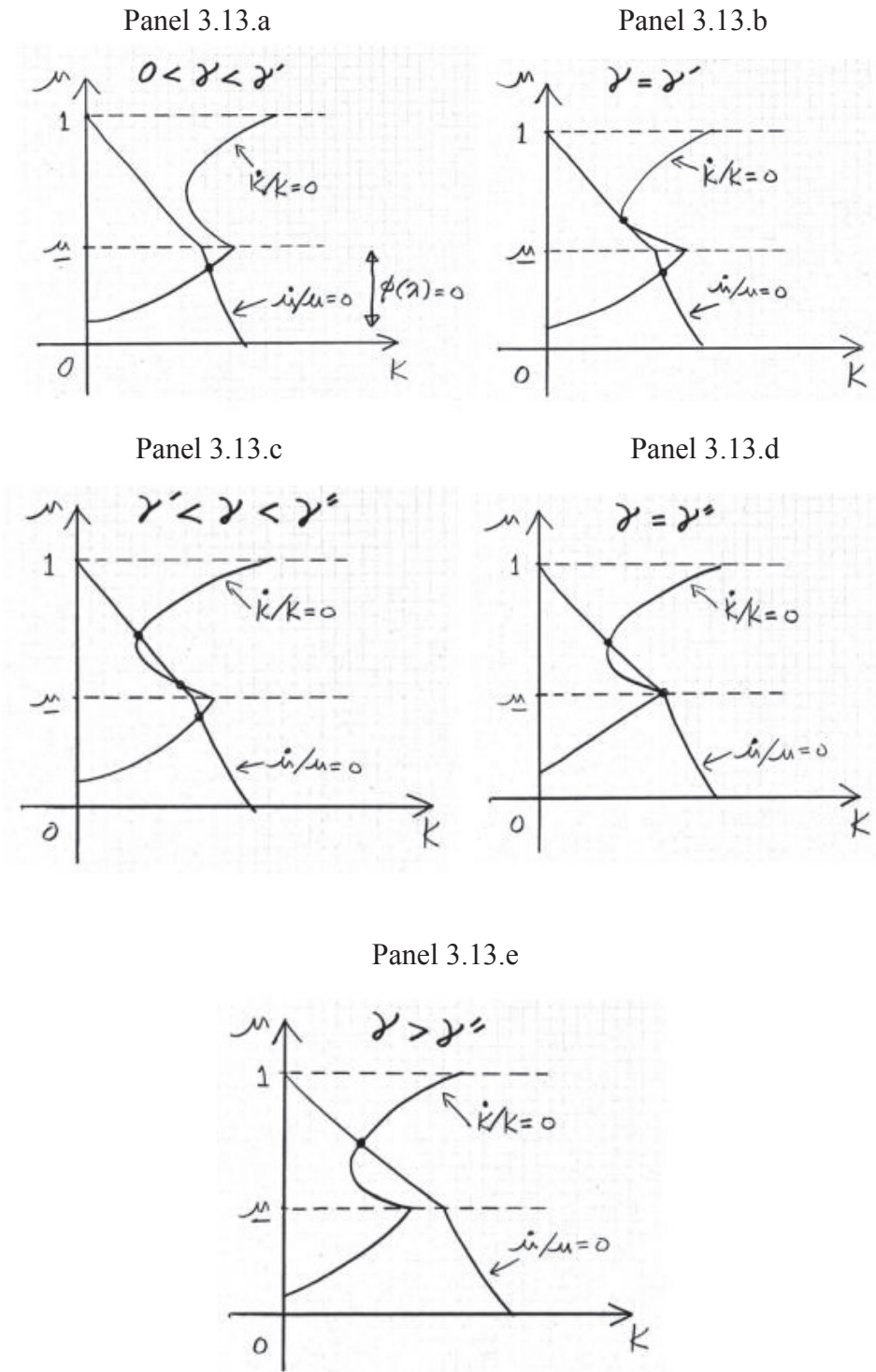
(3.13.C) $\gamma' < \gamma < \gamma''$. There are three steady states $\{k_s^H, \mu_s^H\}, \{k_s^M, \mu_s^M\}, \{k_s^L, \mu_s^L\}$. $\{k_s^H, \mu_s^H\}$ and $\{k_s^L, \mu_s^L\}$ are saddle points, while $\{k_s^M, \mu_s^M\}$ is either a source or a sink with limit cycle. The corresponding human capital growth rates are $\phi(\lambda_s^H) > \phi(\lambda_s^M) > \phi(\lambda_s^L) = 0$.

(3.13.D) $\gamma = \gamma''$. There are two steady states.

(3.13.E) $\gamma > \gamma''$. There is a unique steady state which is a saddle point with positive

human capital growth rate $\phi(\lambda_s) > 0$.

Figure 3.13



When $0 < \gamma \leq \gamma'$, the economy is in stagnant phase. It converges to a steady state with $\phi(\lambda_s) = 0$. When $\gamma' < \gamma < \gamma''$, the economy may converge to a steady state with

positive growth rate of human capital $\phi(\lambda_s^H) > 0$ or to a steady state with $\phi(\lambda_s^L) = 0$. The divergence may depend on the initial $k(0) = K(0)/H(0)$, or on the belief (self-fulfilling expectation). The latter happens if the DGE is indeterminate at the neighborhood of the middle steady state $\{k_s^M, \mu_s^M\}$. Given the initial $k(0)$, a DGE is indeterminate if there are multiple $\mu(0)$ satisfying the dynamical system $\{(3.7), (3.8)\}$. Given the initial $k(0)$, the economy may choose $\mu(0)$ on the DGE path converging to $\{k_s^H, \mu_s^H\}$, or $\mu(0)$ on the DGE path converging to $\{k_s^L, \mu_s^L\}$. When $\gamma > \gamma''$, the economy converges to a steady state with positive growth rate of human capital $\phi(\lambda_s) > 0$. (The development process described above may be caused by changes in values of any parameter $\{\rho, \delta_K, \delta_H, \alpha, \beta, \gamma\}$.)

Scenario 2. The two phases of development process may be caused by the change in relative importance of learning places. Theorem 2 predicts that if nonmarket activity is relatively more important for human capital accumulation than market activity, then economies with similar structure will converge toward a unique steady state (case 1). On the other hand, if market activity is relatively more important for human capital accumulation (case 3), then multiple steady states may emerge. Some economies may converge toward a steady state with higher growth rate, while the others may converge toward a steady state with lower growth rate. The divergence, as stated above, may depend on the initial $k(0) = K(0)/H(0)$, or on the belief.

In addition to the two scenarios presented above, we are able to provide many other scenarios which may explain the two phases of economic growth within our model's framework. Which one or some of the scenarios are appropriate for explaining the reality is a question to be explored through empirical analyses, but yet there is one testable implication of the model. When there are three steady states as depicted in figure 3.11, world economies in the long run will be divided into two groups. One group of economies converges to a steady state with higher rate of human capital accumulation and economic growth driven by larger time allocation to market activity, while the other group of

economies converges to a steady state without economic growth because of larger time allocation to nonmarket activity. Therefore, it may be interesting to explore if economies which allocate relatively more time to market activity than nonmarket activity indeed grow faster.

3.5 The Implications to China

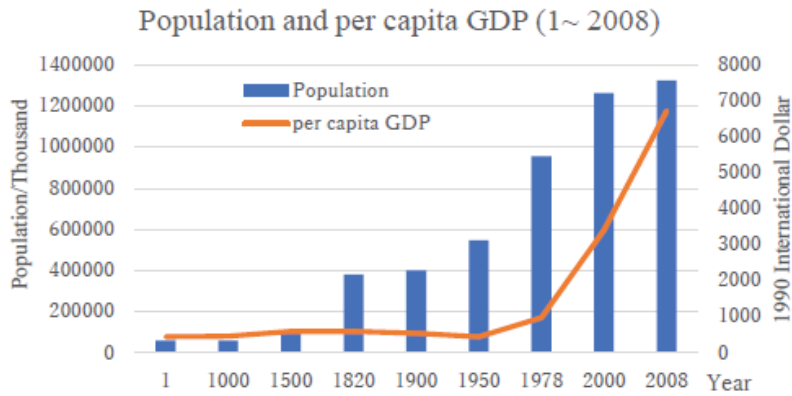
The unified growth theory divides the transition of economy from stagnation to modern growth into three phases: the Malthusian regime, the Post-Malthusian regime and the Modern Growth regime (Galor, 2011). During the Malthusian regime, the slow technological progress ensured a stable population as well as the income per capita. The interaction between population and technological generated faster technological, which triggered a growth of income per capita and population. The economy transferred into the Post-Malthusian regime from the industrialization and the acceleration in the rate of technological progress increased industrial demand for human capital, inducing a significant human capital investment, and thus a faster technological progress. The faster technological progress in turn raised the demand of human capital investment. During the same period, the preference of household gradually chose the quality of child instead of quantity, which induced a decline in population with low fertility and low mortality. The temporary increase of labor population proportion enhanced the labor productivity, thus triggered the growth of income per capita and sustained economic growth.

As the description of the unified growth theory, China has also experienced the stagnation with underpopulation and low living standard for several centuries. (See figure 3.14) Since the foundation of PRC, the GDP per capita and the population started to grow simultaneously. Especially from late 1970s, the reform and open has brought a growth miracle that the GDP per capita increased nearly 7-fold with huge population by 2008. During this period, the technological progress brought by advancing industrialization and foreign direct investment (FDI) created a massive demand of human capital investment³⁰.

³⁰Liu and Wang (2003) empirically studies the effect of FDI on TFP for a cross-sectional sample of Chinese industrial sectors. They find FDI inflow is not merely a source of capital, it is also a conduit for technology transfer.

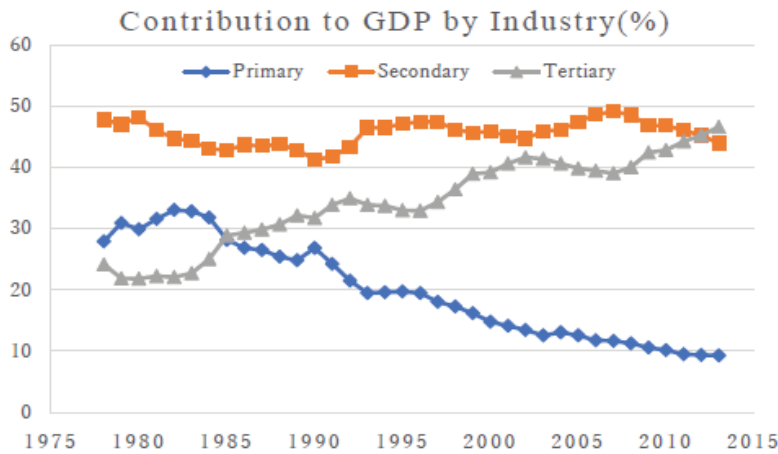
Fig 3.15 shows the trend of the industrial structure since 1978 to 2015, a continuous decline of the contribution to GDP of the primary sector accompanied by an increasing of that of the tertiary sector. Figure 3.16 shows the employment distribution among 3 sectors, which indicates an economic transition from rural to industrial.

Figure 3.14



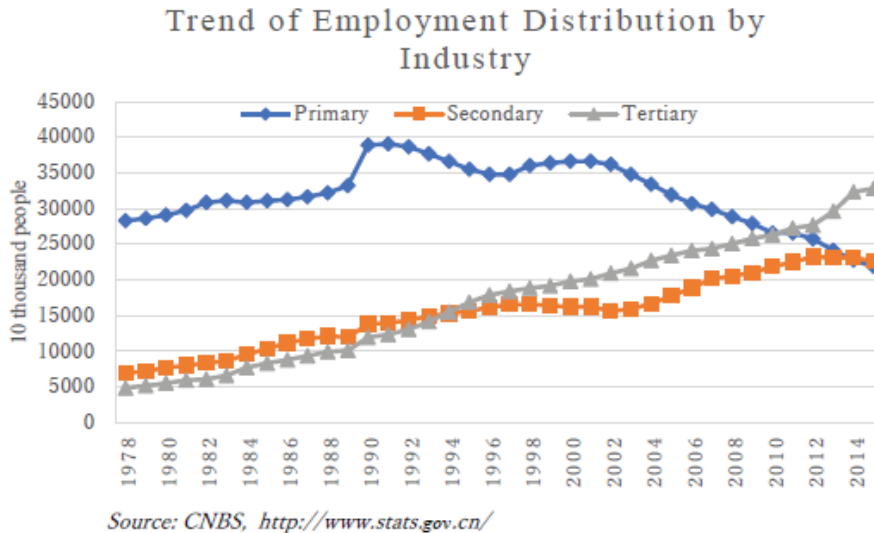
Data source: Maddison, A., *Statistics on world population, GDP and per capita GDP, 1~2008 AD*, University of Groningen, 2010.

Figure 3.15



Source: CNBS, <http://www.stats.gov.cn/>

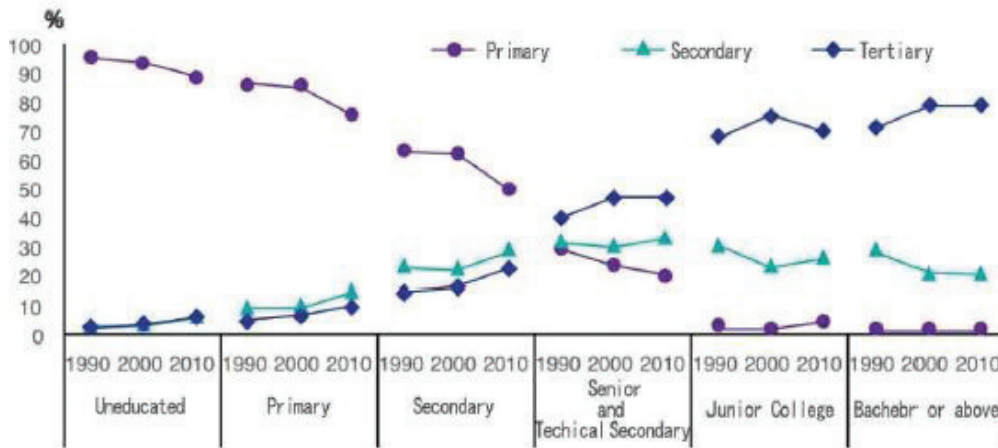
Figure 3.16



As consequences, the labor’s human capital in terms of schooling increased, figure3.17 indicates the education level of workers employed by each sector from 1990 to 2010. It shows that the workers employed by the tertiary sector are better educated and in the primary sector, the opposite is true. Additionally, with the implementation and popularity of the 9-year compulsory education, the educational attainment composition of China’s overall population has changed dramatically. By the end of 2010, the majority population has attended at least junior secondary school, and the proportion of higher educated people has doubled compared to that of 2000 (See figure 3.18). On the other hand, the population policy of China directly triggered a low fertility rate, which would force the household to shift their preference towards the quality of their offspring, thus increased the investment on human capital³¹.

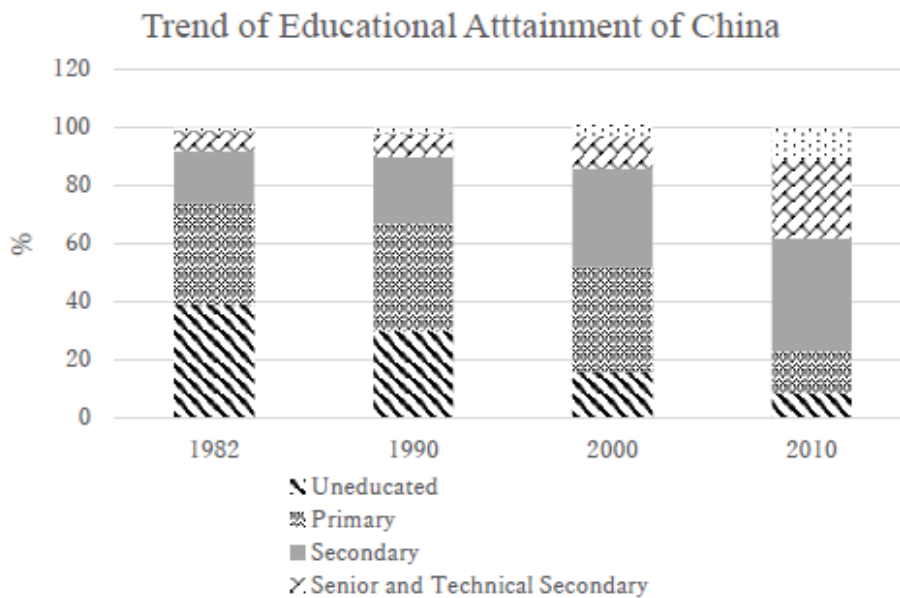
³¹ According to the World Bank’s database, the fertility rate of China decreased from 2.61 in 1982 to 1.57 in 2015. <https://data.worldbank.org/indicator/>

Figure 3.17



Source: "Skills Shortages in the Chinese Labor Market" by JPMorgan, 2016.

Figure 3.18



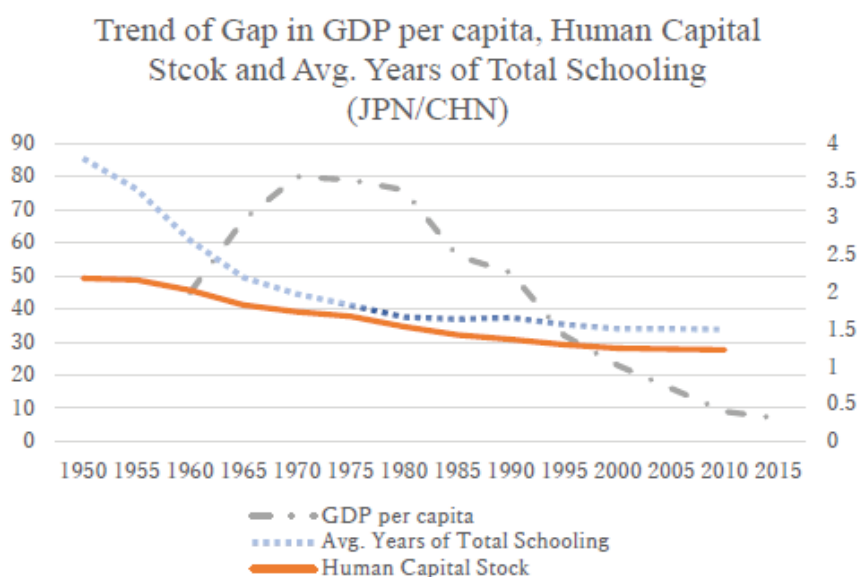
Source: CNBS, <http://www.stats.gov.cn/>

By contrast, the human capital also played a crucial role during the Japan's high-growth

era (1955-1973). Godo (2010) suggests that the Japanese success of catching-up to advanced economies is due to the human capital capability of borrowing advanced foreign technology, which in turn triggered the increasing investment on formal education. Additionally, he attributes the poor performance of Japanese economy after 1980s to the failure of insufficient investment on high-level education which can create innovational idea to maintain the competitiveness respect to other advanced economies.

The different phases of economic development between Japan and China, to some extent, could also be interpreted by the unified growth theory which points out that the differences in the timing of take-off from stagnation to growth contributed to the divergence in income per capita between countries. Although there is still huge gap of the per capita GDP between Japan and China, the gap is narrowing as well as the human capital stock (See figure 3.19).

Figure 3.19



Source: Calculated by The World Bank, <https://data.worldbank.org/> and Barro and Lee, (2013)

Another different worth noting comes from the household: in recent years, the time allocation between home and market in China has changed significantly, whereas that in Japan is not obvious. During 1996-2011, the ratio of time spent in home production and

that in market work of Japan stabilized around 33% (See table 3.1). In China, Wang (2014) shows that the weekly average ratio of hours spent in home production and market work has fallen from 50% to 35% during 2004-2009.

Table 3.1

Weekly Hours Allocation between Home Work and Market Work of Japan			
	Hours Spending at Market Work	Hours Spending at Home Work	Hours Spending home/market (%)
1996	43.35	14.14	32.60%
2001	41.53	14.35	34.60%
2006	43.03	14.56	33.80%
2011	42.14	15.1	35.80%

Source: Calculated by the "Family Income and Expenditure Survey", MIC of Japan.

It seems that these features embodied during the economic development of China and Japan could be partially interpreted by our preceding model. Under the assumption that the home production is more labor intensive than the market work, relatively more time spent in market generated more faster growth for China. However, since there is no direct evidence to show that home (or market) is the relative important place for human capital accumulation, for predicting the future of economic growth for China, it should be further studied.

3.6 Conclusion

In this chapter, we provided a framework which combines the theory of time allocation and the unified economic growth theory, and showed that the relative importance of learning places (home or market) matters for the process of economic development. Under the assumption that home technology is more labor intensive than the market

technology, when market activity is more important for human capital accumulation than home activity, then multiple steady states may emerge in dynamic general equilibrium. Some economies converge toward a higher growth steady state, while the others toward a lower growth steady state. Furthermore, the divergence may depend on initial condition and self-fulfilling expectation. This result may help to explain the convergence of economic growth between China and the advanced economies.

References

- [1] Aguiar, M., and E. Hurst, (2016), "The Macroeconomics of Time Allocation", in Taylor, J. B. and H. Uhlig, eds, *Handbook of Macroeconomics*, North-Holland, pp. 203-253.
- [2] Aoki, M. (1984) *The Co-operative Game Theory of the Firm*, Oxford University Press.
- [3] Arrow, K. J. (1962) "The Economic Implications of Learning-by-Doing", *Review of Economic Studies* 29, 155-173.
- [4] Barro, Robert and Jong-Wha Lee, (2013), "A New Data Set of Educational Attainment in the World, 1950-2010." *Journal of Development Economics*, vol.104, pp.184-198.
- [5] Benhabib, J., and R. E. A. Farmer (1994) "Indeterminacy and Increasing Returns", *Journal of Economic Theory* 63, 19-41.
- [6] Benhabib, J., and R. E. A. Farmer (1999) "Indeterminacy and Sunspots in Macroeconomics", in Taylor, J. B. and M. Woodford eds., *Handbook of Macroeconomics*, Vol.1, 387-448.
- [7] Benhabib, J., and K. Nishimura (1979) "The Hopf Bifurcation and Stability of Closed Orbits in Multisector Models of Optimal Economic Growth", *Journal of Economic Theory* 21, 421-444.
- [8] Benhabib, J., and K. Nishimura (1998) "Indeterminacy and Sunspots with Constant Returns", *Journal of Economic Theory* 81, 58-96.

- [9]Benhabib, J., R. Rogerson, and R. Wright, (1991), "Homework in Macroeconomics: Household Production and Aggregate Fluctuations", *Journal of Political Economy* 99, 1166-1187.
- [10]Boldrin, M., and A. Rustichini (1994) "Growth and Indeterminacy in Dynamic Models with Externalities", *Econometrica* 62, 323-342.
- [11]Bond, E. W., P. Wang, and C. K. Yip (1996) "A General Two-Sector Model of Endogenous Growth with Human and Physical Capital: Balanced Growth and Transition Dynamics", *Journal of Economic Theory* 68, 149-173.
- [12]Chamley, C. (1993) "Externalities and Dynamics in Models of Learning or Doing", *International Economic Review* 34, 583-609.
- [13]Dechert, W. D., and K. Nishimura (1983), "A Complete Characterization of Optimal Growth Path in an Aggregate Model with a Non-Concave Production Function", *Journal of Economic Theory* 31, 322-354.
- [14]Doepke, M., and M. Tertilt, (2016), "Families in Macroeconomics", in Taylor, J. B. and H. Uhlig, eds, *Handbook of Macroeconomics*, North-Holland, pp. 1789-1891.
- [15]Ethier, W. J. (1982) "Decreasing Costs in International Trade and Frank Graham's Argument for Protection", *Econometrica* 50, 1243-1268.
- [16]Farmer, R. E. A., and J. T. Guo (1994), "Real Business Cycles and the Animal Spirits Hypothesis", *Journal of Economic Theory* 63, 42-72.
- [17]Futagami, K., and K. Mino (1995) "Public Capital and Patterns of Growth in the Presence of Threshold Externalities", *Journal of Economics* 61, 123-146.
- [18]Gali, J. (1994) "Monopolistic Competition, Business Cycles and the Composition of Aggregate Demand", *Journal of Economic Theory* 63, 73-96.
- [19]Galor, O., (2011), *Unified Growth Theory*, Princeton University Press.
- [20]Godo, Yoshihisa. "The human capital basis of the Japanese miracle: a historical perspective." *Community, market and state in development*. Palgrave Macmillan UK, 2010. 103-120.
- [21]Greenwood, J., and Z. Hercowitz (1991) "The Allocation of Capital and Time over the Business Cycle", *Journal of Political Economy* 99, 1188-1214.

- [22]Greenwood, J., R. Rogerson, and R. Wright (1995) "Household Production in Real Business Cycle Theory", in Cooley, T. F., ed., *Frontiers of Business Cycle Research*, Princeton University Press, 157-174.
- [23]Greiner, A., and W. Semmler (1996) "Multiple Steady States, Indeterminacy, and Cycles in a Basic Model of Endogenous Growth", *Journal of Economics* 63, 79-99.
- [24]Howitt, P., and P. P. McAfee (1988) "Stability of Equilibria with Externalities", *Quarterly Journal of Economics* 103, 261-277.
- [25]Krugman, P. (1991) "History versus Expectations", *Quarterly Journal of Economics* 106, 651-667.
- [26]Ladron-De-Guevara, A., S. Ortigueira, and M. S. Santos (1999) "A Two-Sector Models of Endogenous Growth with Leisure", *Review of Economic Studies* 66, 609-631.
- [27]Liu, X., & Wang, C. (2003). Does foreign direct investment facilitate technological progress?: Evidence from Chinese industries. *Research policy*, 32(6), 945-953.
- [28]Lucas, R. E. (1988) "On the Mechanics of Economic Development", *Journal of Monetary Economics* 22, 3-42.
- [29]McGrattan, E. R., R. Rogerson, and R. Wright, (1997) "An Equilibrium Model of the Business Cycle with Household Production and Fiscal Policy", *International Economic Review* 38, 267-290.
- [30]Matsuyama, K. (1991) "Increasing Returns, Industrialization and Indeterminacy of Equilibrium", *Quarterly Journal of Economics* 106, 617-649.
- [31]Mino, K. (1999), "Preference Structure and Indeterminacy in Two-Sector Models of Endogenous Growth", mimeo, Kobe University.
- [32]Nishimura, K, and G. Sorger (1999), "Non-Linear Dynamics in the Infinite Time Horizon Model", *Journal of Economic Surveys* 13, 619-34.
- [33]Page, J., (1994) "The East Asian Miracle: Four Lessons for Development Policy", in NBER Macroeconomic Annual 1994.
- [34]Pelloni, A., and R. Waldman (1998), "Stability Properties of a Growth Model", *Economic Letters* 61, 55-60.
- [35]Perli, R. (1998), "Indeterminacy, Home Production and the Business Cycles: A Calibrated Analysis", *Journal of Monetary Economics* 41, 105-25.

[36]Schmitt-Grohe, S. (1997), "Comparing Four Models of Aggregate Fluctuations due to Self-Fulfilling Expectations", *Journal of Economic Theory* 72, 96-147.

[37]Skiba, A. K. (1978) "Optimal Growth with a Convex-Concave Production Function", *Econometrica* 46, 527-539.

[38]Spear, S. (1991) "Growth, Externalities and Sunspots", *Journal of Economic Theory* 45, 215-223.

[39]Uzawa, H. (1964) "Optimal Growth in a Two-Sector Model of Capital Accumulation", *Review of Economic Studies* 31, 1-24.

[40]Wang, Yabin. (2014). *Three essays on home production and the Chinese economy*. University of California, Santa Cruz,

[41]Wiggins, S. (1990) *Introduction to Applied Nonlinear Dynamical Systems and Chaos*, Springer-Verlag.

[42]Zhu, X. (2016). "Dynamics of central–local relations in China’s social welfare system". *Journal of Chinese Governance*, 1(2), 251-268.

Conclusion

This study has aimed at predicting the condition and environment of labor market, social security system and economic growth in China. First, we reviewed the labor market and social security system in China and concluded some primary topics. Then, we studied the problem of regional differences in Japanese long-term care insurance, and the reference for China was obtained. Additionally, we provided a theoretical framework to interpret the divergence in economic growth, and discussed the economic growth of China based on the theoretical results. We summarize the major characteristics of each chapter as follow:

In chapter 1, we surveyed the labor market and social security system of China. we concluded the skill gap due to the change of industrial structure generates labor shortage and unemployment co-existence in Chinese labor market; population aging and mobility barriers created by institutional factors lead to potential negative effects on economic growth; We suggested that increasing public expenditure on education and skill training as well as relaxing the family plan and regulation on labor mobility could generate positive effect on economic growth and social welfare.

In chapter 2, we studied the regional differences in the user rate of Japanese LTCI system for providing guideline for establishment of China's LCTI system. By employing the Markov transition matrix to measure the degree of regions' mobility, we found the regional user rate of Japanese LTCI exhibited a conditional convergence according to the regional-specific factors, such as the degree of aging, the fiscal capacity and the evaluation standard, and the 2005 reform which has aimed to adjust those differences in user rates seemed to have little effect. We also calculated the China's regional differences in the degree of aging, fiscal capacity and income level. We found the differences of regional factors in China were more severe than those in Japan. Thus, we suggested that a scheme combined the nationally uniform plan which provides basic social security and the commercial security which can meet various demand seems to have effect on circumventing the issues of regional differences.

In Chapter 3, for predicting the future of economic growth of China, we provided theoretical framework and showed that the relative importance of learning places (home or market) matters for the process of economic development by employing the ideas of “unified growth theory” and “family and time allocation”. Under the assumption that home technology is more labor intensive than the market technology, when market activity is more important for human capital accumulation, then multiple steady states emerge in dynamic general equilibrium. Some economies converge toward a higher growth steady state, while the others toward a lower growth steady state. Furthermore, the divergence may depend on initial condition and self-fulfilling expectation. We also discussed the future of economic growth of China based on this model. We found that the development path of China is in accord with the unified growth theory, and the feature that less time allocated to home production accompanied with the rapid economic growth supports our theoretical results to some extent. Thus, a relative high-speed growth of China could be obtained if the market activities is more important for human capital accumulation.

We point out the limitations and prospect the further research as follow:

- I. In chapter 1, empirical study for investigating how the specific types of social security plan interacts the growth and growth determinants (saving, labor mobility, human capital investment and fertility) in China should be addressed.
- II. In chapter 2, we analyzed the regional differences among prefectures of Japan. The difference, however, may be wider and more prominent among less aggregated levels such as villages, towns, and cities. For example, in each prefecture, the behavior of covered individuals and insurers (municipalities) at countryside may be very different from that of urbane area. Therefore, it might be desirable to employ detailed case studies to supplement the approach employed in this research.
- III. The theoretical model of chapter 2 does not have detailed structure of the market for long-term care services. For a better understanding of the market, it is desirable to enrich the model by incorporating such elements as demand, supply, prices, taxes, and subsidies.
- IV. In Chapter 3, we do not have microeconomic foundation that explains the

determinant of relative importance of learning places. It may be related to the characteristics of production technologies at market and at home.

- V. Which one of the parameters $\{\rho, \delta_K, \delta_H, \alpha, \beta, \gamma\}$ is responsible for causing the appearance and disappearance of multiple steady states? Statistical data and real world observation are needed to answer this question. The question is also related to the following.
- VI. If the steady state multiplicity in our model economy arises under plausible and reasonable parameter values? It may be interesting to numerically calibrate our model economy to explore the issue. The parameter values specified in the calibrated real business cycle model analyses by Benhabib, Rogerson, and Wright (1991), Greenwood and Hercowitz (1991), Greenwood, Rogerson, and Wright (1995), and McGrattan, Rogerson, and Wright (1997) are valuable references.

Acknowledgement

Chapter 2 of the thesis was presented at the Japanese Economic Association 2015 Spring Meeting (Niigata University, May 24, 2015), and the 2nd Annual Workshop in Business and Economics by National ChengChi University and Hiroshima University (Taipei, December 25, 2015). [“The Dynamic Analyses of the Regional Differences in Japanese Public Long-Term Care Insurance System”, HE DU and HIROSHI FUTAMURA] I am grateful to the comments by Tomoya Sakagami, Yih-Chyi Chuang, and participants at the seminars. The earlier version of the research was presented at Kumamoto Gakuen University and Meiji Gakuin University.

Chapter 3 of the thesis was presented at the 3rd Annual Workshop in Business and Economics by National ChengChi University, Hiroshima University, and Tohoku University (Taipei, December 27, 2016), and the Japanese Economic Association 2017 Spring Meeting (Ritsumeikan University, Biwako-Kusatsu Campus, June 25, 2017) [“Home or Market; Relative Importance of Learning Places on the Process of Economic Development”, HE DU and HIROSHI FUTAMURA] I am grateful to the comments by Tomoya Sakagami, Yih-Chyi Chuang, and participants at the seminars. The earlier version of the research was presented at Kobe University and Yokohama National University.

Finally, I would like to express my deep gratitude to Hiroshi Futamura, Atsuhiko Taki, Takashi Senda, and Toshikazu Oosawa of Hiroshima University for the valuable comments and suggestions.