Chapter 7
Revitalization of the Economy of Northeast China

He Gao and Yoji Taniguchi

Abstract The economic stagnation in the Northeast China showed sharp contrast with the rapid economic growth of China as a whole. Revitalization of Northeast China is one of the important practices in regional development. Besides the long term influences of planned economy, the changes of population, especially aging and lower birth rates were also regarded as important factors. However, the decrease of the working-age population and total population are not necessarily to impact negatively on economic growth if labor productivity and capital stock increase. In addition, though Jilin province, Liaoning Province and Heilongjiang Province locate in the Northeast China and are the main parts of the old industrial base, there are still many differences from perspectives of aggregate demand and supply, and it is essential to consider the complementarities among these provinces when making strategic policies. So to revitalize the Northeast economies in the new era, making strategies and policies individually may not be the best method, building up the complementary relationship among the three provinces based on their characters and designing "hub-and-spoke" for different industries in detail are better choices. At the same time, the government should make decisions from demand-side perspective subject to demographic change, decarbonization and the trend of the fourth industrial revolution driven by cutting-edge technologies and digital transformation.

Keywords The Northeast economies · Aging and lower birth rate · Complementary relationship · Demand-side · Industrial transformation

H. Gao
School of International Economics and Trade, Jilin University of Finance and Economics, Changchun, China
e-mail: 305448634@qq.com

Y. Taniguchi (✉)
Faculty of Economics, Chuo University, Hachioji, Japan
e-mail: yojitan@tamacc.chuo-u.ac.jp

T. Ishikawa and D. Nakamura (eds.), *Industrial Location and Vitalization of Regional Economy*, https://doi.org/10.1007/978-981-19-8128-9_7

7.1 Introduction

China's economic growth rate has entered the era of slowing down in the early 2010s after continuous high levels for a long time. Even so, real GDP in 2021 was 43.4 times that in 1978, real GDP per capita was also 29.4 times of the same period, the relatively high growth rate has lasted until the 2020s.[1] Under such background, it is very obvious that the economies of three provinces in the Northeast China are relatively backward. Both from 2001 to 2021 and from 2011 to 2021, the average annual real economic growth rates of three provinces in the Northeast China all ranked at the bottom in 31 provinces, autonomous regions and municipalities of China, Jilin Province ranked 29th, Heilongjiang Province ranked 30th, Liaoning Province was the last, that is 31st. The percentage of total GDP of the three provinces to that of China decreased from 9.0 in 2002 to 4.9 in 2021.

At the same time, the proportion of total population of the three provinces also has decreased relatively, i.e., the percentage decreased from 8.4 in 2002 to 6.9 in 2021. The two decreasing trends occurred in every province of the three ones. Moreover, nominal GDP per capita has declined relatively very obviously. Taking the overall level of nominal GDP per capita of China as reference value 100, from 2002 to 2021, the value decreased from 136.8 to 80.3 in Liaoning Province, from 79.7 to 68.5 in Jilin Province, and from 89.5 to 58.4 in Heilongjiang Province.

The purpose of this paper is to analyze the background of relative stagnation of the economies of the three provinces in the Northeast China (hereinafter referred to as the Northeast economies) and explore the methods of vitalization. In Sect. 7.2, we discuss the relationship between the trend of Northeast economies and aging and lower birth rate. In Sect. 7.3, we examine the relationship between aging and lower birth rate and the economic growth. In Sect. 7.4, we summarize the economic characteristics of the three provinces as the basis of the 5th section. In Sect. 7.5, we illustrate the policy choices of vitalization in the near future according to the economic development strategies of the three provinces. The last section is the conclusion and problems which should be explored in the future.

7.2 Aging and Lower Birth Rates in China and the Northeast Economies

7.2.1 The Dynamics of Aging and Lower Birth Rate

According to the recent three national population censuses, China has been experiencing aging and lower birth rate. On the one hand, the percent of the population who are from 0 to 14 years old (young population) to the total population decreased from 22.9% in 2000 to 16.6% in 2010, but recovered to 18.0% in 2020. On the other

[1] The following data are based on National Bureau of Statistics of China, "Statistical Data".

hand, with the increasing total population, the percent of the population who are 65 and over 65 years old (aged population) increased sharply, from 7.1% in 2000, 8.9% in 2010 to 13.5% in 2020. As the result, the percent of the population who are from 15 to 64 years old (working-age population) increased from 70.0% in 2000 to 74.5% in 2010 at first and then decreased to 68.5% in 2020. The proportion trend of the population in working-age (working-age population, 15–64 years old) shows that China's economy is changing from demographic bonus to demographic onus.

While in the Northeast economies, there existed more rapid development of aging and lower birth rate. Not only the proportion of young population decreased, but also the proportion of aged population rose fast from 2000 to 2020. In general, the progress of lower birth rate slowed down but aging increased sharply. In the dynamics of working-age population, there is the same transformation from demographic bonus to demographic onus as the whole nation. The trends mentioned above are presented in all of the three provinces (Table 7.1).

To compare the average level of China as a whole with the level of the Northeast economies, we can summarize three points as follows. Firstly, the proportion of the young population in the Northeast three provinces was lower and with larger decrease range than the national average level. Especially, the national average level increased slightly during recent ten years, while still decreased in the Northeast three provinces. Secondly, the proportion of the aged population increased sharply with faster speed than that of national average level, especially from 2010 to 2020. Thirdly, the proportion of working-age population was higher than the national average level, but decreased from 2010 to 2020 together with that of the whole nation.

7.2.2 The Analysis of Aging and Lower Birthrate in Detail

There are many aspects in examining aging and lower birth rate. So we try to summarize the related indicators shown in Table 7.2. Because of deficiencies in the statistics of population in the Northeast three provinces, some data are not available. In order to facilitate comparison, we present the related data about the severe situation of aging and lower birth rate in Japan.

There are four indicators to measure lower birth rates. The first one is total fertility rate (TFR) less than the value of 2.08 which can maintain the number of total population. From this aspect, lower birth rate started from 1974 in Japan, and from 1992 in China. It is difficult to make sure the accurate starting year for the Northeast economies because of insufficient data, but it is certain that it appeared before 2000. The second one is the decrease in baby birth. In Japan it started before 1970s though there were 9 exceptions till now, while started from 2017 in China and is similar in the Northeast economies. In recent years, more people are concerned about the large lower birth rate in the Northeast economies than national average level. The third one is the absolute decrease of population who are aged from 0 to 14. Japan started from 1979 (except in 1981), while China started from 1997, but stopped from 2010. The fourth one is the proportion of the population who are aged from 0 to 14 declined,

Table 7.1 Age composition and its change in China: 2000, 2010 and 2020

Ages	Year	National Total	Northeast	Liaoning	Jilin	Heilongjiang
0–14 (%)	2000	22.9	18.4	17.7	18.9	18.9
	2010	16.6	11.7	11.4	11.9	12.0
	2020	18.0	11.0	11.1	10.3	10.3
15–64 (%)	2000	70.0	75.0	74.4	75.5	75.7
	2010	74.5	79.1	78.3	79.8	79.7
	2020	68.5	72.6	71.5	74.1	74.1
65 and over (%)	2000	7.1	6.6	7.9	5.6	5.4
	2010	8.9	9.1	10.3	8.3	8.3
	2020	13.5	16.4	17.4	15.6	15.6

Source National Bureau of Statistics of China, *China Population Census Yearbook*

that is the relative decrease of the young population. Japan started from 1975, China presented this trend from 1992 to 2011, and no obvious change after 2012.

There are also four indicators related to aging. The first one is the absolute increase of aged population (who are 65 and over 65 years old). Japan started before 1970, and China started from 1996. The second one is the increasing proportion of aged population (relative increase). Japan started before 1970, China also started from 1996. The third one is the increasing average age of total population, both Japan and China started before 1970. The fourth one is the increasing median age of total population. Japan started before 1970, China started from 1970.

We list three indicators related to working-age population, especially related to demographic onus. The first one is the absolute decrease of population who are aged from 15 to 64 (working-age population). Japan started from 1996 (two exceptions after that), and China started from 2014. The second one is the decreasing proportion of the working-age population (relative decrease). Japan started from 1993, and China started from 2011. The third one is the decrease of labor force. Japan presented it during 1999 to 2012, and then disappeared. And no such information is available in China.

Two indicators can express the reversal of lower birth rate and aging. The first one is the reversal of absolute numbers (or relative values, proportion in the total population) of the population who are aged from 0 to 14 and from 65 and over 65. It occurred from 1997 in Japan, no such phenomenon occurred in China as a whole, but has presented in the Northeast economies until 2018. The second one is the reversal of the numbers of birth and death. Japan started from 2007, the same situation presented in China as the first indicator, and the Northeast economies started from the second half of the 2010s.

The long effect of aging and lower birth rate is a decrease of total population. The change of total population can be divided into natural change (number of birth-number of death) and social change (inbound number-outbound number). The natural decrease occurred both in Japan and in the Northeast economies. So the decrease

Table 7.2 Indicators on declining birth rate and aging population

Indicators	Definitions	Japan	China	Liaoning	Jilin	Heilongjiang
Declining birth rate	Total fertility rate (TFR) < 2.08	1974	1992	before 2000	Before 2000	Before 2000
	Decrease of births	Before 1970 except 9 times	2017	2018	2017 except 2019	2009 except 2012, 2014, 2016
	Decrease of population aged 0–14 (absolute decrease)	1979 except 1981	1997–2010 except 2002	1992 but intermittent	NA	1992 except 1999, 2005
	Decrease of composition of population aged 0–14 (relative decrease)	1975	1992–2011	1992 but intermittent	Before 2000 but intermittent	1992 except 2005
Aging population	Increase of population aged 65 and over (absolute increase)	Before 1970	1996	At least 1991 except 1994, 1996, 2010	NA	1994 except 2010
	Increase of composition of population aged 65 and over (relative increase)	Before 1970	1996	At least 1991 except 1994, 1996, 2010	Before 2000 but intermittent	1994 except 2010
	Increase of average age	Before 1970	Before 1970	NA	NA	NA
	Increase of median age	before 1970	1970	NA	NA	NA
Declining working-age population	Decrease of population aged 15–64 (absolute decrease)	1996 except 2 times	2014	2012	NA	2011

(continued)

Table 7.2 (continued)

Indicators	Definitions	Japan	China	Liaoning	Jilin	Heilongjiang
	Decrease of composition of population aged 15–64 (relative decrease)	1993	2011	2011	2013	2011
	Decrease of the labor force population	1999–2012	NA	NA	NA	NA
Declining birth rate and aging population	Reversal of population aged 0–14, and population aged 65 and over	1997	No reversal	2012	2018	2016
	Reversal of births and deaths	2007	No reversal	2017 (2015)	2018 (2019)	2015 (2015)
Declining population	Decrease of total population	2011	No decrease	2017 (2012)	2012 (2011)	2011 (2011)
	Decrease of total households	No decrease	No decrease	No decrease	No decrease	No decrease

Note NA = not available

Source Statistical Bureau of Japan, "Population Estimates" and "Labor Force Survey"; National Institute of Population and Social Security Research (IPSS), "Population Statistics" and "Population & Household Projection"; National Bureau of Statistics of China, "Statistical Data," and *China Statistical Yearbook*; Each Province's Bureau of Statistics, *Statistical Yearbook*; Population Division of the United Nations, "World Population Prospects 2022."

of total population started from 2011 in Japan, and the Northeast economies also started from the 2010s. But China as a whole has not natural decrease, so there is no decrease of total population. In addition, neither Japan nor China presented decrease of family households related to the indicator of decrease of total population.

In general, the progress of aging and lower birth rate in the Northeast economies is faster than that of China as a whole, a decrease of total population also presented early because of natural decrease. Outflow of working population and graduates with higher academic degrees to other developed regions in China was generally regarded as one of the important reasons for the decrease of population in the Northeast economies. Anyway, the Northeast economies follow Japan in aging and lower birth rates and decrease of total population.

7.3 The Relationship of Population Growth and Economic Growth

7.3.1 Regional Situation

As the aging and lower birth rate, the absolute and relative decrease of working-age population and the decrease of total population are expected to bring negative effects for economic growth, but what is the fact?

Figure 7.1 shows the relationship of compound annual growth rate of population and compound annual growth rate of real GDP of 31 regions in China from 2002 to 2021. The regions with higher growth rate of population are not necessarily with higher economic growth rate, while the regions with median growth rate of population have higher economic growth rate. It is worth noting that some regions with negative growth rate of population have lower but not negative economic growth rate.

Figure 7.2 presents the relationship of compound annual growth rate of population and compound annual growth rate of real GDP per capita of 31 regions in China from 2002 to 2021. It shows that the regions with higher growth rate of population has lower growth rate of real GDP per capita. It is worth noting that there are relatively higher growth rate of real GDP per capita in the regions where with a negative growth rate of population.

To compare two figures shows that under the conditions of lower or negative growth rate of population, economic growth rate is not inevitably lower or negative, but the growth rate of real GDP per capita is relatively higher. So we should not conclude the negative effects of the decrease of total population on the macroeconomics (economic growth rate) and standard of living (real GDP per capita) from the current situation.

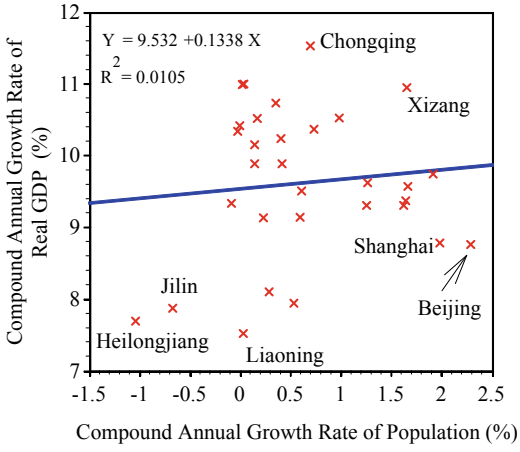

Fig. 7.1 Relationship between population growth and real GDP growth in China: 2002–2021 *Source* Our calculation is based on National Bureau of Statistics of China, "Statistical Data," and *China Statistical Yearbook 2021*

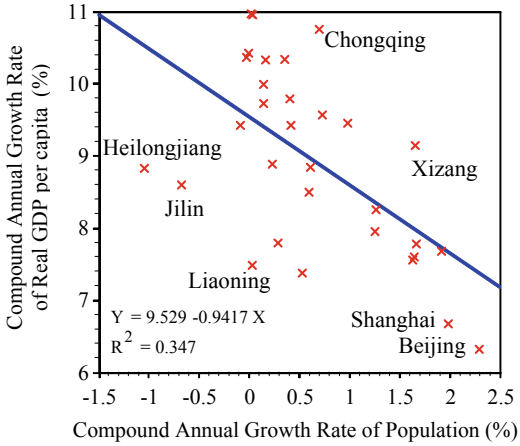

Fig. 7.2 Relationship between Population Growth and Real GDP Growth per capita in China: 2002–2021
Source Our calculation is based on National Bureau of Statistics of China, "Statistical Data," and *China Statistical Yearbook 2021*

7.3.2 Logical Illustration

In order to make clear the relationship of population growth and economic growth, we use simple formulas to deliberate as follows.

Firstly, let us analyze the formula (7.1).

$$\mathrm{Y} = \frac{Y}{Lw} \times Lw = \frac{Y}{Lw} \times \frac{Lw}{L} \times L \tag{7.1}$$

Here, Y = real GDP, L = population, Lw = working-age population, Y/Lw = labor productivity, Lw/L = ratio of working-age population. In order to simplify, suppose Lw = working population or number of workers.

As shown in Sect. 7.2, there are some differences between China as a whole and the Northeast economies. That is to say, though both of them have decreasing trends in Lw and Lw/L, the Northeast economies have a decreasing trend in L. So in the effects on Y, the Northeast economies have larger negative effects than that of national level. According to formula (7.1), whether the decrease of total population and working-age population has an effect on the decrease of Y or not, the change of labor productivity (=Y/Lw) is the key factor, that is.

If Y/Lw increase $\leq$ (Lw/L) *L decrease, then Y decrease. · · · negative (−) growth.

If Y/Lw increase $\geq$ (Lw/L) *L decrease, then Y increase. · · · positive (+) growth.

or

If Y/Lw increase $\leq$ Lw decrease, then Y decrease. · · · negative (−) growth.

If Y/Lw increase $\geq$ Lw decrease, then Y increase. · · · positive (+) growth.

Secondly, let's consider the changes of real GDP per capita (= Y/L).

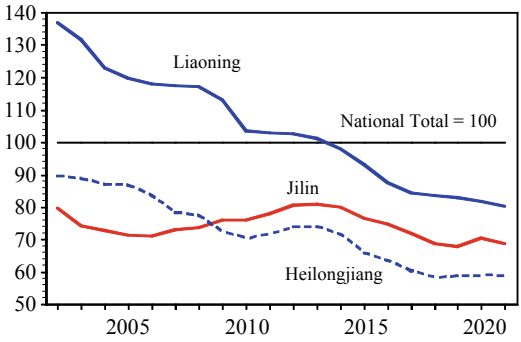

Fig. 7.3 Nominal GDP per capita: 2002–2021. *Source* National Bureau of Statistics of China, "Statistical Data"

$$\frac{Y}{L} = \frac{Y}{Lw} \times \frac{Lw}{L} = \frac{Y}{K} \times \frac{K}{Lw} \times \frac{Lw}{L} \tag{7.2}$$

Here, K = capital stock, Y/K = the reciprocal of capital-output ratio or capital coefficient, K/Lw = ratio of capital to labor.

If Y/Lw increase$\leqq$ Lw/L decrease, then Y/L decrease.

If Y/Lw increase$\geqq$ Lw/L decrease, then Y/L increase.

If (Y/K)*(K/Lw) increase$\leqq$ Lw/L decrease, then Y/L decrease.

If (Y/K)*(K/Lw) increase$\geqq$ Lw/L decrease, then Y/L increase.

So the key factors are the changes of Y/Lw, Y/K and K/Lw, especially the trends of labor productivity and capital stock, to examine the increase of real GDP per capita or standard of living.

Combining with Figs. 7.1 and 7.2, we can see that even if L, Lw and Lw/L decreased, Y and Y/L still increased based on the rises of K, Y/K and K/Lw. So the absolute and relative decrease of working-age population and the decrease of total population will not be necessary to reduce economic volume and economic growth, the increase in technologies enhancing labor productivity and capital stock will promote economic volume, economic growth and standard of living.

The real GDP and the real GDP per capita of the Northeast economies are increasing, but as shown in Fig. 7.3, the latter is decreasing relative to the national average level. Especially, Liaoning Province and Heilongjiang Province decreased with larger margins. It shows that it is necessary to make strategic policies to revitalize the Northeast Economies.

7.4 The Characters of the Northeast Economies

According to the analysis in Sect. 7.3, labor productivity, technological progress and capital stock are the key factors to the revitalization of the Northeast economies. It is essential to discuss the characters of the Northeast economies at first from demand-side and supply-side before putting forward the possible suggestions of revitalization.

Firstly, Fig. 7.4 shows the percentages of consumption and investment expenditures. From the first half of 2000s to the first half of 2010s, the consumption proportion of the Northeast three provinces experienced large decrease, after that Liaoning Province increased largely, Heilongjiang Province increased with median margin, and Jilin Province had no obvious change. And the capital stock proportion experienced large increase from the first half of 2000s to the first half of 2010s, then Liaoning Province decreased sharply, Heilongjiang Province decreased with median margin, and Jilin Province still had no obvious change. So these three provinces have different trends with the national average level.

Secondly, Fig. 7.5 shows the industrial structures of the Northeast economies and the whole nation according to GDP proportion. For the primary industry, the proportion of Heilongjiang Province rose as an exception with a popular decreasing trend. The proportions of the three provinces were all higher than the national level. For the secondary industry, Liaoning Province had the similar trend with the national level, Jilin Province was relatively stable, and Heilongjiang Province decreased sharply. For the tertiary industry, the proportions of all of the provinces increased together with the national level, though Heilongjiang Province started from lower level, all the proportions were over 50% in 2021.

From the advantages of industrial products and farm, livestock and aquatic products, in 2020, crude oil and cars accounted for over 20% of total products, and ethylene, motor vehicles and beer accounted for over 10% of the total. But for the Northeast economies, the shares of the main products including the above decreased in a long time.

In the main industrial products, the share of Liaoning Province was the largest but with a declining trend, the steel products (crude steel, rolled steel, pig iron), ethylene, metal-cutting machine tools and coke were advantageous. Accordingly, Jilin Province had advantages in motor vehicles and cars and Heilongjiang Province had advantages in crude oil and ethylene as part of industrial products. Table 7.3 shows in detail.

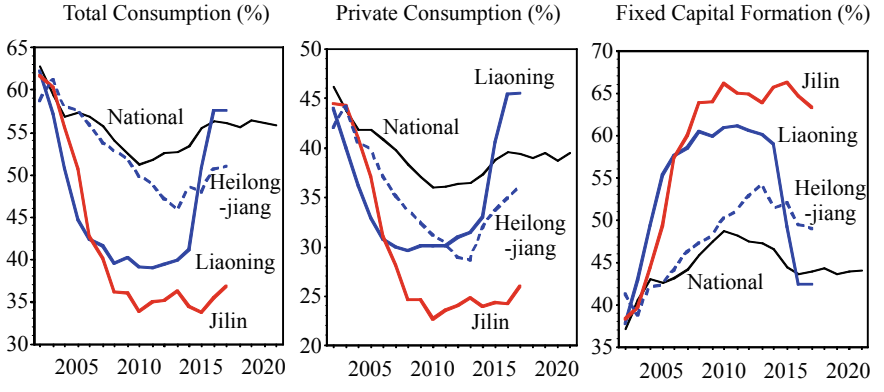

Fig. 7.4 Composition of GDP (Gross Domestic Expenditure): 2002–2021. *Note* Denominator = GDP—Trade Balance of Goods and Services. *Source* National Bureau of Statistics of China, "Statistical Data"

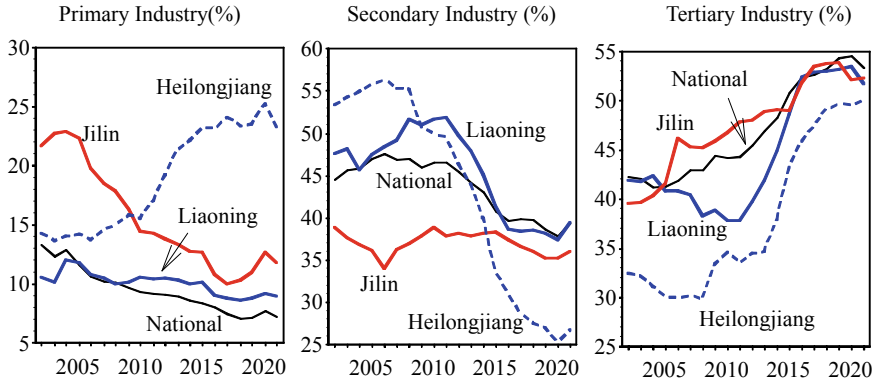

Fig. 7.5 Composition of GDP: 2002–2021. *Source* National Bureau of Statistics of China, "Statistical Data"

Table 7.3 The Northeast economies' share of main industrial products

Industrial products	Northeast economies' share (%)					2020 share (%)			2020 ranking		
	2002	2005	2010	2015	2020	Liao-ning	Jilin	Heilong-jiang	Liao-ning	Jilin	Heilong-jiang
Crude oil	41.1	34.9	27.9	25.8	22.9	5.4	2.1	15.4	7	10	2
Cars	22.6	13.2	16.3	19.8	20.4	4.0	15.6	0.8	8	3	17
Ethylene	26.1	20.4	16.1	18.2	18.6	8.5	4.0	6.1	5	11	8
Motor vehicles	24.5	17.0	14.2	13.3	13.7	3.0	10.5	0.3	14	2	22
Beer	16.6	15.4	12.9	12.5	10.9	5.0	2.1	3.8	8	16	10
Pig iron	13.0	10.8	11.5	10.8	10.7	8.1	1.6	1.0	4	18	22
Crude steel	13.0	10.7	11.0	9.4	9.5	7.1	1.4	0.9	4	19	24
Primary plastic	15.1	12.2	8.2	7.5	8.8	5.1	1.3	2.3	8	20	15
Coke	8.5	7.5	8.4	7.0	7.9	4.9	0.8	2.3	6	23	13
Rolled steel	12.8	10.5	9.1	7.6	7.6	5.7	1.3	0.7	4	21	25
Plate glass	9.7	7.0	3.6	2.5	6.6	4.9	1.3	0.4	7	20	27
Metal-cutting machine tools	10.8	23.5	20.0	13.2	6.4	6.3	0.0	0.1	6	–	24
Electricity	8.9	7.7	6.4	5.6	5.5	2.7	1.3	1.5	17	24	23
Cigarettes	4.7	4.7	4.6	5.0	5.0	1.1	2.2	1.6	23	19	21

Source National Bureau of Statistics of China, "Statistical Data"

As shown in Table 7.4, in the main farm, livestock and aquatic products, the shares of the Northeast economies were high, especially in Heilongjiang Province which had an increasing proportion in the primary industry. Cereal (rice and corn) and beans (soybean) were the top ones and cow milk and wool are also at the top of the list. Jilin Province had large shares in corn, soybean and beef, and Liaoning Province had relatively large shares in corn, poultry eggs and cashmere. The share of aquatic products was high in Liaoning Province which is the only province with coastal areas in the Northeast economies.

Above all, the Northeast three provinces have more differences than the commons in consumption and investment from demand-side, and the proportion changes of the primary industry and the second industry, industrial products and farm, livestock and aquatic products mentioned above. From this aspect, to discuss the countermeasures of revitalizing the Northeast economies in the same way is not correct, it is necessary to think about the complementary relationship from the differences among the three provinces.

7.5 The Strategy of Revitalizing the Northeast Economies

7.5.1 Structural Transformation of Chinese Economy and Change to the "New Normal"

The relative stagnation of the Northeast economies was recognized early, Chinese central government made the decision of revitalizing the Northeast China in 2003 after the large-scale development of western China from 2000. According to *Some opinions on Implementing the Revitalization Strategy of Old Industrial Bases in Northeast China* released in October 2003, the old industrial bases including the one in Northeast China ever made important contributions to reform and opening-up, and modernization, but existed some problems, such as lower-level marketization, high proportion of state-owned economy, slow adjustment of industrial structures and aging equipment and technology, imperfect social security and employment systems, recession of leading industries in resource-based cities, etc. So the Northeast economies should use abundant natural resources, enormous capital stock, good industrial basis, technological and educational advantages, a large number of technological talents and better fundamental conditions to transform traditional industrial bases, introduce advanced technologies and build new-style industrial bases with stronger competitiveness. And the government put forward some opinions including deepening the reform of state-owned enterprises, upgrading the secondary industry, modernization of agriculture, accelerating the development of the tertiary industry, promoting economic transformation of resource-oriented cities, strengthening the infrastructure, and enlarging internal and external opening up.

China's nominal GDP per capita in the first half of 2000s was less than USD 1000, and China was in the stage of increasing demand. In fact, China's economy realized

Table 7.4 The Northeast economies' share of farm, livestock and aquatic products

Farm, livestock and aquatic products	Northeast economies' share (%)					2020 share (%)			2020 ranking		
	2002	2005	2010	2015	2020	Liao -ning	Jilin	Heilong -jiang	Liao -ning	Jilin	Heilong -jiang
Grain	14.6	15.3	18.3	20.9	20.4	3.5	5.7	11.3	12	5	1
Cereals	14.0	14.8	18.1	21.1	20.4	3.7	6.0	10.7	12	5	2
Rice	9.7	11.1	16.6	17.8	18.9	2.1	3.1	13.7	15	10	1
Corn	28.6	28.6	30.2	34.4	32.3	6.9	11.4	14.0	7	2	1
Beans	38.0	40.6	41.1	37.9	45.0	1.1	3.2	40.7	21	7	1
Soybean	44.7	48.8	47.5	44.0	51.4	1.2	3.3	46.9	13	6	1
Meat	9.7	11.3	10.6	10.5	11.2	4.9	3.1	3.3	10	17	16
Pork	7.0	8.8	9.0	8.9	10.5	4.5	2.6	3.5	9	17	14
Beef	18.2	21.9	19.7	20.8	17.5	4.6	5.8	7.2	10	7	4
Cow milk	21.7	19.8	23.6	24.0	19.7	4.0	1.1	14.5	8	17	2
Sheep wool	15.7	14.3	16.1	13.8	10.7	1.8	2.6	6.4	11	7	4
Goat wool	4.9	8.1	13.9	10.4	12.0	7.0	1.6	3.4	7	14	10
Cashmere	5.2	12.3	12.9	7.7	8.5	7.9	0.2	0.4	4	15	14
Poultry eggs	14.5	17.5	17.2	15.9	16.5	9.6	3.5	3.4	4	9	11
Seawater aquatic Products	14.2	14.8	12.5	13.4	11.4	11.4	–	–	5	–	–

Source National Bureau of Statistics of China, "Statistical Data"

the real GDP growth rate over 10% driven by investment and industrial sectors in 2000s. The Northeast three provinces also realized about 10% (compound growth rate of nominal GDP was 13–17%) from 2003 to 2011. Four trillion yuan stimulus policy after Lehman Shock also promoted the economic growth.

However, the large-scale stimulus policies brought about overcapacity, excess real estate inventory and high debt leverage. The prices of real estate and stocks also rose many times, shadow banking emerged which represents increasing unsound and nontransparent financing activities. Then Chinese economic policies centered on eliminating excess, controlling prices of real estate and stocks and restraining shadow ranking, which are rebalancing policies related to structural transformation. This is the change from high growth rate in quantity to quality which is called the "New Normal".

Structural transformation and change to the "New Normal" led to the economic growth rate slowing down.[2] China's real economic growth rate was 9.6% in 2011, 7.7% in 2012, and 6.7% in 2016, and the annual average from 2020 to 2021 was 5.1% under the influence of Covid-19.

Among the three excess problems, overcapacity and excess production impact the Northeast economies directly. There are many fields related to overcapacity and excess production, such as steel, coal, cement, plate glass, electrolytic aluminum, chemicals, paper products, solar power, shipbuilding, coal thermal power, etc., some of them are manufactured by the state-owned enterprises in Liaoning Province and Heilongjiang Province.

From the perspective of main industrial products in Liaoning Province, drop in production of some products was very obvious from 2015 to 2018. Besides ferroalloy, rolled steel (2015–2016 drop in production, similarly hereinafter), coal (from 2012), cement (2014–2017), plate glass (2014–2015), chemical pesticides (2010–2016, except 2014), chemical medicines (2015–2018), agricultural chemical fertilizers (2013–2018), machine-made paper and paperboards (2011–2015), and metal-cutting machine tools (from 2012), spinning machines for cloth, yarns and raw silk (from 2015) also decreased sharply. Under such circumstances, the nominal value added of the secondary industry in Liaoning Province decreased by 14.5% from 2014 to 2016 as a period compared to the last three years.

Some main products also dropped in production in Heilongjiang Province. The overcapacity and excess production included pig iron, crude steel, rolled steel (2014–2016), cement (2014–2018, except 2016), plate glass (2011–2012), aluminous materials (2012), chemical pesticides (2011–2016, except 2013), proprietary Chinese medicine (2012–2017), agricultural chemical fertilizers (2013–2018, except 2015, 2016), paper products and paperboard (2011–2016, except 2013), machine tools (2012–2016), finished product sugar (2013–2016), special equipment for mine (2013–2017), railway passenger engines (2012–2016), mini-computers (2015–2017), large and medium tractors (2013–2017), small-sized tractors (2011–2016) also dropped sharply. Under such circumstances, the nominal value added of the

[2] The slowdown in growth was particularly noticeable in coal production areas and the Northeast China. See Taniguchi (2019).

secondary industry in Heilongjiang Province decreased by 32.4% from 2014 to 2017 as a period compared to the last four years.

As for Jilin Province, in terms of overcapacity and excess production, besides coke (especially 2015–2016), pig iron, crude steel, rolled steel (2015–2016), cement (2015–2018), plate glass (2015), paper products and paperboard (2012–2013), metal-cutting machine tools (2017–2018), caustic soda (2011–2016) also dropped sharply. However, the production of these goods were less than those of Liaoning Province, but motor vehicles which accounted for more than half of the sales (52% in 2020) of given scaled enterprises developed strongly until 2019, so the nominal value added in the secondary industry from 2015 to 2019 still increased by a small margin and presented increasing trend.

7.5.2 The Choices of Revitalizing the Northeast Economies

Some opinions on the Comprehensive Revitalization of Old Industrial Bases in Northeast China released in April 2016 showed that after implementing the strategy from 2003, the Northeast economies have got some results, but still existed some problems which should be settled, such as stagnation of marketization, lack of vigor for the state-owned enterprises, backward of private enterprises, slow fusion of technologies and economic development, unsuitable resource-oriented and heavy chemical industrial structures and traditional productive structures, city transformation facing difficulties, social security and livelihood pressure, etc. So this policy aimed to promote the Northeast China to become the base for advanced equipment manufacturing, strategic base for important technological equipment, national base for new raw materials, base for modern agriculture, R&D base for important technologies by means of new industrialization, computerization, urbanization and modernization of agriculture.

According to the comprehensive strategy of revitalizing the Northeast China, the three provinces made and released individually some strategies and policies in detail. For example, Jilin Province released the 14th Five-Year Plan, which emphasized the upgrading industries, strengthening industrial cooperation and enhancing modern agricultural manufacturing. By 2025, the goal is to realize an increase of labor productivity to over 6.5%, and the proportion of value added of core industries in digital economy to the regional GDP reaching 10%, and so on. To realize these goals, Jilin Province will develop the new energy vehicles, digitalization of manufacturing industry, electronic information industry, metallurgical and building materials industries, and at the same time, promote the digital technologies to be used in the ice and snow economy, the deep fusion of digital technologies and manufacturing, fusion of digital technologies and the substantial economy, and take AI technology as the new engine for regional economic development.

These ambitious goals are based on national digital strategies, such as the "Made in China 2025" plan from 2015 and AI development strategy and Internet Plus, and so on, which will be beneficial to promote the fourth industrial revolution through

actively introducing advanced technologies. In this sense, though no doubts about these strategies and goals, we still have some other viewpoints about realizing them successfully.

Firstly, pay much attention to the differences among the three provinces as shown in section four, they should consider cooperation with each other according to the complementarities but not make their own similar strategies separately. So, the three provinces should try to build up the "hub-and-spoke" relationship.[3]

For instance, it is well known that Jilin Province has the stronger comparative advantage in manufacturing automobiles and thus can be set to be the hub of new energy vehicles, and other two provinces can be the spokes to undertake manufacturing parts and R&D. The same mode also goes for the industrial robots face to automobile industry.[4] Considering that the annual production of vehicles all over the world is 90 million, and most of them will be changed into electric vehicles and new energy vehicles, Jilin Province has no doubt to play a more important role as a hub of manufacturing new energy vehicles.

As a province with advantages in heavy industrial products, such as ironwork (including crude steel, rolled steel and pig iron), ethylene, machine tools, coke, etc., Liaoning Province should consider the long term decline of market share and the population dynamics (increase of aging and decrease of working-age population) and promote the development of IoT (Internet of things) and smart factory. Smart factory is the advanced factory that uses cutting-edge technologies including AI, Big data, cloud computing, Robotics, 3D printer, etc. and put the censor, actuator and embedded system into equipment, devices or terminals, which are taken as the CPS (cyber physical systems) interconnecting in the global network to drive. Liaoning Province can play the role of the hub of smart factory.

Heilongjiang Province that exists decreasing proportion of the secondary industry and increasing proportion of the primary industry should use the cutting-edge technologies, such as AI, Big data, cloud computing, Robotics, 3D printer, etc. to modernize agriculture on the one hand, on the other hand, use the experiences of resource-oriented manufacturing to promote the development of greening industries

[3] Our recommendations here are in line with the idea of place-based policies that have been attracting attentions in the United States in recent years. In general, place-based policies aim to expand employment opportunities and raise wages, targeting generally stagnant areas (see Neumark and Simpson, 2015). Our arguments are close to the following positions recommended by the Biden Administration's Council of Economic Advisers. That is to say, "a third common recommendation for successful place-based policies is to avoid one-size-fits-all solutions. Place-based policies can be designed so that the same measure will be applied to any eligible region; or, at the cost of additional complexity, measures can be differentiated to accommodate local conditions and the relative strengths, needs, and existing assets of individual communities." (The White House 2022, p.245).

[4] The automotive industry is the second largest customer of industrial robots after the electronics industry. The world robot installations in 2020 was 383,545 units, among them, the automotive industry accounted for 21% (79,848 units). China was the largest customer of industrial robots and accounted for 44% (168,377 units), but Japan and German are still the main manufacturing bases. See the International Federation of Robotics, *Executive Summary WR 2021 Industrial Robots* (https://ifr.org/img/worldrobotics/Executive_Summary_WR_Industrial_Robots_2021.pdf).

which can contribute to decarbonization and the related environmental protection industries. So Heilongjiang Province can be the hub of agriculture and environmental protection.

In order to build up and realize the relationship of "hub-and-spoke", infrastructures, such as digital telecommunications network, traffic network and logistics network are essential for hub-and-spokes and different inter-spokes, so these are important preconditions for intra- and extra- Northeast economies.

Secondly, adopt demand-side perspectives to promote the strategies and policies. Considering from demand-side is the successful experience from some typical electronic enterprises, such as Amazon, Google and Facebook, etc., and the lesson from constructing electronic government in Japan.[5] But in Japan, the successful example is, as the decreasing proportion of heavy chemical industry, the transformation of industries from thick, heavy, long and large to slim, light, short and small based on customers' demand. At the same time, manufacturing and marketing transformed from large to small production and sales, and provided customized or personalized products and services. These measures are not occasional, but the presentation of higher living standards, which can be regarded as the phenomenon of the transformation from supply-side to demand-side.

Thirdly, new strategies should promote according to the social changes, requirements and restraints. The most important factors are the population dynamics including aging, decreasing working-age and total population, and the goals of decarbonization and carbon neutrality. In addition, the fourth industrial revolution driven by the cutting-edged technologies, AI, Big data, cloud computing, robotics, 3D printer and innovations are all essential. These elements are essential premises for demonstrating regional characteristics based on a "hub-and-spoke" relationship. Of course, we should promote them from demand-side perspective.

7.6 Concluding Remarks

From the analysis above, we can make conclusions as follows.

Firstly, the Northeast economies went faster in aging and lower birth rate, decreasing total population caused by natural decrease compared to China as a whole. This led to an absolute and relative decrease of the working-age population (Sect. 7.2).

Secondly, the decrease of the working-age population and total population are not necessarily to impact negatively on economic growth, it is possible to keep a positive growth rate. In addition, there is a negative relationship between the compound annual growth rate of total population and the compound annual growth rate of real GDP per capita. The reasons are the increase of labor productivity and capital stock (Sect. 7.3).

[5] On the current situation and challenges of Electronic Government in Japan, see Taniguchi and Gao (2020). A particularly serious flaw is the emphasis on the supply side and the incomplete view of the demand side.

Thirdly, though exist the findings above, the growth rate of real GDP per capita of the Northeast economies is declining relative to the national average level, especially for Liaoning province and Heilongjiang Province with large decreasing margins. This means it is essential to make strategic policies to revitalize the Northeast economies by considering the characters of the three provinces (Sect. 7.3).

Fourthly, there are many differences in the characters of the Northeast three provinces from demand and supply. In demand, the structures of consumption and investment are different. In supply, the trends of the primary industry and the secondary industry are very different. The main industrial products and farm, livestock and aquatic products are also different. From this aspect, it is essential to consider the complementarities among these provinces when making strategic policies (Sect. 7.4).

Fifthly, the central government of China recognized the stagnation of the Northeast economies and made the strategy of revitalizing the Northeast china in 2003. With the promoting route of enlarging necessary volume, the Northeast economies created high growth rate in 2000s. The stimulus policy as the countermeasure of Lehman Shock in 2008 also contributed to the growth of the Northeast economies but brought about overcapacity and excess production in heavy chemical industry from state-owned enterprises. In order to resolve these problems, it is essential to carry out industrial transformation and change to the "New Normal" (Sect. 7.5).

Besides the opinions from the central government of China in 2016, we also put forward some suggestions as follows: (1) the significance of building up the complementary relationship among the three provinces based on their characters and designing "hub-and-spoke" for different industries in detail. (2) demand-side perspective should be emphasized. (3) under the circumstance of the population dynamics and the global goal of decarbonization and carbon neutrality, it is essential to consider the fourth industrial revolution driven by cutting-edge technologies and digital transformation.

This paper discusses the revitalizing of the Northeast economies, but does not concern about several important aspects. The first one is the improvement in the quality of human resource by means of education and training. The second one is the openness policies of the Northeast economies, especially the role of foreign investment in introducing advanced technologies, but the introduction of foreign investment was backward in the Northeast economies.[6] The third one is the effects of fiscal policy. In China, central government can implement inter-governmental transfer expenditure in dealing with insufficient financial resources and realizing balanced financial resources.[7] In the financial budget in 2020, the proportion of the inter-governmental transfer expenditure in the GDP of the Northeast economies were very high, reaching 28.4% in Heilongjiang Province, 20.0% in Jilin Province

[6] On the external trade in the Northeast, see Zhu (2014).

[7] On the relationship of the revitalization strategy in the Northeast China and inter-governmental fiscal transfer payments, see Zhu, Li and Zhang (2015).

and 11.6% in Liaoning Province, these proportions were only 17.1, 16.8 and 8.9% respectively in 2010.[8] The effects of these financial supports on the revitalizing of the Northeast economies will be the research topic in the future.

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[8] See the Ministry of Finance of the People's Republic of China, "Transfer Payments in General Public Budget from Central Government to Local Governments by region" (http://yss.mof.gov.cn/2020zyjs/202106/t20210629_3727251.htm).