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Article

Scenario-based prediction of the transition period from demographic dividend to debt in China

Xianhong Qin

Hohai University, Nanjing 211100, Jiangsu Province, China; qinxh-1982@163.com

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Abstract: The demographic dividend is a research hotspot in demography and economics. Scholars agree that China is in a demographic dividend period with a shrinking opportunity window, but there is no consensus on its duration. This study takes the quantitative demographic dividend as the research object, selects the dependency ratio as the index, uses the 1957 Swedish life table as the demographic standard, analyzes the transformation trend of China's demographic structure. It shows that China has entered the demographic dividend period, which lasted until 2010, and then the total dependency ratio changed from decline to rise, because of the demographic aging. It predicts that China's demographic opportunity window will close around 2033, followed by a long-term demographic debt period. This study will help the Chinese government better understand the current crisis of demographic structure transformation and put forward more scientific solutions and policies.

Keywords: demographic dividend; demographic debt; demographic opportunity window; dependency ratio

1. Introduction

The demographic dividend is a phenomenon in which the productive population far exceeds the consuming population in the demographic structure, thus providing an additional boost to economic growth [1]. This concept was firstly proposed by Andrew Mason in 1997 when he studied the economic growth miracle of East Asian countries, and then the United Nations Population Fund formally used the concept of "demographic dividend" in the report World Population State 1998 [2]. At present, scholars agree that China has a demographic dividend and is in the demographic dividend period, but how long can it last? Chen [3] believes that China's demographic opportunity window has 40 years, of which 2010 is the year with the lowest population burden coefficient. Then the population burden coefficient will start to rise due to the accelerated aging rate, and it is expected that the demographic dividend will disappear around 2030. Fang [4] believes that China has been enjoying a demographic dividend since the 1960s, but around 2013–2015, China's demographic dividend will reach a turning point. After that, the accelerated aging of the population will turn the demographic dividend into a "demographic debt". Peng [5] believes that the demographic dividend will come to an end around 2025 and end even earlier in the urban and eastern coastal areas. Wang [6] believes that although China's demographic opportunity window has already crossed the peak, the demographic dividend is still at a high level overall and will be able to last until around 2050.

By combing the relevant literature in the past 20 years, it can be found that the theoretical construction and empirical research on the demographic dividend in China are being continuously improved. In terms of theoretical construction, scholars mainly

adopt the method of literature review to fully discuss the conceptual definition, mode of action and conditions for realizing the demographic dividend [7–15]. In terms of empirical research, scholars have explored the duration of China's demographic dividend by taking the indexing, and quantitative study of demographic dividend as the logic of analysis [3,16–19]. In general, although the theoretical research on the demographic dividend has become more and more perfect, the empirical research needs to be further explored: firstly, due to the different concepts, definitions and measurement methods of the demographic dividend by the researchers, the conclusions of the research on the period of China's demographic dividend are very inconsistent. Secondly, due to the adjustments of China's demographic policy, the preconditions used in the original research on the prediction of the demographic dividend period are no longer valid. Further forecasting studies are needed on the timing of the shift from a demographic dividend to a demographic debt in China.

Based on this, the paper intends to take the quantitative demographic dividend as the object of research based on the relationship between demographic dividend, demographic opportunity window and age structure of the population, choose the population dependency ratio as the measurement index, analyze the trend law of the demographic situation transformation in China. At the same time, use the United Nations PADIS-INT software to predict the time node of the transformation of the demographic dividend to the demographic debt.

2. Concept and methodological definition

2.1. Demographic dividend and demographic opportunity window

The demographic dividend refers to a shift in the age structure of the population that results in favorable socio-economic development, and the definition of the demographic dividend cannot be separated from the discussion of the demographic opportunity window.

2.1.1. Demographic opportunity window

The demographic opportunity window is a demographic concept that predates the demographic dividend. Generally speaking, the demographic opportunity window emerges with the transformation of the stage of demographic development. It emerges as a result of the change in the type of population reproduction from the "high birth rate, low death rate, high natural growth rate" pattern in the middle stage to the "low birth rate, low death rate, low natural growth rate" pattern in the late stage. In the process of changing the age structure of the population caused by the transformation of this growth pattern, because the decline of the birth rate occurs before the aging, and the proportion of the aged population grows slowly in the early stage of the decline of the birth rate, the structure of the population will maintain a state of "big in the middle and small at the ends" in a relatively long period of time. In other words, a state in which the labor force is abundant, and the total dependency ratio is relatively low. This special stage in the transition of the population reproduction mode is known as the demographic opportunity window [13]. At the level of specific operationalization, the definition of the population opportunity window relies on the division of the age structure of the population, and the current division method with a

high degree of acceptance is to take the age of 15 and 65 as the division node. We take the age of 0–14 as the juvenile group, the age of 15–64 as the adult group, and the age of 65 and above as the old-age group. In China's statistical caliber, the age structure of the population is usually portrayed in terms of the child dependency ratio as showed in Equation (1), the old-age dependency ratio as showed in Equation (2); and the total dependency ratio as showed in Equation (3).

$$P_{0-14}/P_{15-64} \times 100\% \quad (1)$$

$$P_{65+}/P_{15-64} \times 100\% \quad (2)$$

$$(P_{0-14} + P_{65+})/P_{15-64} \times 100\% \quad (3)$$

Here P_{0-14} is the number of people in the age group of 0–14, P_{65+} is the number of people in the age group of 65 years old and above, and P_{15-} is the number of people in the age group of 15–64 years old.

The dependency ratio is also known as the population burden coefficient, where the higher the dependency ratio, the heavier the burden on the population. Included here is the assumption that the population aged 0–15, 65 and above is purely consuming population, while only the population aged 15–64 is effectively productive and there is no difference between the labor forces. A higher dependency ratio means lower productivity per capita, and it is not surprising why many scholars use the demographic opportunity window to carve out a demographic dividend. Calculating the old-age dependency ratio on the basis of the population aged 65 and above, the demographic opportunity window is generally recognized internationally as being opened when the dependency ratio is below 50%, and closed when the dependency ratio exceeds 50% [20].

2.1.2. Demographic dividend

The demographic dividend, as an economic concept based on the "demographic opportunity window", is often confused with the "demographic opportunity window" in domestic research. In fact, demographic dividend is categorized into quantitative demographic dividend and qualitative demographic dividend. Quantitative demographic dividend means that with the transformation of population age structure or the opening of population opportunity window, a country's working-age population accounts for a larger proportion of the total population and the dependency ratio of the working population to the child and old-age population is relatively low, which creates favorable demographic conditions for the economic development. The qualitative demographic dividend refers to the "talent dividend" that results from the increasing abundance of human capital due to higher levels of education and quality of the population. Although the derivation of the qualitative demographic dividend has had an impact on the projection of the demographic dividend based on the demographic opportunity window, the demographic dividend is still judged on the basis of the additional economic benefits relative to the standard stable population. If a country has a more productive population than the standard stable population, i.e., is in a demographic opportunity window, the age structure of the population is certainly conducive to its economic growth. On the contrary, when the demographic opportunity

window closes, a long-term "demographic debt period" will be reached, because the decline in the proportion of productive population and the rise in the proportion of consumptive population will certainly constrain long-term economic growth. Therefore, this paper still adopts the quantitative demographic dividend as the research object to judge whether China is in the demographic dividend period at present and in the future.

2.2. Methodology for measuring the "demographic dividend period"

Although there is basically no controversy over the connotation and extension of the concept of demographic dividend, scholars have different views on the measurement method of the starting and ending points of the "demographic dividend period". The measurement method of the study will be defined around the following two aspects:

2.2.1. Dependency ratio

The use of the dependency ratio to measure the demographic dividend period is one of the most commonly used and simple methods. The dependency ratio can be expressed by dividing the purely consuming population by the effectively productive population. When a country's dependency ratio is decreasing, it means that a country's productive population is increasing relative to its consuming population, and a country's greater availability of labor resources makes its demographic dividend greater. The dependency ratio can be divided into theoretical dependency ratio and practical dependency ratio. The theoretical dependency ratio can be expressed by the ratio of the number of non-working age population to the number of working age population. Due to the difficulty of obtaining the practical dependency ratio data for most of the countries, the theoretical dependency ratio is generally used instead of the practical dependency ratio to measure the demographic dividend period. In practical calculations, the theoretical population dependency ratio can also be divided into the total dependency ratio, the child dependency ratio and the old-age dependency ratio, and the total dependency ratio can be expressed as the sum of the child dependency ratio and the old-age dependency ratio.

2.2.2. Demographic frame of reference

The dependency ratio only provides an analytical indicator for measuring the demographic dividend period, and an evaluation criterion for measuring the level of the dependency ratio is needed to determine whether a country is in the demographic dividend period. Obviously, the use of different criteria to classify the demographic dividend period will lead to different results, so it is very important to choose a standard demographic frame of reference. Chen [3] advocates choosing the 1957 Swedish life table as the demographic standard, mainly due to the following considerations: Firstly, the quality of vital statistics in Sweden is very high, and together with Japan, it is regarded as the two countries with the highest quality of vital statistics in the world. Secondly, there is no obvious gender preference in Sweden, so the mortality rate of the population in the country is a standardized one without "human interference". Thirdly, the life expectancy of the Swedish population in 1957 was 72.5 years (70.8 years for males and 74.3 years for females), which is slightly

higher than the current life expectancy of the world's population, and even closer to the current life expectancy of China. If we choose Sweden in 1957 as the standard demographic reference frame, the proportion of the population aged 0–14, 15–64, and 65 and above in the life table population at that time was 20.24%, 64.15%, and 15.61%. Respectively, the total dependency ratio at that time could be further calculated to be 55.88%, 31.55%, and 24.33%, which can be used as a criterion to distinguish between the demographic dividend period and the demographic debt period in China.

3. Analysis of overall trends in China's population growth and structural transformation

The data used in this paper comes from the China Statistical Yearbook and the China Population and Employment Statistics Yearbook of previous years, but because of the change in the statistical caliber of the census, it is decided to use the adjusted data in **Table 1** for analysis for the sake of consistency with the later article.

Table 1. Changes in China's population structure over the years.

Year	Proportion of population by age group (%)			Dependency ratio (%)		
	0-14 years	15-64 years	65 and over	Total	Child	Old-age
1953	36.28	59.31	4.41	68.61	61.17	7.44
1964	40.69	55.75	3.56	79.37	72.99	6.39
1982	33.59	61.50	4.91	62.60	54.62	7.98
1987	28.68	65.86	5.40	51.84	43.55	8.29
1990	27.69	66.74	5.57	49.84	41.49	8.35
1995	26.60	67.20	6.20	48.81	39.58	9.23
1996	26.40	67.20	6.40	48.81	39.29	9.52
1997	25.96	67.50	6.54	48.15	38.46	9.69
1998	25.70	67.60	6.70	47.93	38.02	9.91
1999	25.40	67.70	6.90	47.72	37.52	10.20
2000	22.89	70.10	6.96	42.56	32.64	9.92
2001	22.50	70.40	7.10	42.05	31.96	10.09
2002	22.40	70.30	7.30	42.25	31.86	10.38
2003	22.10	70.40	7.50	42.05	31.39	10.65
2004	21.50	70.90	7.60	41.01	30.32	10.69
2005	20.30	72.00	7.70	38.81	28.14	10.67
2006	19.80	72.30	7.90	38.27	27.31	10.96
2007	19.40	72.50	8.10	37.87	26.78	11.10
2008	19.00	72.70	8.30	37.36	26.03	11.33
2009	18.50	73.00	8.50	36.89	25.30	11.60
2010	16.60	74.50	8.90	34.17	22.27	11.90

Table 1. (*Continued*).

Year	Proportion of population by age group (%)			Dependency ratio (%)		
	0-14 years	15-64 years	65 and over	Total	Child	Old-age
2011	16.50	74.40	9.10	34.35	22.10	12.25
2012	16.50	74.10	9.40	34.86	22.20	12.66
2013	16.40	73.90	9.70	35.28	22.20	13.08
2014	16.50	73.40	10.10	36.14	22.45	13.69
2015	16.52	73.01	10.47	36.90	22.60	14.30
2016	16.70	72.51	10.80	37.90	22.90	15.00
2017	16.80	71.82	11.39	39.25	23.39	15.86
2018	16.86	71.20	11.90	40.44	23.68	16.77
2019	16.80	70.60	12.60	41.64	23.80	17.85
2020	16.64	70.38	12.98	42.09	23.64	18.45

3.1. Changes in the natural population growth rate

Changes in the rate of population growth are an important reason for the demographic transition. As can be seen from **Figure 1**, since the establishment of the Family Planning Commission in 1964, China has been in the process of transforming its population growth pattern from "high birth rate, low death rate, high natural growth rate" to "low birth rate, low death rate, low natural growth rate". Prior to 1964, although the birth rate had fallen sharply as a result of the three-year period of natural disasters, compensatory childbearing occurred after 1962. On the other hand, the death rate gradually declined as a result of the improvement in the level of medical care and security, so it can be assumed that the pattern of population growth during this period was still "high birth rate, low death rate, high natural growth rate". After 1964, the government advocated late marriage and childbearing. For example, in 1970 it emphasized "one is not less, two are just right, and three are too many", and required that births be spaced at least three years apart. In 1980, it emphasized "one is preferable, and two are preferable at the most". In 1982, family planning was established as a basic national policy, and in 1984 the requirements for rural areas were relaxed somewhat, but the requirement was still to "relax control over small ones while block big ones" and then tightened up again and strictly enforced, which is why there were two fluctuations in the fertility rate between 1980 and 1989. However, the overall trend is that the family planning policy has been gradually tightened and the birth rate has been declining.

After 1990, the birth rate continued to decline steadily, and after 2004 it began to fluctuate around 12‰, dropping to a low of 11.9‰ in 2010, which was also the lowest point in the total dependency ratio. Later, because of the arrival of the aging society, the country began to implement the "two-child fertility policy for couples where either the husband or the wife is from a single-child family" in 2014, and the "universal two-child policy" in 2016. But the implementation of this policy has not contributed to the rise in the birth rate, and even continued to fall. In 2022 it has fallen to 6.77‰, which is the lowest point of the birth rate in history. There are many reasons for this

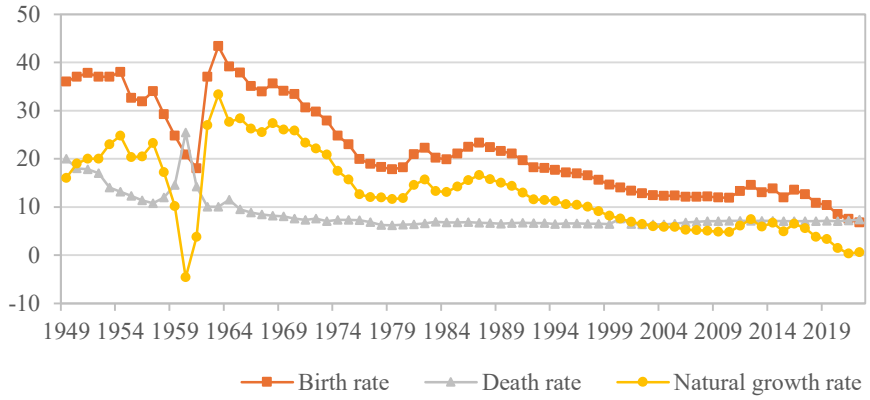

Figure 1. Changes in birth rate, death rate and natural growth rate over the years since the founding of the people's republic of China (‰).

phenomenon, such as the acceptance of the concept of family planning, the economic downturn caused by the pressure of survival, etc. Because of the aspects involved in sociology, economics and other disciplines, this paper will not be specifically developed here. The mortality rate has been maintained between 6‰–8‰ after 1990, and if subdivided, it is roughly divided into two stages. The first stage is 1990-2005, in which the mortality rate is roughly maintained at around 6.5‰. The second stage is 2006–2022, in which the mortality rate is maintained at around 7.1‰, but a slow upward trend has already emerged. This change is due to the fact that China officially entered an aging society in 2000 (the proportion of people over 65 years of age exceeded 7%), the increase in the aging rate of the population has led to an increase in the mortality rate, which was originally confined to a relatively low level due to the perfect health care conditions. The natural growth rate is determined by both the birth rate and the death rate, and its trend is generally similar to that of the birth rate. It is worth noting that in 2022, for the first time in China's history, the natural growth rate of the population will be lower than zero, and the birth rate will even be lower than the death rate, which means that China has officially entered the stage of negative population growth.

3.2. Changes in the age structure of population

Changes in the age structure of the population are an important result of the changing situation of population growth, and meanwhile a direct cause of the shift in the demographic dividend. The demographic opportunity window has been open in China since the early 1980s, which stems from the strict implementation of family planning in China. From the data in **Table 1**, the proportion of China's population aged 0–14 years was 33.59%, which aged 65 years and above was 4.91%, and aged 15–64 years was 61.50% in 1982. This period belonged to the age structure of the adult type population. With the passage of time, the age structure of the adult type population gradually changed to that of the elderly. By 1990, the proportions of the population aged 0–14, 65 and over, and 15–64 were 27.69%, 5.57%, and 66.74%, respectively and still belonged to the adult type age structure.

By 2001, the proportion of the population aged 65 and above exceeded 7%, which aged 0–14 was reduced to 22.50%, and the aged-child ratio reached 31.5%. There are

two main criteria for judging the population type, namely the coefficient of old-age, the coefficient of child, and the aged-child ratio. According to the criteria for judging the population age structure of the standard old-age type, the coefficient of old-age (the proportion of the population aged 65 and above) > 7%, the coefficient of child < 30%, and the aged-child ratio > 30%, it can be judged that the age structure of the population in China has changed from the adult type to the old-age type. However, from the proportion of working-age population, it seems that the proportion of population aged 15–64 is still over 70%, and labor resources are still abundant. After 2001, the proportion of the population aged 0–14 continued to decline, while the proportion of the population aged 65 and over began to accelerate. With an average annual increase of 0.2 percentage points between 2001 and 2008, an average annual increase of 0.3 percentage points between 2009 and 2013, and an even greater increase after 2014, it shows that the aging degree is becoming more and more serious.

3.3. Changes in the dependency ratio

The change in the dependency ratio is the main indicator for analyzing the trend of the demographic dividend shift. By 1987, the total dependency ratio had already fallen below 53%. Although the child dependency ratio was still well above 30%, the country had already entered the demographic dividend period by 1987 if we consider child and the elderly as an undifferentiated consuming population. The downward trend in the child dependency ratio began around 1964 (previous data are missing) and continued through 2011, while the old-age dependency ratio has been on an upward trend since 1964. The downward trend in the total dependency ratio, on the other hand, lasted from 1964 to 2010, after which it turned upward. Comparing the rate of decline of the total dependency ratio with that of the child dependency ratio during 1990–2010, it can be found that although both are in a decelerating downward trend, the absolute value of the child dependency ratio declining rate has always been higher than that of the total dependency ratio, which implies that the decline of the total dependency ratio has been driven by the decline of the child dependency ratio. Similarly, after 2010, although the child dependency ratio has also changed from a declining to a rising trend, the absolute value of the total dependency ratio rising rate has always been lower than that of the old-age dependency ratio, and higher than that of the increasing rate in the child dependency ratio. It implies that the increase in the total dependency ratio has been driven mainly by the increase in the old-age dependency ratio, so the population opportunity window has a tendency to be closed as a result of the aging of the population. By 2020, China's total dependency ratio will have reached 42.09%, although it is not yet possible to talk about the exhaustion of the labor force, the trend of the demographic dividend to demographic debt has become very obvious.

4. Three scenario predictions on transition time from demographic dividend period to demographic debt period in China

Demographic dividend refers to the positive economic consequences resulting from the shift in the age structure of the population, and the time point when the future demographic dividend period shifts to the population debt period depends on the

scientific simulation of the age structure of the population. In the following, this paper will use the PADIS-INT software to simulate the future population life table of China and forecast when it will enter the population debt period.

4.1. Forecasting methodology and parameterization

PADIS-INT is an international population projection software developed by the China Population and Development Research Center under the guidance of the United Nations Population Division. PADIS-INT can not only make multi-regional population projections, but also make projections over a longer time span. At the same time, the software introduces an iterative algorithm, a nonlinear forecasting model, and a multi-regional dynamic equilibrium forecasting tool. Compared with MORTPAK and Spectrum, PADIS-INT has a higher degree of implementation of the cohort-element methodology, and the error rate between the budgeted results and the given results of the United Nations is no more than 1%. The parameters to be set in PADIS-INT include: the number of population in the base year by sex and age group, life expectancy, mortality patterns, total fertility rate, age-specific fertility rates, migration levels and age-specific migration patterns. Except for the sex-segregated age-specific population, the age-specific mortality rate (mortality pattern) and the age-specific fertility rate, which can be found in statistical yearbooks, the other parameters need to be set according to the available data.

4.1.1. Starting population size structure

The population size and gender and age structure of the starting year of this projection are set on the basis of 2020 data. Firstly, based on the original sample data provided by the relevant survey data, the overall situation of China's population is extrapolated from the total population data (the result is consistent with the population size of 1,400.05 million at the end of 2020, as announced by the National Bureau of Statistics). Then, according to the average monthly population growth rate during the five-year period from 2015 to 2020, the actual number of Chinese people by gender and age extrapolated from the 2015 "mini-census" is projected from the point of time of the survey to the end of 2020, and weighted and adjusted with reference to the gender and age structure of the population at the end of 2020 as announced by the National Bureau of Statistics. (the result is consistent with the population size and corresponding gender and age structure at the end of 2020 published by the National Bureau of Statistics). In the subsequent specific projections, in conjunction with the operational needs of the software, this paper also adopts the same method to convert the corresponding time point of the national population by gender and age to mid-2020.

4.1.2. Average life expectancy and mortality pattern setting

At present, there are two main ways of calculating average life expectancy: one is to use the exponential regression method to measure the mortality rate of each sex at each age on the basis of the population census data of previous censuses, and then use the life table method to calculate life expectancy. The other is to calculate it on the basis of the empirical value of the United Nations life expectancy growth step. Considering that the use of census data to calculate life expectancy may result in

fluctuations in the relevant indicators due to the large time span (the existence of under reporting, and omission of data in the early period), as well as the influence of some socio-economic factors, the data do not correspond to the objective law. Therefore, this paper chooses to adopt the latter, to utilize the empirical value of the step size of life expectancy growth in the United Nations to calculate. According to the 2015 China Population and Employment Statistics Yearbook, the average life expectancy is 76.34 years, male life expectancy is 73.64 years, and female is 79.43 years. According to the results of the calculations, male life expectancy and female life expectancy in 2030 will be 75.65 years and 82.09 years respectively. And in 2050, male life expectancy and female life expectancy will be 77.62 years and 83.87 years respectively. As for the setting of the mortality model, based on the data on age-specific mortality rates by sex in 2020, the "Far East" in the life table of the United Nations regional model was selected as the closest mortality model by comparing the data for 2015–2019 with the data model given by PADIS-INT.

4.1.3. Total fertility rate setting

The total fertility rate (TFR) refers to the average number of children born to each woman during her reproductive years. In general, a TFR of 2.1 is required to maintain replacement level so that the population does not decline. In this paper, we set up three scenarios to assess demographic change: the medium range scenario takes into account the calculation of China's total fertility rate in 2020, which is 1.3. It assumes that with the encouragement of the two-child policy, women of childbearing age will be able to release their fertility potential in a concentrated manner and that the fertility build-up effect will be realized. Finally, the fertility level will reach 1.5 in 2030 and then 1.7 in 2035. After the general trend has been stabilized, the level will be maintained. The low scenario mainly takes into account the fact that after the implementation of the universal two-child policy, the total fertility rate shows a certain degree of increase. But then begins to rebound and decline in the following few years, and falls to its lowest level in 2020. Therefore, with reference to the rate of decline of the national total fertility rate from 1.7 in 2017 to 1.3 in 2020, and based on the changes in the number of births and the birth rate as published in the China Population and Employment Statistics Yearbook for the years 2015–2019, it is assumed to rebound to a fertility level of 1.4 by 2035 and return to a level of 1.5 by 2050. The high scenario takes into account the fact that the implementation of the universal two-child policy and the three-child policy can indeed increase the number of births. Referring to National Population Development Planning (2016–2030), the total fertility rate can be raised to the level of 1.8 by 2030, and reach 2.1 by 2035, and then be maintained at this fertility level.

4.2. Analysis of multi-scenario prediction results

According to the above parameter settings, based on the simulation of three population fertility scenarios of high, medium and low, different prediction results will be obtained. As shown in **Table 2**, the first one is the medium range scenario, which expects that China's total dependency ratio will exceed 50% in 2033 and reach 56.1% in 2036, surpassing the level of Sweden's total dependency ratio in 1957. The second is the low scenario, which projects that our total dependency ratio will exceed 50% in

2034 and reach 56.07% in 2037, exceeding Sweden's total dependency ratio level in 1957. The third is the high scenario, which predicts that our total dependency ratio will exceed 50% in 2032 and reach 57.22% in 2035, exceeding the level of Sweden's total dependency ratio in 1957. Combining the results of the three predictions above, it can be seen that the differences among them are very small, and it is entirely possible to adopt the medium range scenario as a compromise. In other words, our demographic opportunity window may close around 2033, while the demographic dividend period will end around 2036, and then usher in a long-term demographic debt period.

Table 2. Three scenario predictions of national dependency ratio, 2021–2050 (%).

Year	Low scenario			Medium range scenario			High scenario		
	Total	Child	Old-age	Total	Child	Old-age	Total	Child	Old-age
2021	42.46	23.41	19.05	42.47	23.42	19.05	42.55	23.50	19.05
2022	42.97	23.16	19.81	43.01	23.20	19.81	43.14	23.33	19.81
2023	43.17	22.80	20.37	43.24	22.87	20.37	43.50	23.13	20.37
2024	42.84	22.32	20.52	42.96	22.44	20.52	43.32	22.80	20.52
2025	42.91	22.06	20.85	43.09	22.24	20.85	43.61	22.77	20.84
2026	42.39	21.51	20.88	42.63	21.75	20.88	43.31	22.43	20.88
2027	43.18	21.11	22.07	43.50	21.43	22.07	44.40	22.33	22.07
2028	44.60	20.79	23.81	45.01	21.20	23.81	46.11	22.30	23.81
2029	45.45	20.32	25.13	45.96	20.83	25.13	47.32	22.19	25.13
2030	46.41	19.88	26.53	47.03	20.50	26.53	48.64	22.11	26.53
2031	47.17	19.25	27.92	47.92	20.00	27.92	49.82	21.91	27.91
2032	47.64	18.60	29.04	48.55	19.51	29.04	50.71	21.67	29.04
2033	49.18	18.27	30.91	50.29	19.38	30.91	52.77	21.86	30.91
2034	50.49	17.97	32.52	51.81	19.30	32.51	54.58	22.07	32.51
2035	52.51	17.98	34.53	54.09	19.56	34.53	57.22	22.69	34.53
2036	54.29	17.99	36.30	56.10	19.81	36.29	59.45	23.19	36.26
2037	56.07	18.03	38.04	58.09	20.07	38.02	61.70	23.74	37.96
2038	57.78	18.09	39.69	60.00	20.34	39.66	63.75	24.21	39.54
2039	59.41	18.19	41.22	61.78	20.62	41.16	65.71	24.72	40.99
2040	60.80	18.29	42.51	63.31	20.89	42.42	67.28	25.12	42.16
2041	62.15	18.41	43.74	64.78	21.17	43.61	68.82	25.56	43.26
2042	63.09	18.51	44.58	65.82	21.41	44.41	69.80	25.86	43.94
2043	64.29	18.67	45.62	67.08	21.68	45.40	71.06	26.24	44.82
2044	65.59	18.86	46.73	68.42	21.97	46.45	72.27	26.55	45.72
2045	66.62	19.03	47.59	69.46	22.22	47.24	73.21	26.84	46.37
2046	67.93	19.24	48.69	70.74	22.48	48.26	74.30	27.09	47.21
2047	69.75	19.52	50.23	72.46	22.77	49.69	75.90	27.44	48.46
2048	71.02	19.74	51.28	73.57	22.96	50.61	76.79	27.61	49.18
2049	72.31	19.96	52.35	74.65	23.11	51.54	77.72	27.80	49.92
2050	73.65	20.19	53.46	75.70	23.22	52.48	78.53	27.89	50.64

5. Discussion

The quantitative demographic dividend in this paper only utilizes the concept of dependency ratio in the context of demography, and does not further explore the intrinsic connection between demographic transformation and economic growth. In fact, the quantitative demographic dividend or the opening of demographic opportunity window only provides a favorable production condition for economic growth, but is not a sufficiently necessary condition for economic growth. In order to fully realize the demographic dividend, it is necessary to have a good social system and policies to support it. In specific measurements, the use of dependency ratio as a measure of quantitative demographic dividend itself also has many shortcomings, this approach ignores the impact of unemployment and non-working-age employment on the effective working population measurement, such as the existence of a large number of laborers in the population of retirement age. Besides, the productive capacity of the population of different age dependents differs, there are also differences in the level of consumption of the population of the dependent population. In other words, there is distinction in the consumption level and production capacity of a person in different stages of life, which cannot be simply divided into two categories of productive and consuming populations. In the future, we need to try to establish a dynamic way of measuring the dependency ratio from the perspective of the whole life cycle, and to continue to improve the existing research on the prediction of the demographic dividend.

6. Conclusion

The population dividend is a cross-cutting research hotspot between demography and economics, which can not only help academics to figure out the contribution between demographic factors to economic growth in China, but also help our government to realize the current crisis of population growth and structural transformation as soon as possible. Then scientific policy will be formulated to solve the population problem. Based on the relationship between demographic dividend, demographic opportunity window and population age structure, this paper takes the quantitative demographic dividend as the research object. Meanwhile, chooses the dependency ratio as the measurement index, and adopts the 1957 Swedish life table as the standard demographic reference frame. The paper predicts the time node of the nation's demographic dividend to demographic debt based on the analysis and research on the trend of China's population growth and structural transformation. The conclusions are as follows:

Firstly, from the perspective of changes in the dependency ratio, the downward trend in China's total dependency ratio began in 1964, and around 1987 it began to enter the demographic dividend period, which lasted until 2010. After that, the total dependency ratio began to shift from a downward trend to an upward trend, entering a stage in which the demographic opportunity window became smaller.

Secondly, analyzing and comparing the trends of the total dependency ratio, the child dependency ratio and the old-age dependency ratio, it can be found that the decline in China's total dependency ratio before 2010 was driven by the decline in the child dependency ratio, and that the rise in China's total dependency ratio after 2010

was mainly caused by the rise in the old-age dependency ratio.

Thirdly, based on the simulation results of the three scenarios of the country's future fertility, if the medium range scenario is adopted, it is projected that the national demographic opportunity window will close around 2033. While the demographic dividend period will end around 2036, after which a long period of demographic debt is likely to ensue.

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