Training Course on Population Census Data Analysis for National Institute of Statistics of Cambodia
(Nov. 2019, Beijing)

Introduction to Methods of Population Projection in China

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Methods of Population Projection (Key Takeaway)

I. Introduction to Population Projection
II. Methods of Population Projection
III. Results of Population Projection
IV. Population Projection Software

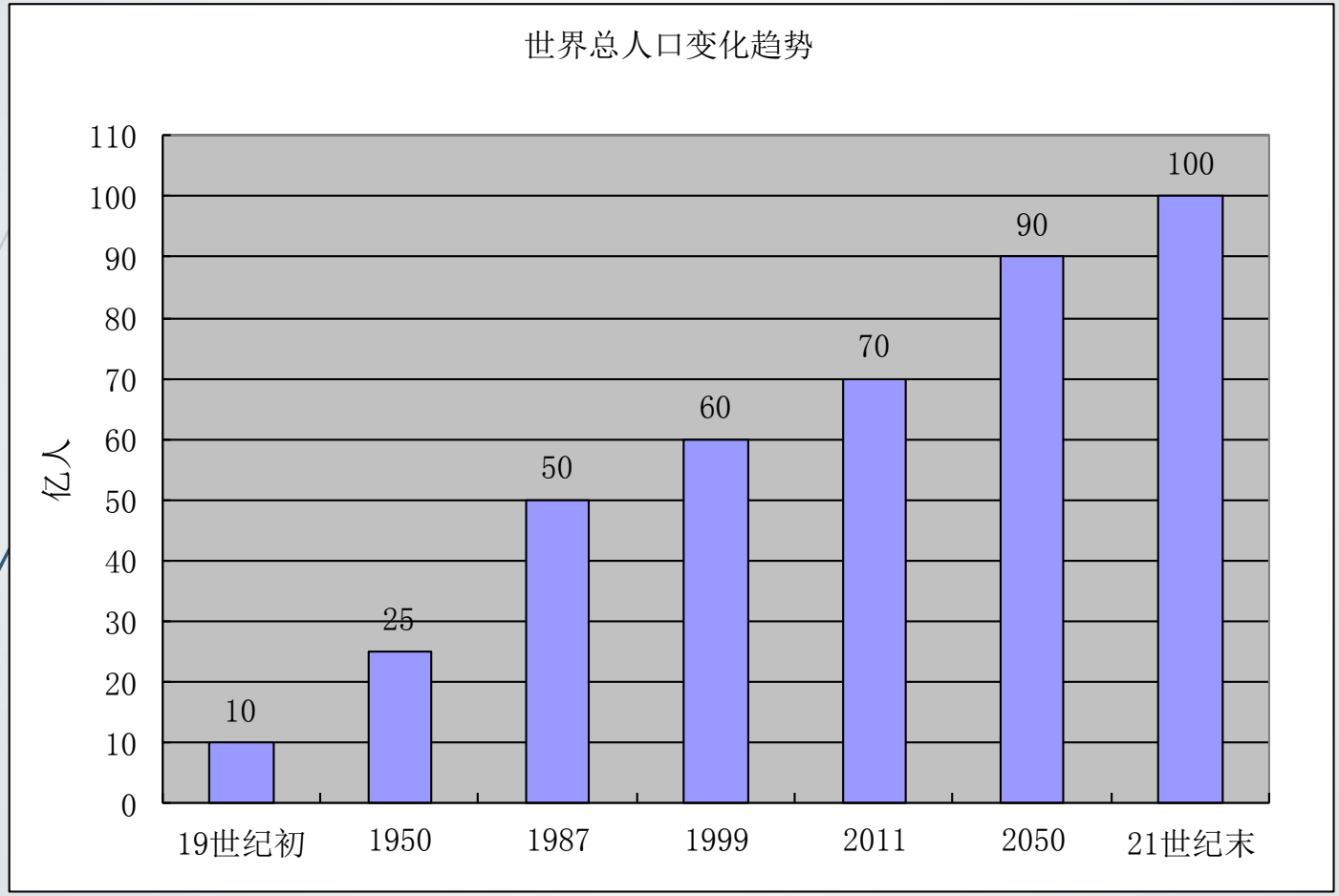
I. Introduction to Population Projection (Key Takeaway)

1. The Concept of Population Projection
2. Features of Population Projection
3. Roles of Population Projection
4. National and International Producers of Population Projection
5. Knowledge Required to Learn Methods of Population Projection

1. The Concept of Population Projection

- Population Projection Calculations of a country or region's total population, its regional distribution and age structure at a future date through mathematic models based on the current population size and assumed factors impacting future population changes (mortality, fertility, and migration).
- Population Planning Identification of population and its structure, quality and distribution, and the formulation of plans of controlling population based on the current population size, natural resources and other factors impacting population changes of a country or region.
- Population Estimate Calculations of the past and current population size.
- Population projection, planning and estimate adopt similar methods if studied and analyzed through population projection model (Cohort Component Model)

Projection of World Population Growth



1. The Concept of Population Projection

- In a Traditional Sense

√ (1) By Region (Traditionally): country, provinces, cities, towns, counties, and villages (age structure)

- In a Broad Sense: age structure + demographic features (multi-state and multidimensional model)

Levels of Schooling: illiteracy, primary school, secondary school, high school, and university.

Economic Activities: labor participation rate, employment and unemployment.

1. The Concept of Population Projection

(2) By Time Range

For the short term, it reflects the population growth in 10 years. It is crucial for the formulation of Five-Year Plans for the national economy as it provides basis for making specific population-related policies in recent years.

For the mid term, it reflects the population growth in 20 years. It is important for the planning of employment, education, health care, architecture and transportation infrastructure, providing base data for making mid-term population-related policies.

For the long term, it looks at the population growth in more than 20 years (doubling time and halving time of population). It is significant for studies on water, forests, land, food and mineral resources, providing basis for the far-future planning of social and economic development.

1. The Concept of Population Projection

(3) By quantity

Assumed Factors	Plans
Life Expectancy	high, medium, low
Fertility	high, medium, low
Migration	high, medium, low

Quantity of Plans 27= 3× 3× 3

Generally the focus is placed on projected data under the plans for the medium level.

2. Features of Population Projection

(1) Population projections are cornerstones for predicting socioeconomic development which in turn takes people-centered development as its ultimate objective.

- people as labor force
- people as consumers
- The reproduction of the population — a change of a generation into a new one — allows the continuation and development of mankind.

2. Features of Population Projection

(2) Methods of population projections are more effective and have more laws to follow than those of economic and social projections.

- Population growth is influenced by natural, social and economic factors, but also follows its internal laws and historical continuity.
- A baby boom will surely lead to another peak of education, employment, marriage and fertility several years or decades later, and a peak of aged population 60 years later.
- A fertility rate increasingly declined below the replacement level will inevitably result in a decrease in population.
- If factors influencing population growth change, population projection results need to be renewed.
- Population projection is an important task after a demographic census.

3. Roles of Population Projection

(1)Providing basis for social and economic development plans.

- Population projections show a population development trend under different scenarios, important for choosing an appropriate range for population development or identifying the most possible development trends.
- Population projections provide data of infants, school-aged population, working-age population, and aged population necessary for making government policies for education, employment, health, and social security.
- They are foundations for studies of stable population, optimum population size, and sustainable development of human and environment.

3. Roles of Population Projection

(2) Providing basis for population data estimation

- Using methods of population projections to estimate and restructure population (analyzing possible unreported data)

- Roles in Sampling survey (weighting of sample data)

(3) Providing inspirations (approaches of population projections)

Life table in projections; promotion of working life table

4. International and National Producers of Population Projection

(1) **International Producers**

a dramatic increase of population after the World War II

- Since 1950, the UN has started to routinely produce national, regional, and global population prospects. Starting from 1978, the UN has revised and published world population prospects every two years. In 2010, the period was extended from 1950-2050 to 1950-2100 (estimates and projections).
- Starting from 1978, the World Bank has been projecting world populations. Since 1990, it has started to adopt multiple packages in projections which will last till 2050.
- Population Reference Bureau projects world population every year and produces its world population data sheet annually.
- The U.S. Census Bureau, Australian Bureau of Statistics, National Institute of Population and Social Security Research, Statistics Sweden, National Population Commission, International Institute for Applied Systems Analysis (IIASA), etc., all routinely project regional and national population.

4. International and National Producers of Population Projections

(2) National Producers

Rapid population growth in the 1980s led to the implementation of family planning across the nation

- NHFPC, NBS, CNCA as well as related departments of some provinces and cities, universities and institutes such as PKU Institute of Population Research, and RUC Population Development Studies Center.
- In 2004, national studies on population development strategy were launched. After over two years of efforts by over 300 experts and professionals, the ***Research Report on National Population Development Strategy*** of over 2.6 million characters in length was rolled out. The Report shows that by current fertility rate of 1.8, Chinese population will reach the peak of 1.5 billion by 2033.
- In 2007, CAS released the ***Overview of China Sustainable Development*** on which six challenges facing China's sustainable development and three population peaks were laid out.
- NBS population projections

5. Knowledge Required to Learn Methods of Population Projection

- Analysis Technique of Population Statistics

  By gender and age

  By fertility, mortality and migration

- Estimation Technique of Population Data

  By base data

  By determined parameters — current fertility, mortality and migration level

II. Methods of Population Projection (Key Takeaway)

1. Total Population Projection
   (1) Trend Extrapolation
   (2) Structural Models
2. Cohort Component Models（projections of total population and age structure）
   (1) Basic Steps
   (2) Base Data
   (3) Mortality, Fertility and migration Models
   (4) Calculation Methods
   (5) Factor Determination
   (6) Plans for High, Medium or Low Levels

1. Total Population Projection

Natural increase

(1) Trend Extrapolation

Population at year end=population at the year's start + <u>births-deaths</u> + <u>net migrants</u>

Migratory increase

Linear growth $P_t = P_0 + k \times t$

Geometrical growth $P_t = P_0(1+r)^t$

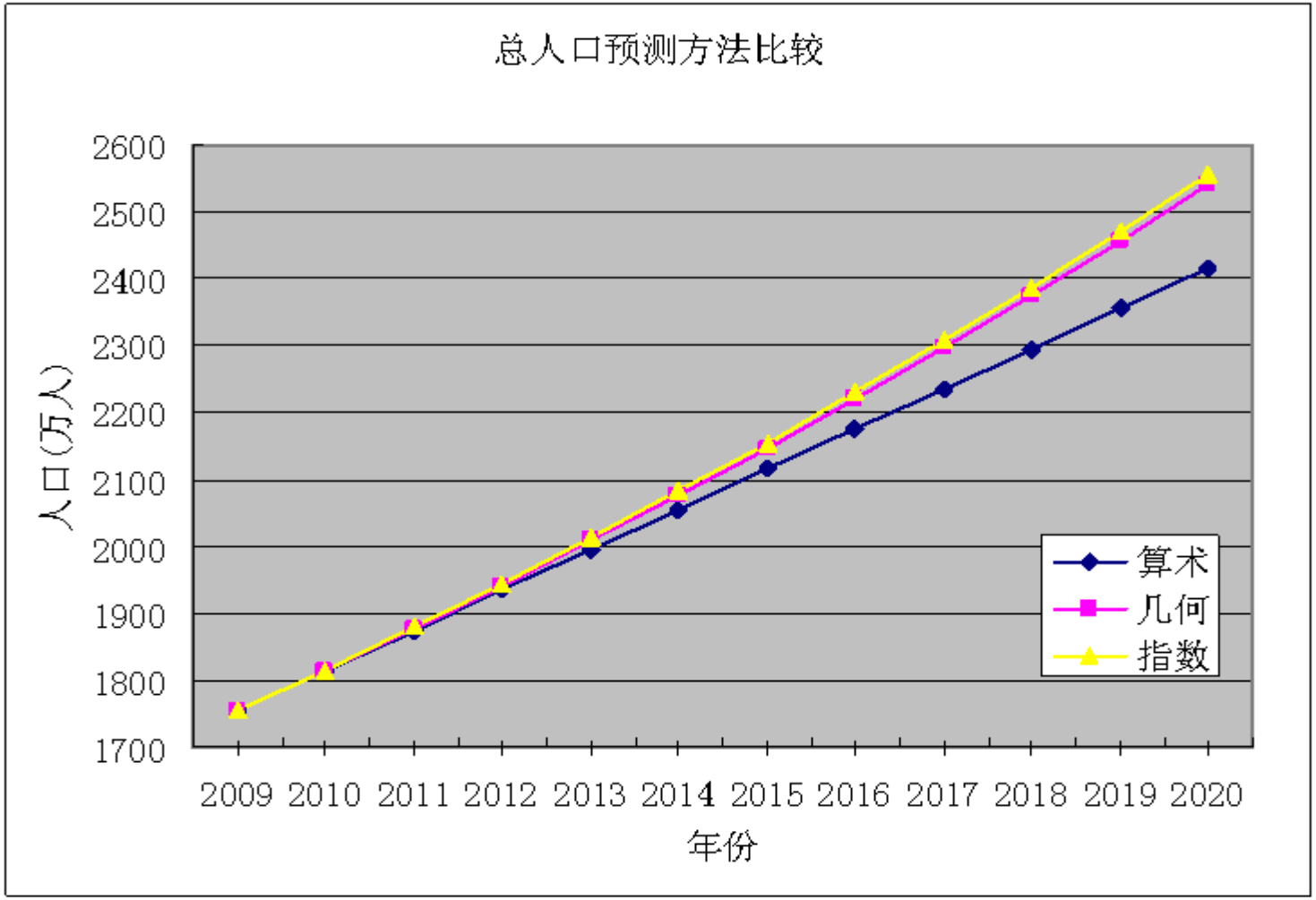
Exponential growth $P_t = P_0 e^{rt}$

Logistic growth $P_t = \dfrac{K}{1+e^{\alpha+\beta t}}$

1. Total Population Projections

(1) Trend Extrapolation

Figure: data source: CHEN Wei



1. Total Population Projections

(2) Structural Models

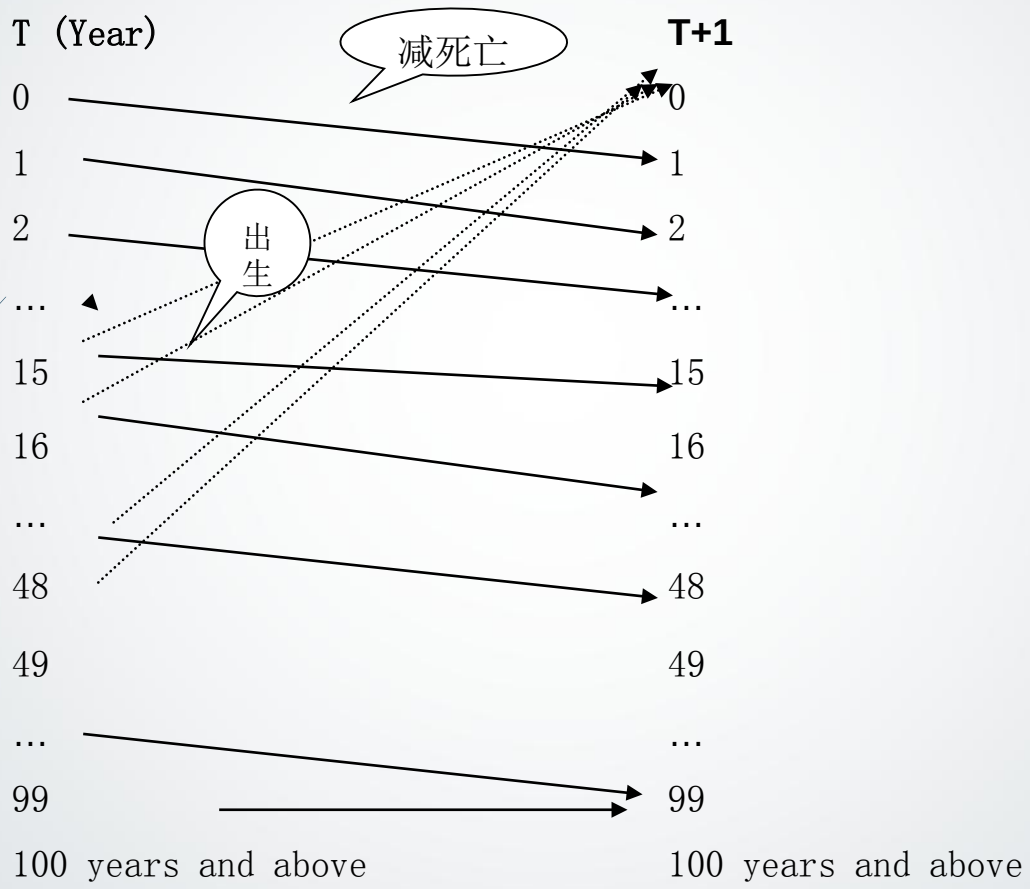
Economic demographic model is the most widely used method.

Population is projected through relations between demographic variables and non-demographic variables. This model takes demographic variables as dependent variables and non-demographic variables as independent ones, predicting changes on independent variables with changes on dependent ones.

$$y(t) = a_1 x_1 + a_2 x_2 + a_3 x_3 \ldots$$

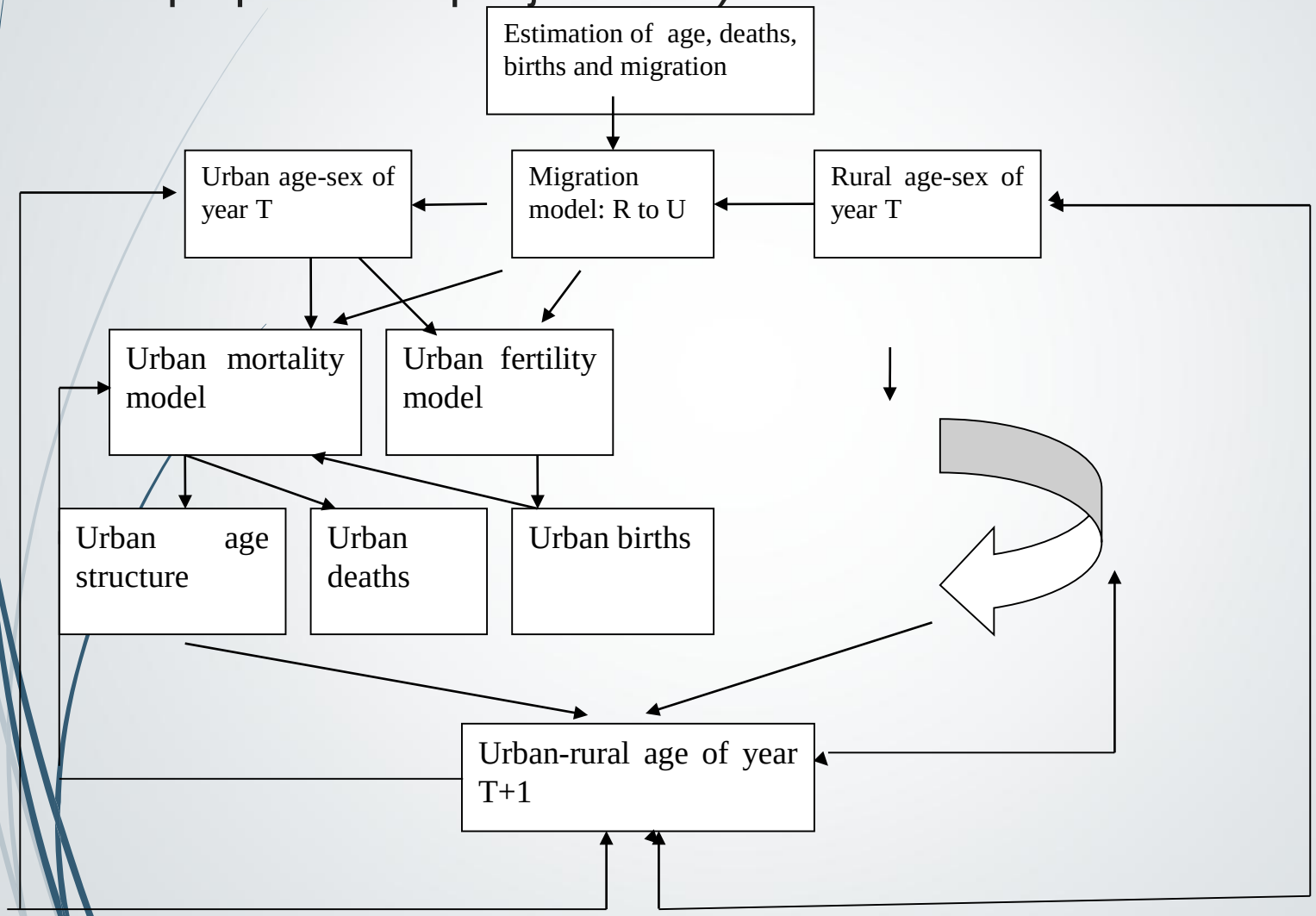
2. Cohort Component Models

(1) Basic Steps (Single-year or 5-year groups)Figure Source: CHEN Wei



2. Cohort Component Models

(1) Basic Steps (e.g. systematic figure of rural and urban population projections)



2. Cohort Component Models

(1) Basic Steps

1) To calculate the population of all ages and genders in the base year according to their survival rate to 1 year or 5 years of the next year.

2) To calculate births of one year through the number of age-specific women of childbearing age and age-specific FTR, and to apply the births to the cohorts aged zero.

3) To add all ages to net migrants if migrations need to be taken into considerations.

4) Years of iteration.

5)Determinants like births, mortality and migrations should be set during the process of going through each step.

2. Cohort Component Models

(2) Base Data

1) Age-sex-specific Population (single-year; five years) in the launch year(2011)

2) Age-sex-specific life table (mortality rate or survival rate) or model life table during the interval of projection (2011-2050)

3) Age-specific fertility during the interval of projection (2011-2050)

4) Net migration rates (multi-state) during the interval of projection (2011-2050)

nation

rural, urban areas; regions

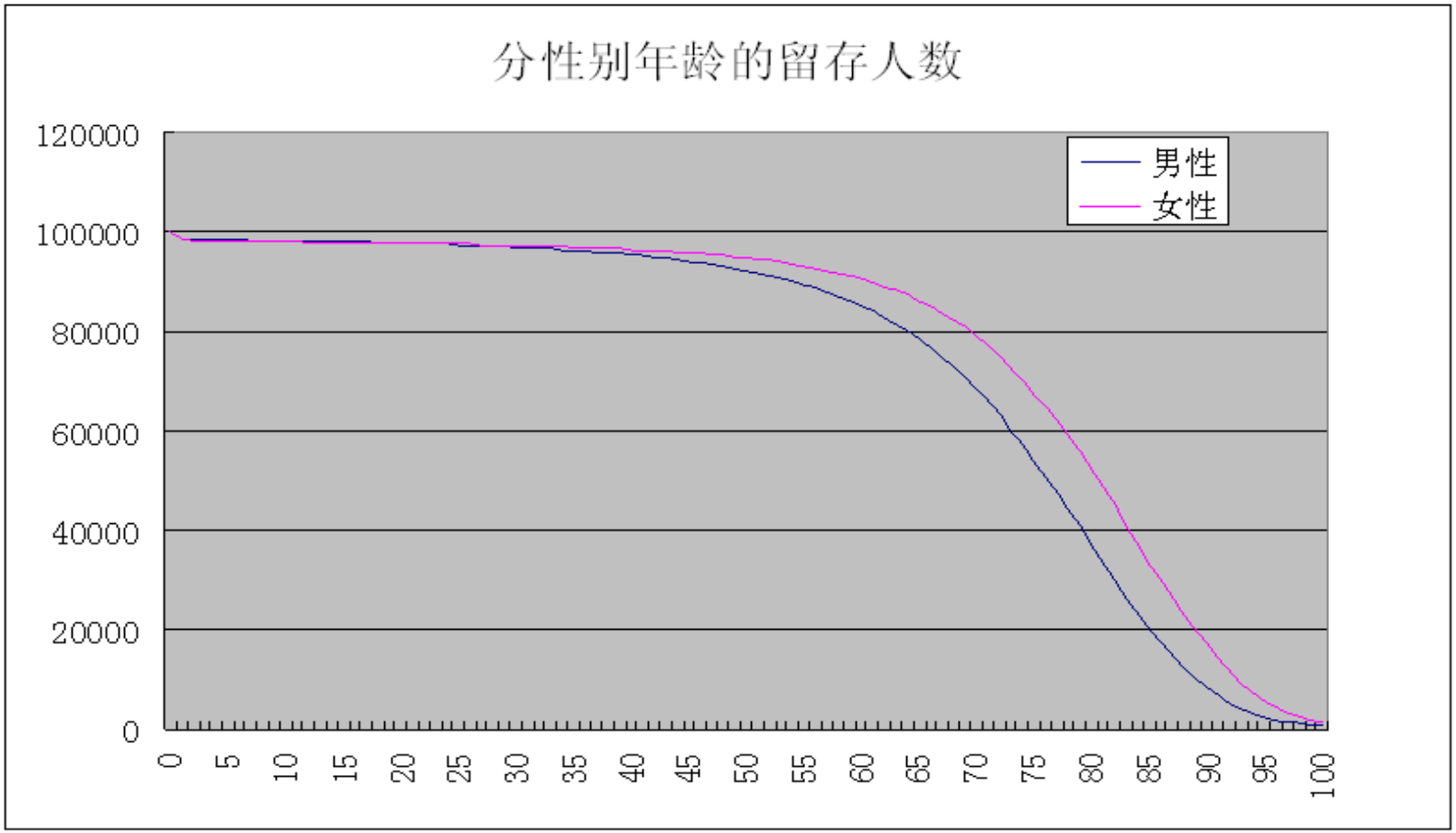
province

rural, urban areas; regions

2. Cohort Component Model

(3) Mortality, Fertility and Migration Models

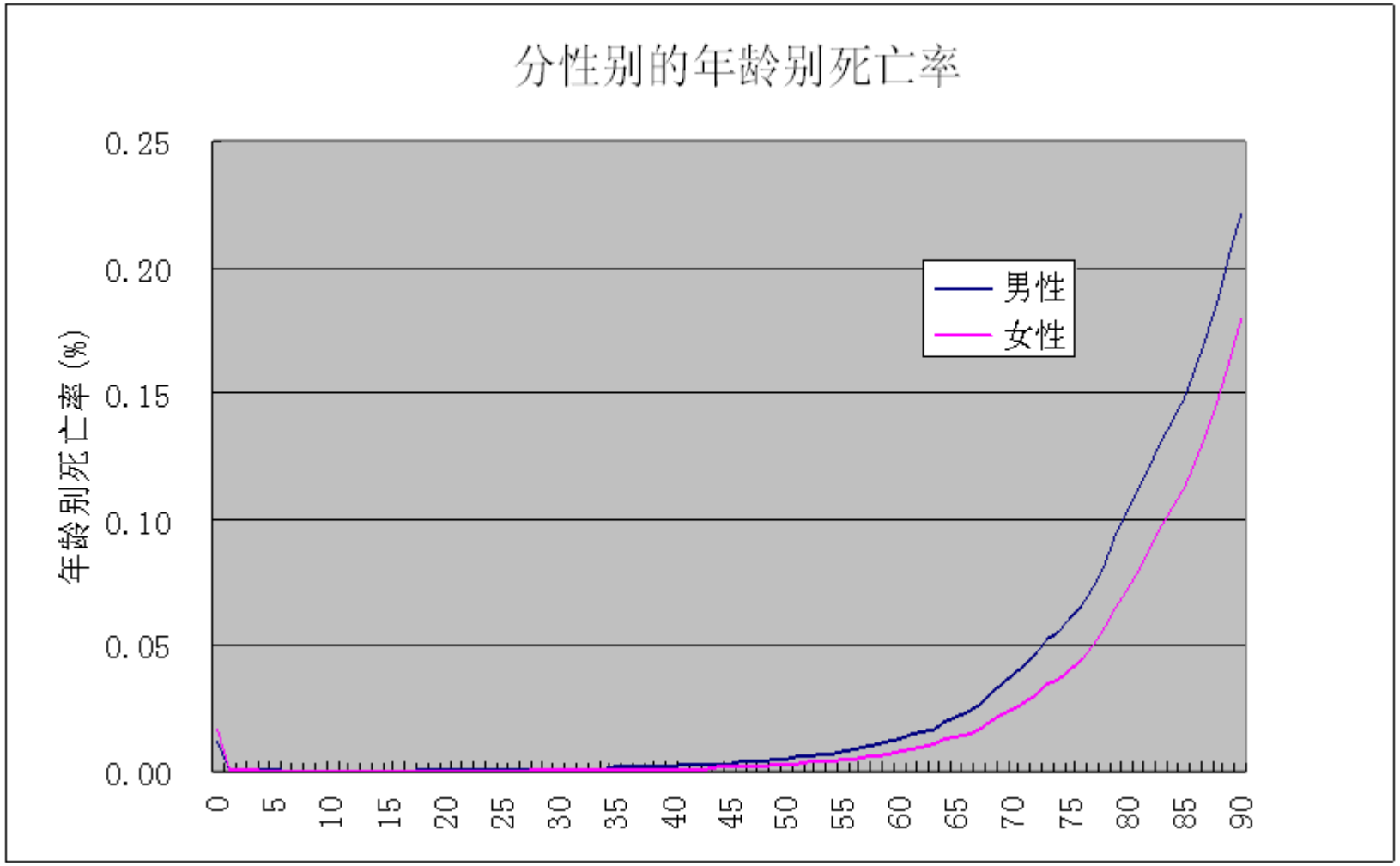
1) Mortality Model (Survivors in life table)



2. Cohort Component Model

(3) Mortality, Fertility and Migration Models

1) Mortality Model（Mortality Curve）



2. Cohort Component Model

(3) Mortality, Fertility and Migration Models

1) Mortality Model

- Calculation of Life Table through Census Data

Logit System: The British demographer William Brass discovered a logit transformation of survival probabilities of two different life tables to l(x) made the relationship between the probabilities approximately linear — number of survivors of the two life tables.

$$\lambda(l_x^*) = \alpha + \beta\lambda(l_x)$$

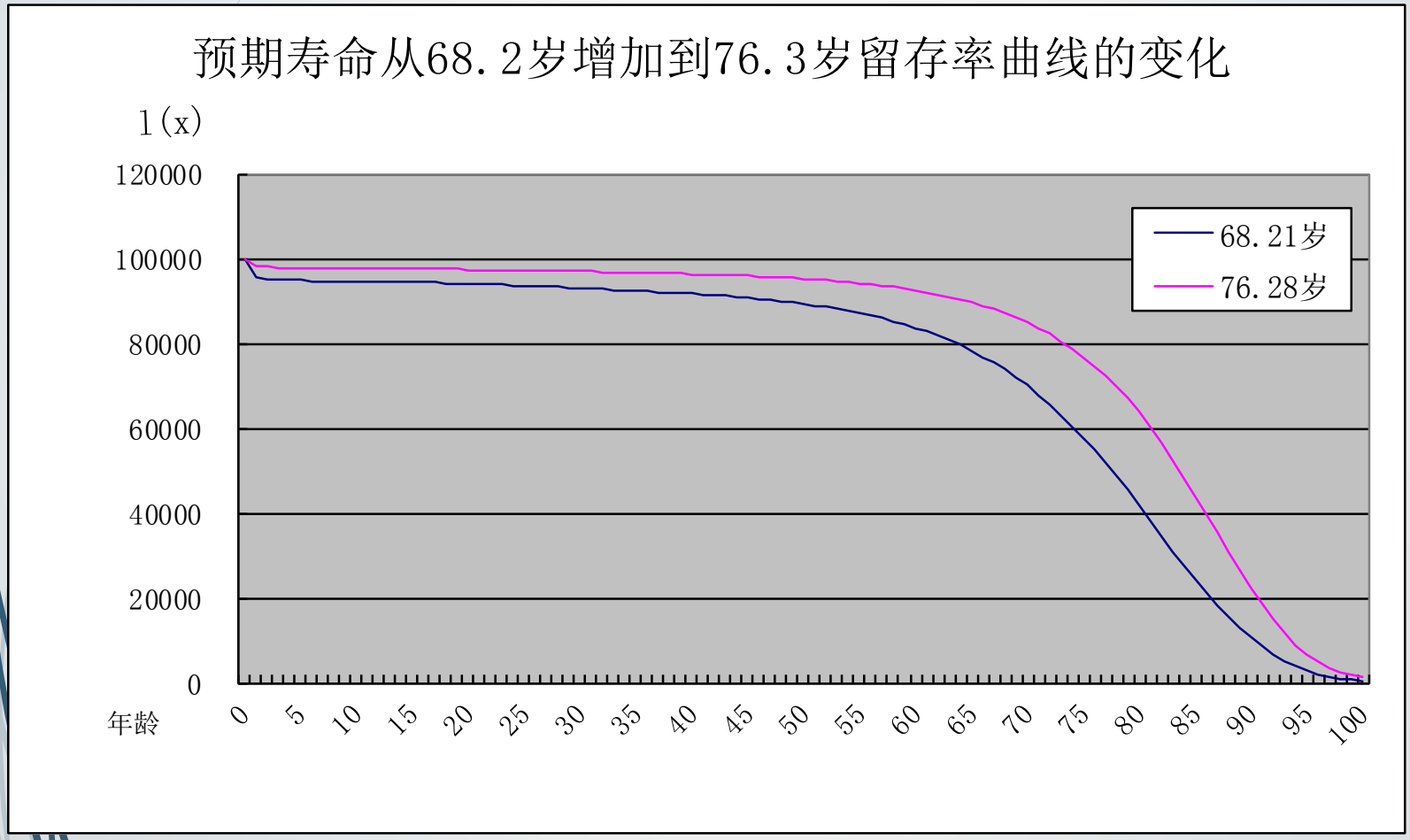
$$\lambda(l_x) = \mathrm{logit}(1.0 - l_x) = 0.5\ln\left(\frac{1.0 - l_x}{l_x}\right)$$

- Model Life Table. After a comparison of all mortality models in model life tables and the ones in projected regions, the mortality model most similar to the ones in projected regions will be chosen in projections. Age-specific survival rate each year in the future will be calculated based on the determined average life expectancy and the chosen model life table.

2. Cohort Component Model

(3) Mortality, Fertility and Migration Models

1） Mortality Model



2. Cohort Component Model

(3) Mortality, Fertility and Migration Models

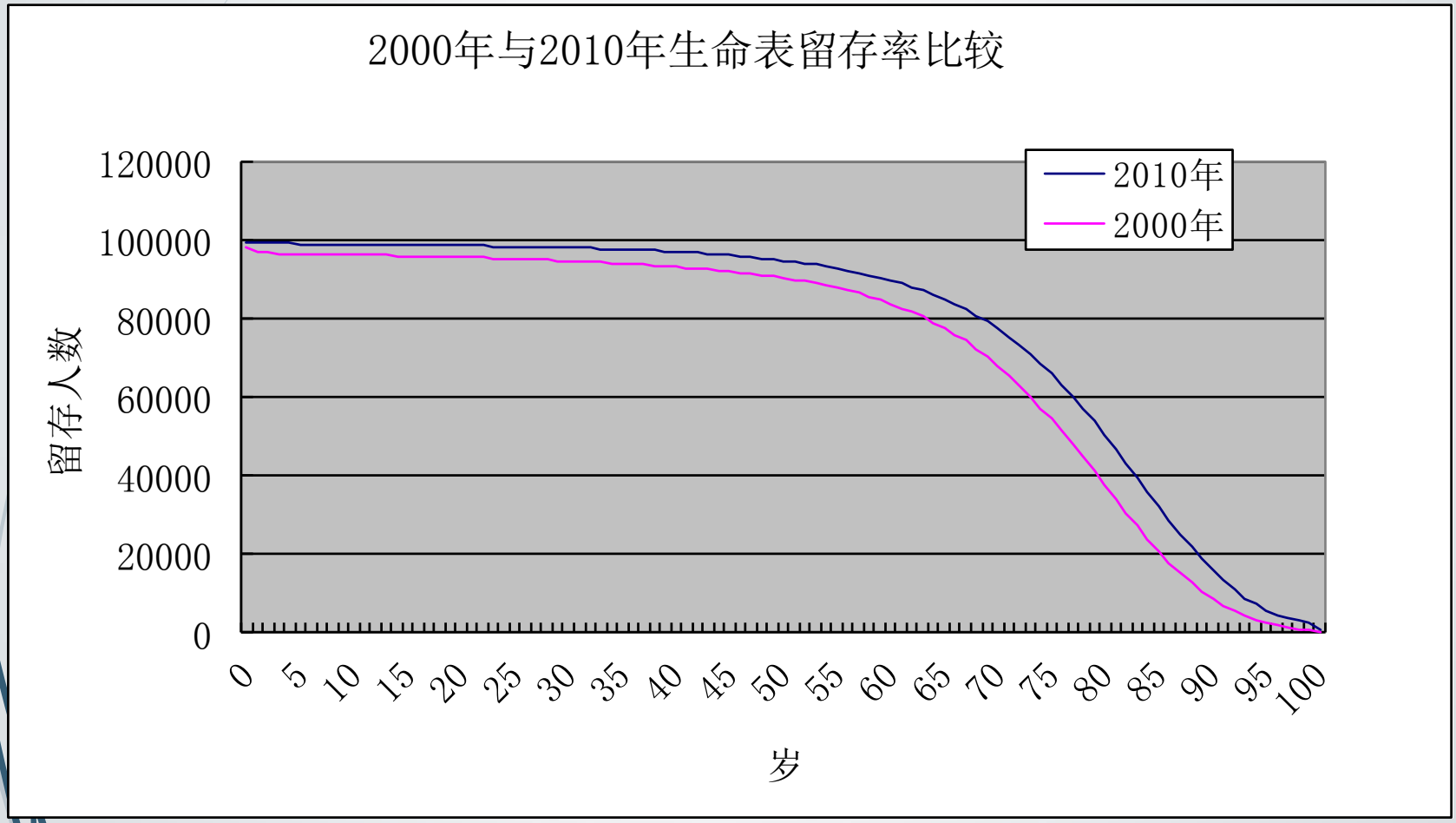
1) Mortality Model $\lambda(l_x^*) = \alpha + \beta\lambda(l_x) \quad \beta = 1$

0	0.055281	0.053801	0.051399
1	-0.011000	-0.017680	-0.014340
2	-0.011960	-0.018760	-0.015360
3	-0.012360	-0.019920	-0.016140
4	-0.012800	-0.021240	-0.017020
5	-0.012400	-0.018560	-0.015480
6	-0.012840	-0.019640	-0.016240
7	-0.013320	-0.015880	-0.014600
8	-0.013800	-0.016720	-0.015260
9	-0.014320	-0.012840	-0.013580
10	-0.014040	-0.013280	-0.013660

2. Cohort Component Model

(3) Mortality, Fertility and Migration Models

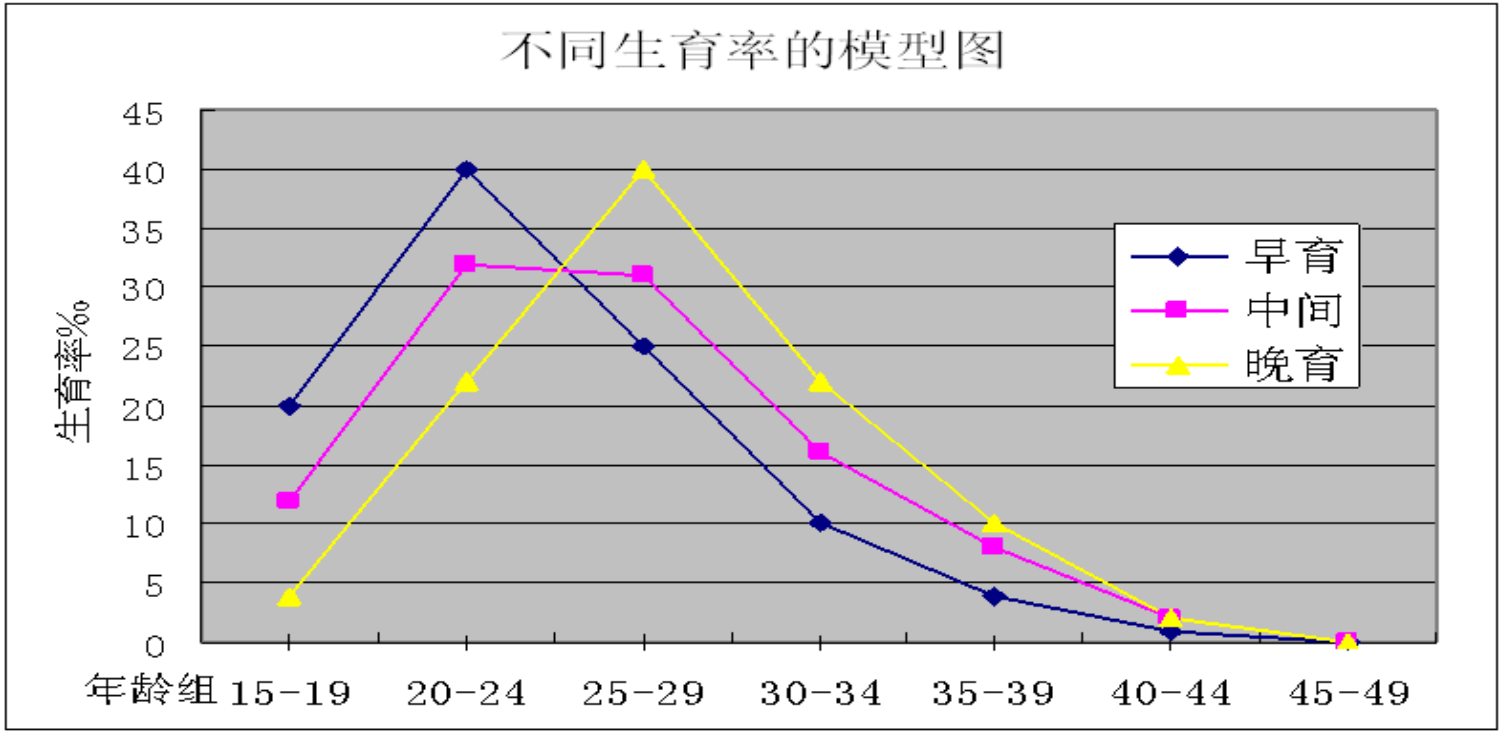
1） Mortality Model (Analysis 2010)



2. Cohort Component Model

(3) Mortality, Fertility and Migration Models

2） Fertility Model (curve) source: CHEN Wei



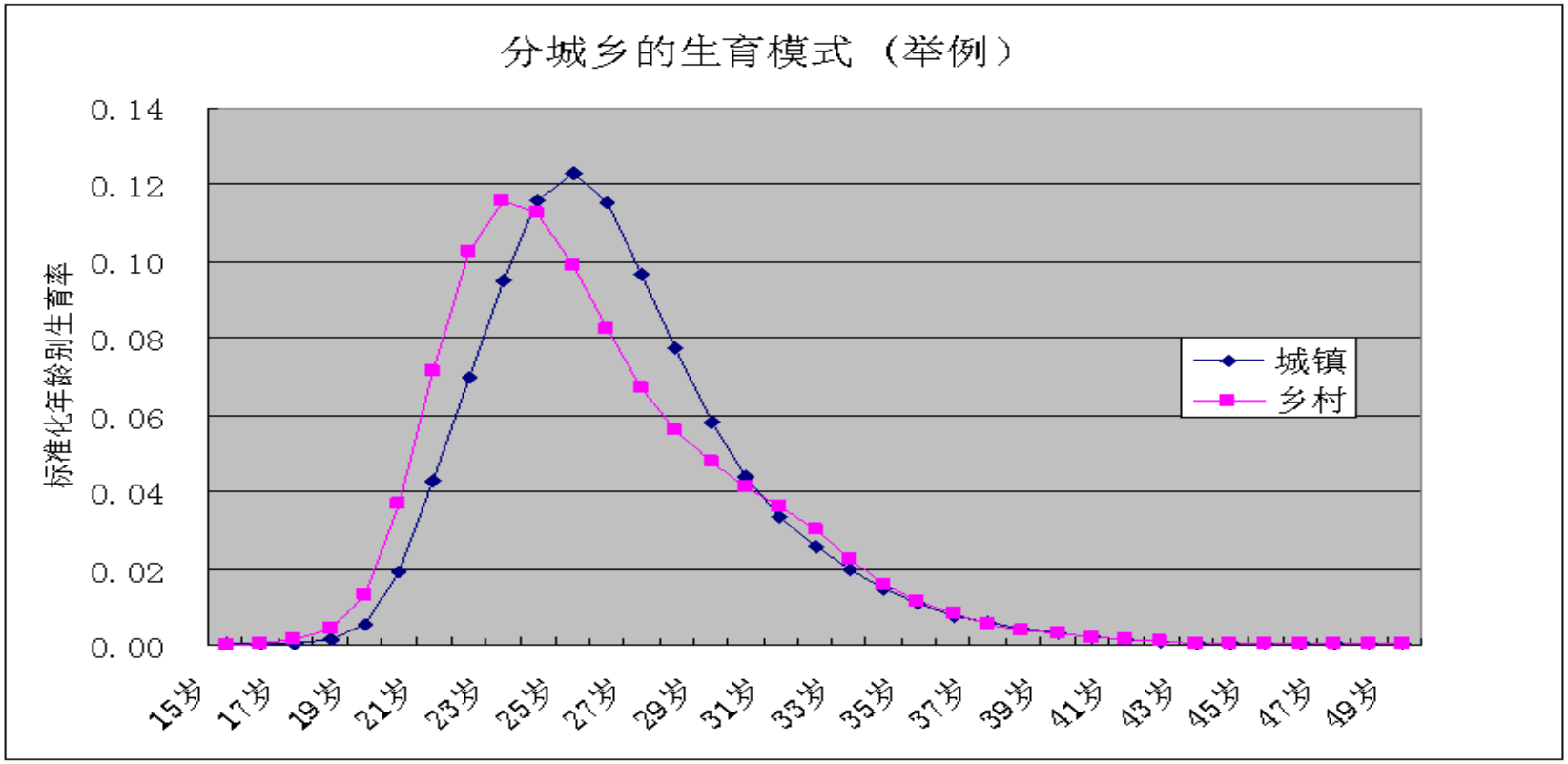
2. Cohort Component Model

(3) Mortality, Fertility and Migration Models

2） Fertility Model

$$\sum_{i=15}^{49} BTFR(t)_i = 1$$

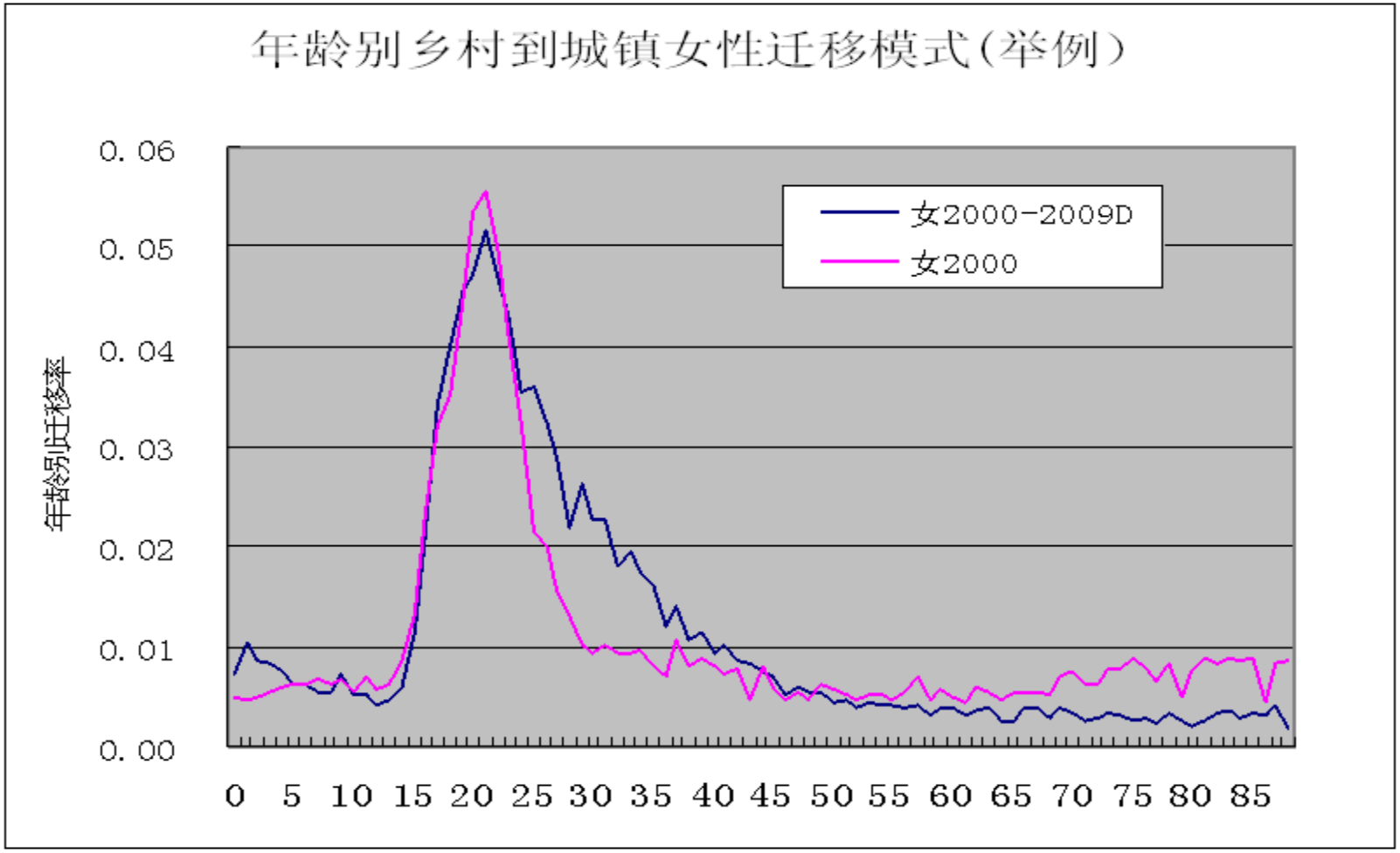
The ratio of age-specific fertility to TFR



2. Cohort Component Model

(3) Mortality, Fertility and Migration Models

3） Migration Model



2. Cohort Component Model

33 (4) Calculation Methods

1）Projection of Births

$$B(t) = \sum_{i=15}^{49} (F_i(t) + F_i(t+1)) \times 0.5 \times ATFR_i(t)$$

$$ATFR_i(t) = BTFR_i(t) \times TFR(t) \qquad \sum_{i=15}^{49} BTFR(t)_i = 1$$

$ATFR_i(t)$ Age-specific fertility rate i in year **t**: 15…49 years

$BTFR_i(t)$ Standardized age-specific fertility i in year **t**: 15…49 years

$TFR(t)$ TFR in year t (controlled parameters for birth rate)

$F_i(t)$ The number of women of childbearing age(i years) in year t.

$B(t)$ Births in the year of t

Male births

Female births

$$B_{nan}(t) = B(t) \times sex(t)$$

$$B_{women}(t) = B(t) \times (1 - sex(t))$$

$sex(t)$ Sex ratio at birth

2. Cohort Component Model

(4) Calculation Methods

1）Projection of Births(Five-year Groups)

2010 Number of Population Aged Zero to Four: 2006-2010 births and survivors till 2010 (source: CHEN Wei)

Age Group	Number of Women	Fertility Rate	Births	Survival Rate	2010 Number of Population Aged 0-4 years
15-19	435618	0.00172	3745		
20-24	711459	0.04613	164094		
25-29	879531	0.08364	367820		
30-34	835899	0.02897	121097		
35-39	811533	0.00541	21960		
40-44	787636	0.00091	3593		
45-49	744749	0.00021	794		
Sum			683104		
Female				0.99602	328689
Male				0.99616	351748

2. Cohort Component Model

(4) Calculation Methods

2) Projections of the Zero-year-old

$P_0(t)$ *Population aged 0 in the year of t (divided by female and male)*

$SR_0(t)$ *Survival rate of infants born in the year of t (survival rate of population aged 0)*

$L(0)$ Average number of survivors aged 0 in the life table(divided by female and male)

$I(i)$ Number of survivors aged i in the life table $I(0) = 100000$

$$SR_0(t) = L(0) / I(0)$$

$$P_0(t) = SR_0(t) \times B(t)$$

Births in the year of t (divided by female and male)

Calculation based on survival rates of female and male infants

2. Cohort Component Model

(4) Calculation Methods

3) Projections of All Age Cohorts (e.g. Urban and Rural population)

$$P^1(t+1) = P_0^1(t) + \sum_{i=i}^{100} P_i^1(t) \times SR_i^1(t) + Q(t+1)$$

$$P^2(t+1) = P_0^2(t) + \sum_{i=1}^{100} P_i^2(t) \times SR_i^2(t) - \sum_{i=0}^{100} P_i^2(t) \times QR_i^2(t)$$

$P_i^2(t)$ Rural age/sex specific population aged **i** in **year t**

$SR_i^1(t)$ Survival rate of age/sex specific population aged **i** in **year t** in the urban life table

$SR_i^2(t)$ Survival rate of age/sex specific population aged **i** in **year t** in the rural life table

$P^1(t)$ Projected urban population in **year t**

$P^2(t)$ Projected rural population in **year t**

2. Cohort Component Model

- (4)Calculation Methods
  3) Projections of All Age Cohorts (e.g. five-year groups)

All Age Groups of 2005 Survived till 2010 (source: CHEN Wei)

	Female Population			Male Population		
Age Group	2005	Survival Rate	2010	2005	Survival Rate	2010
0-4	219131	0.99602		245206	0.99616	
5-9	244030	0.99846	218793	270833	0.99817	244757
10-14	290591	0.99912	243815	302254	0.99845	270414
15-19	527433	0.99910	290328	585966	0.99839	301767
20-24	737156	0.99876	526780	789468	0.99758	584546
25-29	657965	0.99815	735791	674660	0.99651	786712
30-34	681612	0.99774	656475	713753	0.99552	671639
35-39	665321	0.99716	679674	709602	0.99410	709542
40-44	726488	0.99598	662648	789678	0.99196	703897
45-49	663745	0.99363	721859	675343	0.98833	780460
50-54	605311	0.98970	656906	591589	0.98200	663186
55-59	394484	0.98351	595329	371799	0.97144	574694
60-64	315504	0.97062	382893	268918	0.95449	354878
65-69	331997	0.94530	298245	295184	0.92034	247495
70-74	259322	0.89841	298271	257879	0.86024	253929
75-79	153903	0.82313	213455	148484	0.76972	198494
80-84	77713	0.70894	109108	70884	0.63690	94569
85+	38253	0.47668	55278	28542	0.42093	41851

2. Cohort Component Model

(4) Calculation Methods

4) Projections of Migrants (e.g. projections of migrants from rural to urban areas)

$$Q(t+1) = \sum_{i=0}^{100} P_i^2(t) \times QR_i^2(t) \times SR_i^1(t)$$

$$QR_i^2(t) = AQR_i^2(t) \times TQR(t)$$

$QR_i^2(t)$ *Migration rate of sex-specific groups aged i (in year t)at the end of year t*

$Q(t+1)$ *Number of migrants by age-sex in year t*

$AQR_i^2(t)$ *Standardized migration rate of sex-specific groups aged i (in year t) at the end of t (i refers to age ranging from 0 to 100 years)*

$TQR(t)$ *Sex-specific total migration rate in year t*

2. Cohort Component Model

(4) Calculation Methods

4) Projections of Migrants

	女性人口			男性人口		
年龄组	净迁入人口	存活率	2010年	净迁入人口	存活率	2010年
0-4	91839	0.99801		127387	0.99808	
5-9	58749	0.99923	91768	84505	0.99908	127270
10-14	53499	0.99956	58723	57903	0.99923	84440
15-19	159082	0.99955	53475	194554	0.99919	57857
20-24	365646	0.99938	158983	408101	0.99879	194319
25-29	334089	0.99907	365308	398638	0.99825	407389
30-34	278467	0.99887	333711	366543	0.99776	397746
35-39	186510	0.99858	278071	267347	0.99705	365462
40-44	104226	0.99799	186135	162063	0.99598	266272
45-49	48367	0.99681	103894	78417	0.99416	161117
50-54	46126	0.99485	48118	60749	0.99100	77712
55-59	35981	0.99176	45746	40433	0.98572	59881
60-64	26720	0.98531	35452	27661	0.97724	39513
65-69	20173	0.97265	25989	20911	0.96017	26559
70-74	11030	0.94921	19148	11845	0.93012	19450
75-79	5073	0.91156	10055	5228	0.88486	10481
80-84	4424	0.85447	4334	2713	0.81845	4279
85+		0.73834	3266		0.71046	1928

2. Cohort Component Model

(5)Projection Parameters

- Approaches to Determining Parameters (by urban-rural)

1) Average Life Expectancy — Deaths

2) Total Fertility Rate — Births

3) Speed of Urbanization; Share of Immigrants — Migrants

Think:

How do we determine these parameters in projecting population development trends of this province?

2. Cohort Component Model

(5) Projection Parameters

Factors Impacting Average Life Expectancy

Three Health Indicators: average life expectancy, maternity death rates and infant death rates.

- At the Macro Level: multiple increase in the number of health professionals; growth in the number of community-based health service centers and stations, hospitals and hospital cots; higher quality of drinking water; efficient prevention and control of major diseases and public health emergencies.
- At the Micro Level: diet, hobby, habit, education, profession, marriage, interpersonal relationship, relative.
- Vertically: historic evolution; fertility changes in 1982, 1987, 1990, 1995, 2000, 2005, 2010.
- Horizontally: East, West, Northeast, and Central China/north, east and south coastal areas/middle reaches of the Yellow River, Northwest and Southwest China, and midstream of the Yangtze River/ china.
- Planning Indicator: National Medium- and Long-Term Program in Education Reform and Development Plan (2010–2020).

2. Cohort Component Model

(5) Projection Parameters

Factors Influencing Fertility

- At the Macro Level: fertility policy; women's mean years of schooling
- At the Micro Level: personal hobby, education level, and profession
- Vertically: historic evolution; life expectancy changes in 1982, 1987, 1990, 1995, 2000, 2005, 2010.
- Horizontally: East, West, Northeast, and Central China/north, east and south coastal areas/middle reaches of the Yellow River, Northwest and Southwest China, and midstream of the Yangtze River/ china.
- Planning Indicator: National Medium- and Long-Term Program in Education Reform and Development Plan (2010–2020).

2. Cohort Component Model

(5) Projection Factors

Speed of Urbanization

- At the Macro Level: migrant population changes; urban-rural structure
- At the Micro Level:
- Vertically: historic evolution; urbanization changes in 1982, 1987, 1990, 1995, 2000, 2005, 2010.
- Horizontally: East, West, Northeast, and Central China/north, east and south coastal areas/middle reaches of the Yellow River, Northwest and Southwest China, and midstream of the Yangtze River/ china.
- Planning Indicator: National Medium- and Long-Term Program in Education Reform and Development Plan (2010–2020).

(5) Projection Parameters

1) Average Life Expectancy source: CHEN Wei

(UN) Growth Model of Average Life Expectancy: Increments Every Five Years Based on Average Initial Life Expectancy

Initial Life Expectancy (year)	Very Fast		Fast		Moderate		Slow		Very Slow	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
67.5-70.0	2.0	3.3	1.5	2.6	1.2	2.1	1.0	1.5	0.6	1.0
70.0-72.5	1.5	3.0	1.2	2.0	1.0	1.8	0.8	1.2	0.5	0.8
72.5-75.0	1.3	2.0	1.0	1.5	0.9	1.2	0.8	0.9	0.5	0.8
75.0-77.5	1.1	1.8	0.8	1.2	0.6	1.0	0.5	0.8	0.5	0.7
77.5-80.0	1.0	1.6	0.5	1.0	0.5	0.9	0.4	0.7	0.4	0.5
80.0-82.5	0.9	1.4	0.5	0.8	0.5	0.6	0.4	0.5	0.4	0.5
82.5-85.0	0.8	1.3	0.5	0.5	0.5	0.5	0.4	0.4	0.3	0.4
85.0-87.5	0.7	1.3	0.5	0.5	0.4	0.4	0.3	0.3	0.2	0.2
87.5-90.0	0.6	1.2	0.5	0.5	0.4	0.4	0.3	0.3	0.2	0.2
90.0-92.5	0.6	0.8	0.5	0.5	0.4	0.4	0.3	0.3	0.2	0.2

(5) Projection Parameters

1) Average Life Expectancy(Reference) source: CHEN Wei

Changes of average life expectancy in the U.S., Japan, Germany, France, Britain during 1980-2006 Unit: year

Country	Average Life Expectancy				Average Growth Rate Every Five Years			Mean Value of Growth Every Five Years
	1980	1990	2000	2006	1980-1990	2000-1990	2006-2000	1980-2006
U.S.	73.7	75.2	77.0	77.8	0.8	0.9	0.4	0.7
Male	70.0	71.8	74.3	74.9	0.9	1.3	0.5	0.9
Female	77.5	78.8	79.9	80.3	0.6	0.6	0.3	0.5
JP	76.0	78.8	81.1	82.3	1.4	1.3	0.6	1.1
Male	73.3	75.9	77.9	78.7	1.3	1.0	0.7	1.0
Female	78.8	81.9	85.1	85.8	1.6	1.6	0.6	1.2
DE	72.6	75.1	77.9	79.1	1.3	1.9	1.1	1.4
Male	69.4	71.9	76.0	77.8	1.3	2.1	1.5	1.6
Female	76.0	78.5	81.8	82.7	1.3	1.7	0.8	1.2
FR	74.3	76.8	78.9	80.6	1.3	1.1	0.6	1.0
Male	70.3	72.8	75.2	76.2	1.3	1.2	0.8	1.1
Female	78.4	81.0	82.8	83.2	1.3	0.9	0.3	0.8
UK	73.8	75.6	79.2	81.0	0.9	1.3	0.3	0.8
Male	70.8	72.9	75.7	76.3	1.1	1.4	0.5	1.0

2. Cohort Component Model

(5) Projection Parameters (Determinants)

1) Average Life Expectancy (National Level)

Comparison of Average Life Expectancy Target under Different Scenarios: 2010-2050 Unit: yea

Year	Low			Medium			High		
	Total	Male	Female	Total	Male	Female	Total	Male	Female
2000	71.4	69.6	73.3	71.4	69.6	73.3	71.4	69.6	73.3
2005	73.0	70.8	75.3	73.0	70.8	75.3	73.0	70.8	75.3
2010	73.8	71.8	76.0	74.2	72.1	76.4	74.5	72.4	76.8
2015	74.7	72.8	76.7	75.4	73.4	77.5	76.1	74.0	78.2
2020	75.4	73.6	77.4	76.5	74.5	78.6	77.5	75.5	79.6
2025	76.2	74.4	78.1	77.6	75.7	79.6	79.0	77.1	80.9
2030	77.0	75.2	78.7	78.7	76.7	80.7	80.2	78.3	82.2
2035	77.6	75.8	79.4	79.6	77.7	81.6	81.4	79.4	83.4
2040	78.3	76.4	80.1	80.6	78.6	82.6	82.6	80.5	84.6
2045	78.9	77.0	80.8	81.4	79.5	83.5	83.6	81.5	85.6
2050	79.4	77.6	81.5	82.3	80.3	84.4	84.7	82.5	86.6

2. Cohort Component Model

(5) Projection Parameters (Determinants)

1) Average Life Expectancy (National Level)

- Low Level: a scenario of China's life expectancy of 79 years by 2050. In the next 40 years, life expectancy will increase by five years — a growth of 0.6 year every five years according to UN's latest projection.
- High Level: a scenario of China's life expectancy of 85 years by 2050. In the next 40 years, life expectancy will increase by 10 years — a growth of 1.3 years every five years according to the *Overview of China Sustainable Development* released by Chinese Academy of Sciences.
- Medium Level: a scenario of China's life expectancy of 82 years by 2050. In the next 40 years, life expectancy will increase by 8 years — a growth of about 1 year every five years. Empirical data of life expectancy change in developed countries and regions show that when life expectancy stays at 74 years, it grows by 1.2 years every five years, and when it reaches 80, it grows by 0.7 year every five years. By this growth rate, it's projected to take around 25 years for China to have a life expectancy of 80 years — that is, by 2035; the life expectancy is projected to reach 82 by 2050.

2. Cohort Component Model

(5) Projection Parameters (Determinants)

1) Total Fertility Rate (Urban and Rural Level)

Parameter Setting for Urban-Rural Total Fertility Rate

	Low			Medium			High		
Period	National	Urban	Rural	National	Urban	Rural	National	Urban	Rural
2001-2005	**1.66**	**1.22**	**2.09**	**1.66**	**1.22**	**2.09**	**1.66**	**1.22**	**2.09**
2006-2010	**1.65**	**1.20**	**2.10**	**1.66**	**1.20**	**2.11**	**1.66**	**1.21**	**2.11**
2011-2015	**1.60**	**1.18**	**2.02**	**1.68**	**1.26**	**2.10**	**1.74**	**1.37**	**2.10**
2016-2020	**1.54**	**1.16**	**1.93**	**1.72**	**1.33**	**2.10**	**1.84**	**1.59**	**2.10**
2021-2025	**1.48**	**1.13**	**1.83**	**1.75**	**1.40**	**2.10**	**1.95**	**1.80**	**2.10**
2026-2030	**1.42**	**1.11**	**1.74**	**1.79**	**1.48**	**2.10**	**2.06**	**2.02**	**2.10**
2031-2035	**1.40**	**1.10**	**1.70**	**1.80**	**1.50**	**2.10**	**2.10**	**2.10**	**2.10**
2036-2040	**1.40**	**1.10**	**1.70**	**1.80**	**1.50**	**2.10**	**2.10**	**2.10**	**2.10**
2041-2045	**1.40**	**1.10**	**1.70**	**1.80**	**1.50**	**2.10**	**2.10**	**2.10**	**2.10**
2046-2050	**1.40**	**1.10**	**1.70**	**1.80**	**1.50**	**2.10**	2.10	**2.10**	**2.10**

2. Cohort Component Model

(5) Projection Parameters (Determinants)

2) Total Fertility Rate (Urban-Rural)

- **Scenario of Medium Level:** TFR will reach 1.8 by 2030, up from current rate of1.5-1.65. On average, urban families will have 1.5 children and rural families two children based on current fertility policies.
- **Scenario of Low Level:** TFR will fall from current rate to the rate of 1.4 by 2030 and stay unchanged during 2030-2050. This rate is relatively close to current surveyed rate and represents a low rate in current developed countries.
- **Scenario of High Level:** TFR will return to the replacement rate of 2.1 by 2030. In the next 40 years, in order to avoid development issues brought by low FTR, every couple can have two babies. A proper future urbanization requires urban FTR to reach the replacement level that ensure zero growth or decline in total population.

2. Cohort Component Model

(5) Projection Parameters (Determinants)

3) Urbanization Level

Projection Parameters for Level Ⅰ and Level Ⅱ

Period	Annual Growth Rate(%)		Percentage Point of Annual Growth	
	Level Ⅰ	Level Ⅱ	Level Ⅰ	Level Ⅱ
2001-2005	4.13	4.13	1.4	1.4
2006-2010	2.52	2.65	0.9	1.0
2011-2015	2.10	2.63	0.8	1.0
2016-2020	1.67	2.02	0.7	0.9
2021-2025	1.32	1.56	0.6	0.8
2026-2030	1.08	1.24	0.6	0.7
2031-2035	0.88	0.99	0.5	0.7
2036-2040	0.68	0.74	0.5	0.6
2041-2045	0.44	0.48	0.5	0.6
2046-2050	0.21	0.23	0.4	0.5

2. Cohort Component Model

(5) Projection Parameters (Determinants)

3) Urbanization Level (Analysis)

- Level Ⅰ: 60% by 2030
- Level Ⅱ: 65% by 2030

2. Cohort Component Model

(6) Plans for High, Medium, and Low Levels (Rural and Urban Areas across China)

2010-2050年人口预测六种组合方案（平均预期寿命取中限）		
2030生育水平	城镇化发展水平 I （2030年 60%）	城镇化发展水平 II （2030年 65%）
低方案 （TFR1.4）	低生育水平和城镇化水平 I	低生育水平和城镇化水平 II
中方案 （TFR1.8）	中生育水平和城镇化水平 I	中生育水平和城镇化水平 II
高方案 （TFR2.1）	高生育水平和城镇化水平 I	高生育水平和城镇化水平 II

2. Cohort Component Model

(6) Plans for High, Medium, and Low Levels (Rural and Urban Areas across China)

Six Combinations of Projections: 2020-2050
Fertility: Medium

2050 Life Expectancy Target	Urbanization Level Ⅰ (60% in 2030)	Urbanization Level Ⅱ (65% in 2030)
79 years (Low)	Low life expectancy and level Ⅰ	Low life expectancy and level Ⅱ
82 years (Medium)	Medium life expectancy and level Ⅰ	Medium life expectancy and level Ⅱ
85 years (High)	High life expectancy and level Ⅰ	High life expectancy and level Ⅱ

III. Analysis of Projection Results (Key Takeaway)

Projection of Population Data

1. General Trend of Population Development
2. Population Growth Trend
3. Trend of Age Structure Change

1. Population Development Trend

(1) Total Population (high, medium, low fertility)

Projection of Total Population Development Unit: 100 million

Years	Urbanization Level Ⅰ			Urbanization Level Ⅱ		
	Low	Medium	High	Low	Medium	High
2009	13.35	13.35	13.35	13.35	13.35	13.35
2010	13.42	13.42	13.42	13.42	13.42	13.42
2011	13.49	13.49	13.50	13.49	13.49	13.50
2012	13.56	13.57	13.58	13.56	13.57	13.58
2013	13.62	13.64	13.66	13.62	13.64	13.66
2014	13.69	13.72	13.74	13.68	13.71	13.74
2015	13.75	13.79	13.82	13.74	13.78	13.82
2020	13.95	14.07	14.18	13.92	14.04	14.16
2025	14.00	14.24	14.45	13.96	14.19	14.42
2030	13.94	14.32	14.66	13.88	14.26	14.63
2035	13.77	14.31	14.81	13.70	14.24	14.78
2040	13.51	14.22	14.90	13.42	14.13	14.87
2045	13.14	14.04	14.93	13.02	13.92	14.89

1. Population Development Trend

(1) Total Population (High, Medium, Low Life Expectancy)

Total Population and Population Aged Above 60 Unit: 100 million

	Urbanization Level I			Urbanization Level II		
	Low	Medium	High	Low	Medium	High
2010						
Total Population	13.42	13.42	13.42	13.42	13.42	13.42
>=60	1.74	1.74	1.75	1.74	1.74	1.75
>=65	1.16	1.16	1.17	1.16	1.16	1.17
>=80	0.20	0.20	0.20	0.20	0.20	0.20
2020						
Total Population	14.05	14.07	14.10	14.02	14.04	14.07
>=60	2.52	2.53	2.56	2.52	2.53	2.56
>=65	1.78	1.79	1.82	1.78	1.79	1.82
>=80	0.30	0.30	0.31	0.30	0.30	0.31
2030						
Total Population	14.24	14.32	14.42	14.18	14.26	14.36
>=60	3.69	3.75	3.84	3.69	3.75	3.84
>=65	2.53	2.59	2.67	2.53	2.59	2.67
>=80	0.44	0.46	0.49	0.44	0.46	0.49
2050						
Total Population	13.45	13.75	14.14	13.30	13.60	13.99
>=60	4.72	4.98	5.34	4.72	4.99	5.35
>=65	3.57	3.82	4.15	3.58	3.82	4.16
>=80	1.10	1.25	1.46	1.11	1.25	1.47

2. Trend of Population Growth

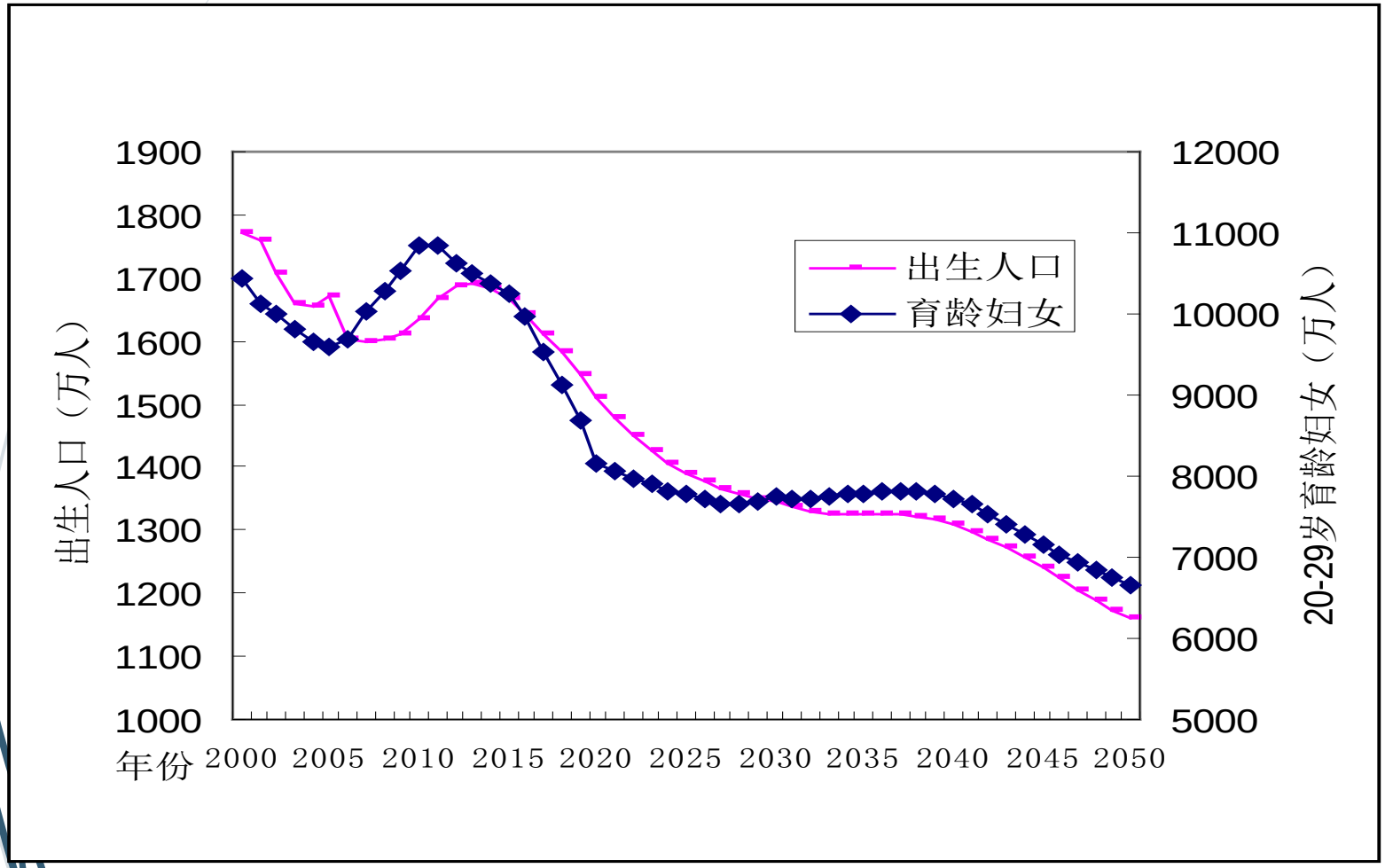
(1) Births

Average Births and Birth Rates

Periods	Average Births(10,000)			Average Birth Rate‰		
	Low	Medium	High	Low	Medium	High
2001-2005	1690	1690	1690	13.1	13.1	13.1
2006-2010	1606	1610	1614	12.1	12.2	12.2
2011-2015	1600	1680	1749	11.8	12.3	12.8
2016-2020	1414	1579	1723	10.2	11.3	12.3
2021-2025	1200	1429	1635	8.6	10.1	11.4
2026-2030	1067	1360	1632	7.6	9.5	11.2
2031-2035	1006	1329	1646	7.3	9.3	11.2
2036-2040	969	1319	1685	7.1	9.2	11.3
2041-2045	890	1270	1691	6.7	9.0	11.3
2046-2050	788	1190	1667	6.1	8.6	11.2

2. Trend of Population Growth

(2)Births and Women of Childbearing Age (20-29 years)



3. Trend of Age Structure Changes

(1) Dependency Ratio

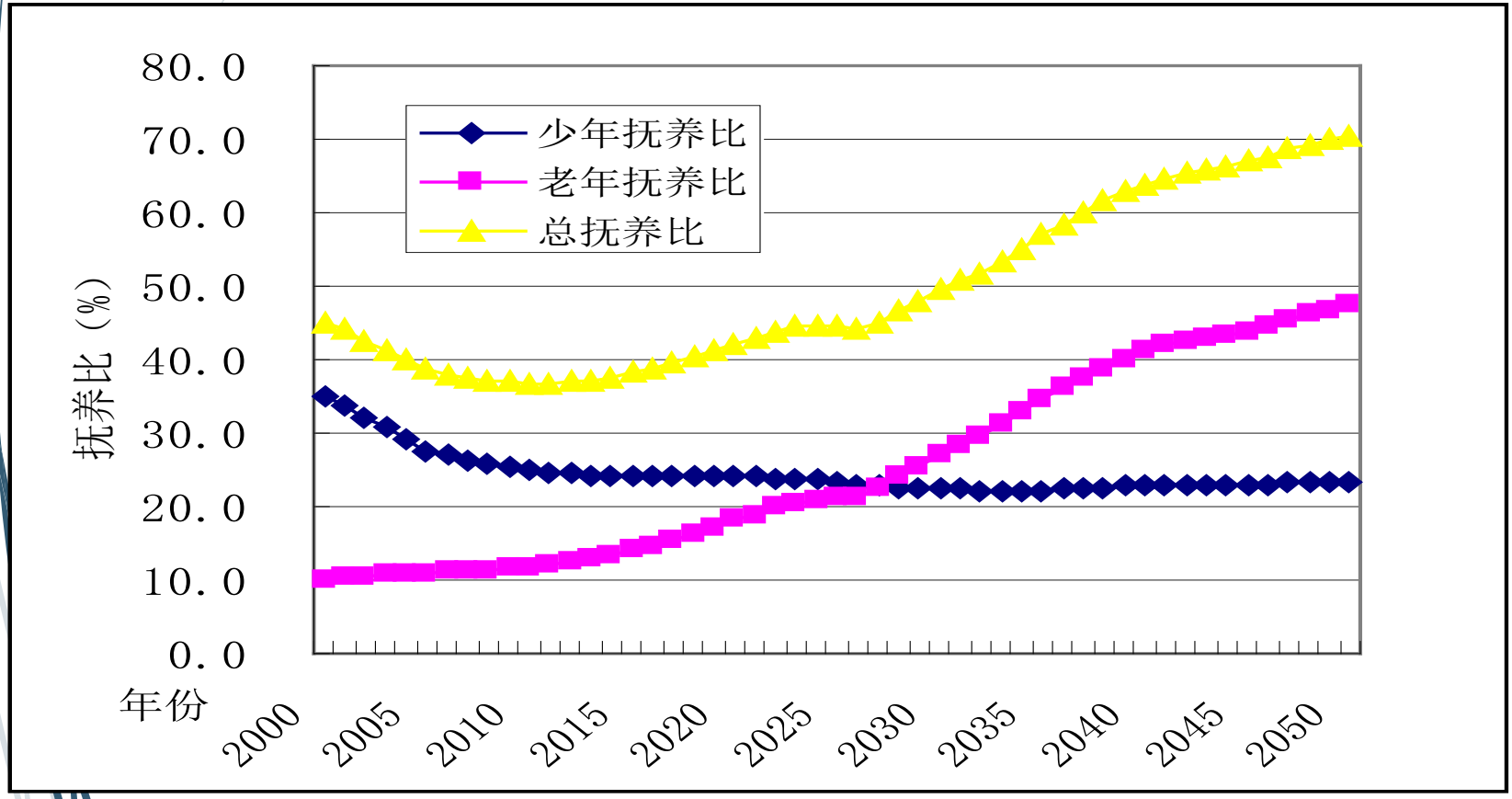
Trend of Average Dependency Ratio: 2001-2050
(Medium Plan; Urbanization Level I)

Period	0-14 years (100 million)	Above 65 years (100 million)	Dependency Ratio	Child Dependency Ratio	Aged Dependency Ratio
2001-2005	2.80	0.97	0.413	0.307	0.106
2006-2010	2.51	1.10	0.374	0.259	0.114
2011-2015	2.42	1.29	0.374	0.244	0.130
2016-2020	2.40	1.62	0.405	0.241	0.163
2021-2025	2.34	2.00	0.440	0.237	0.203
2026-2030	2.21	2.34	0.467	0.227	0.241
2031-2035	2.07	2.92	0.535	0.222	0.313
2036-2040	2.00	3.43	0.614	0.226	0.388
2041-2045	1.96	3.65	0.658	0.230	0.428
2046-2050	1.90	3.77	0.692	0.232	0.460

3. Trend of Age Structure Changes

(1) Dependency Ratio(Figure)

Annual Dependency Ratio: 2001-2050



3. Trend of Age Structure Changes

(2) Working-age Population

Working-age Population (15-64 years) (Mid-Scenario; Urbanization Level I)

Year	Working-age Population (100 million)			Its Shares of the Total Population		
	National	Urban	Rural	National	Urban	Rural
2009	9.74	4.80	4.94	0.730	0.772	0.693
2010	9.81	4.91	4.89	0.731	0.772	0.694
2011	9.86	5.02	4.84	0.731	0.772	0.693
2012	9.91	5.13	4.78	0.730	0.771	0.691
2013	9.95	5.23	4.72	0.729	0.770	0.689
2014	9.96	5.32	4.64	0.726	0.768	0.683
2015	9.96	5.40	4.56	0.723	0.765	0.678
2020	9.90	5.77	4.13	0.703	0.752	0.645
2025	9.85	6.09	3.76	0.692	0.743	0.622
2030	9.58	6.22	3.36	0.669	0.720	0.592
2035	9.12	6.19	2.93	0.637	0.685	0.555
2040	8.68	6.08	2.60	0.610	0.651	0.532
2045	8.41	6.02	2.39	0.599	0.630	0.533
2050	8.06	5.85	2.21	0.586	0.606	0.539

3. Trend of Age Structure Changes

(3) Elder Population

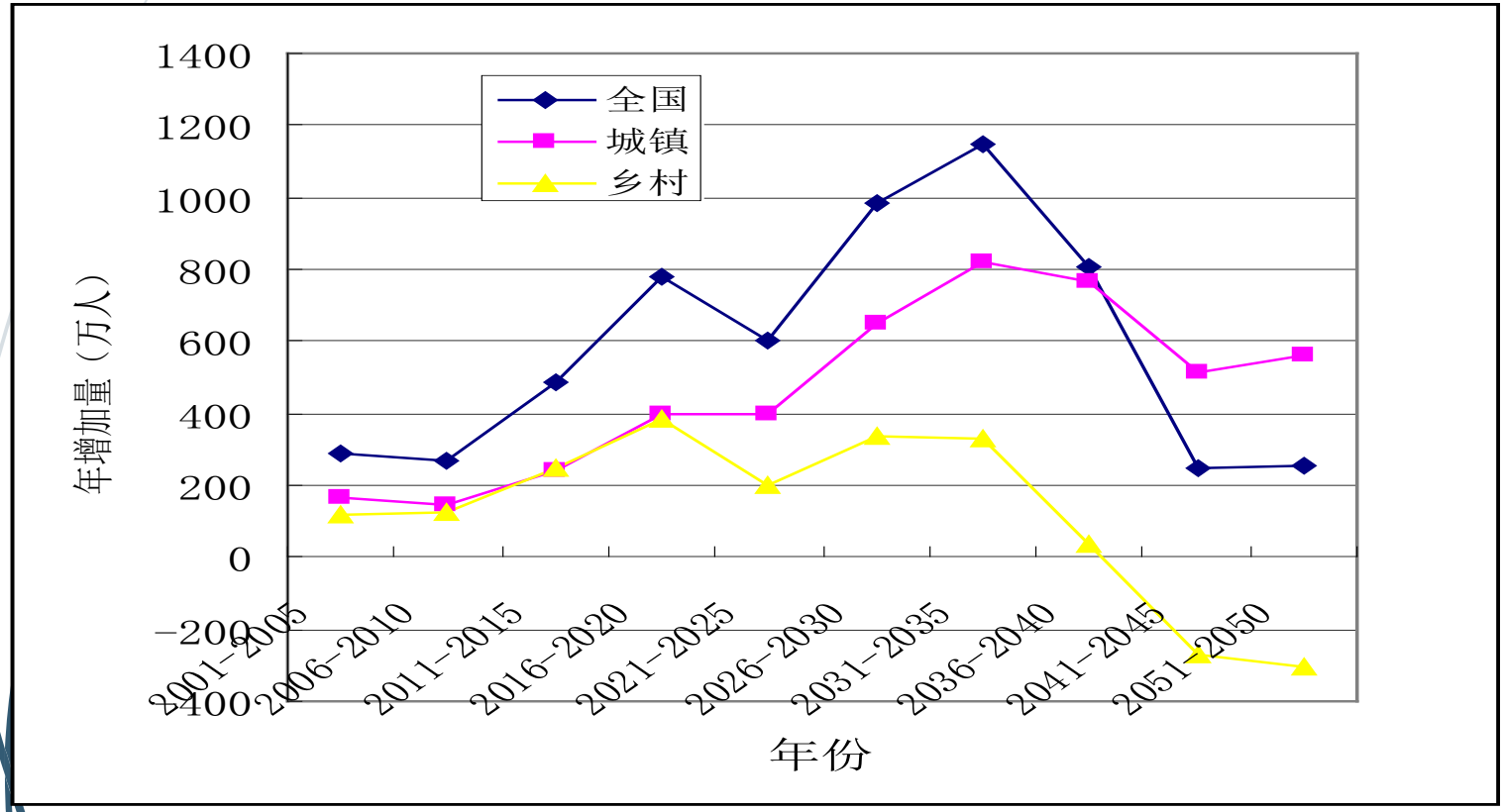
Population Aged Above 60 and 65
(Mid-Scenario; Urbanization Level I)

Year	Above 65(100 million)			Above 60(100 million)		
	National	Urban	Rural	National	Urban	Rural
2001-2005	0.97	0.34	0.63	1.40	0.49	0.91
2006-2010	1.10	0.41	0.69	1.62	0.60	1.01
2011-2015	1.29	0.51	0.78	1.99	0.79	1.20
2016-2020	1.62	0.67	0.95	2.41	1.03	1.38
2021-2025	2.00	0.89	1.11	2.81	1.31	1.51
2026-2030	2.34	1.13	1.21	3.47	1.74	1.73
2031-2035	2.92	1.52	1.40	4.07	2.22	1.85
2036-2040	3.43	1.94	1.49	4.37	2.59	1.78
2041-2045	3.65	2.24	1.41	4.57	2.95	1.63
2051-2050	3.77	2.52	1.25	4.84	3.30	1.54

3. Trend of Age Structure Changes

(3) Analysis of Aged Population Increments

Increments in Population Aged Above 60 and 65: 2001-2050



3. Trend of Age Structure Changes

(4) School-age Population

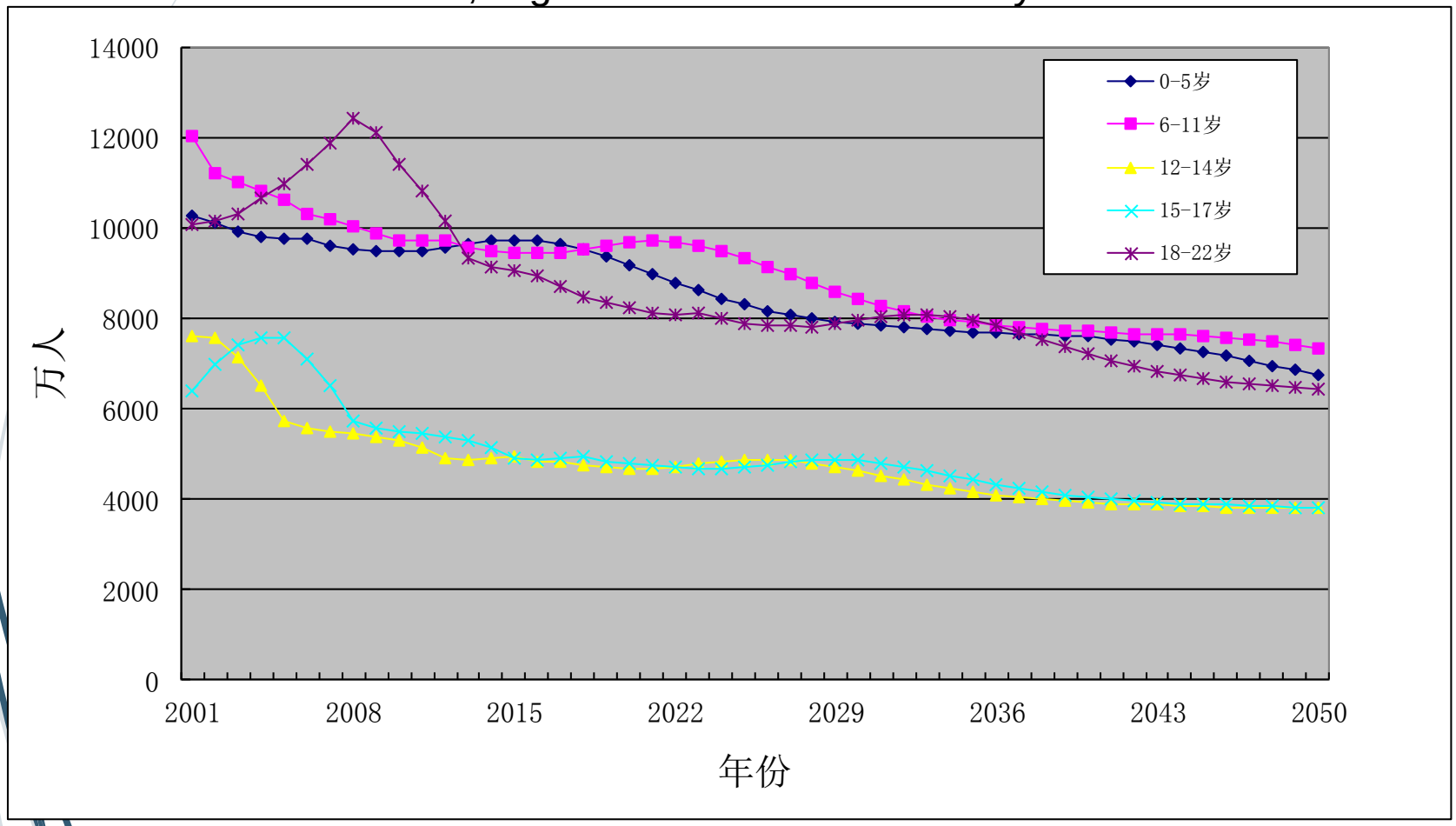
Urban and Rural School-age Population (6-22 years)
(Mid-Scenario; Urbanization Level I) Unit: 100 million

Period	National Level	6-11 years	12-14 years	15-17 years	18-22 years
2001-2005	3.57	1.11	0.69	0.72	1.04
2006-2010	3.34	1.00	0.54	0.61	1.19
2011-2015	2.95	0.96	0.50	0.52	0.97
2016-2020	2.77	0.96	0.48	0.49	0.85
2021-2025	2.72	0.97	0.48	0.47	0.80
2026-2030	2.66	0.90	0.49	0.49	0.79
2031-2035	2.56	0.83	0.45	0.47	0.81
2036-2040	2.41	0.80	0.41	0.43	0.77
2041-2045	2.29	0.79	0.40	0.40	0.70
2046-2050	2.23	0.78	0.39	0.39	0.67

3. Trend of Age Structure Changes

(4) School-age Population (Figure)

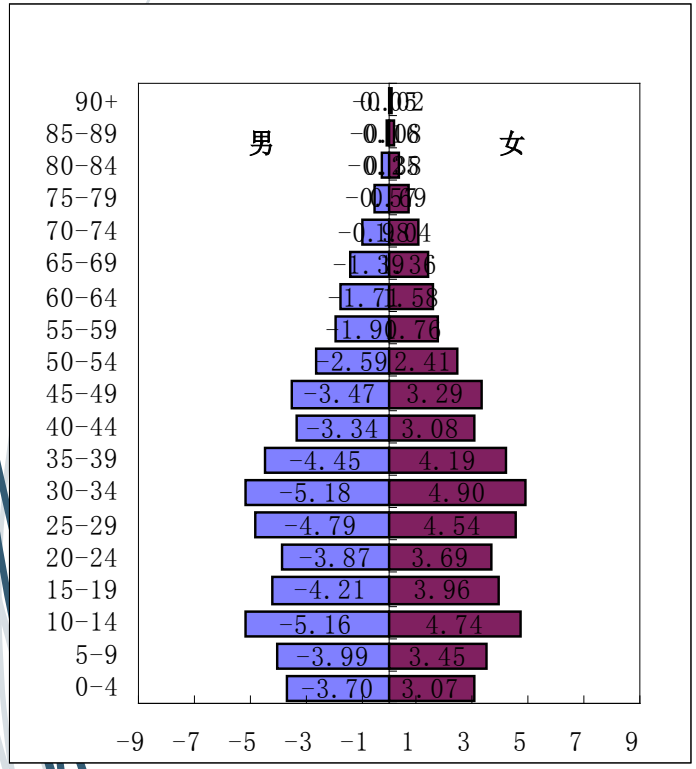
Population of Schooling Age Specified by Preschool, Primary, Middle, High Schools and University



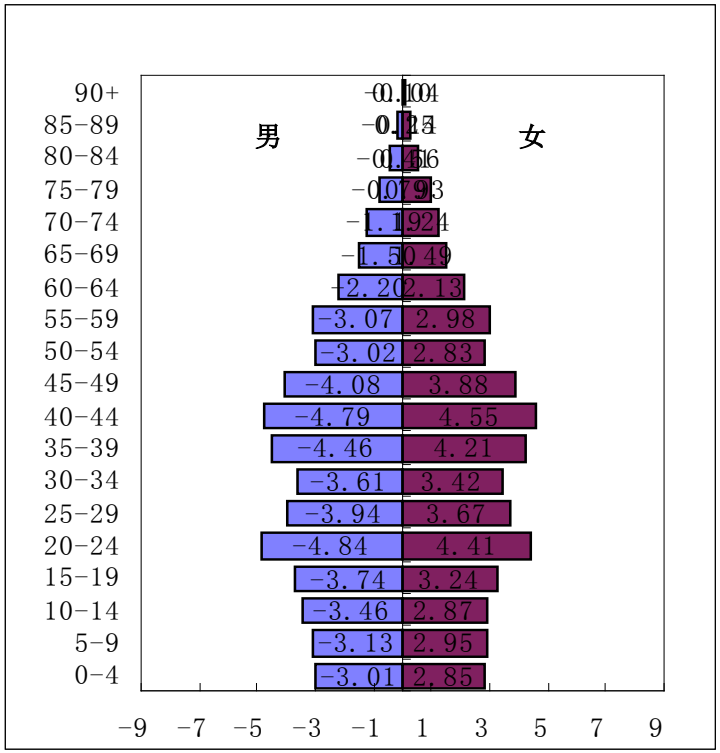
3. Trend of Age Structure Changes

(5) Population Pyramid

2000 China



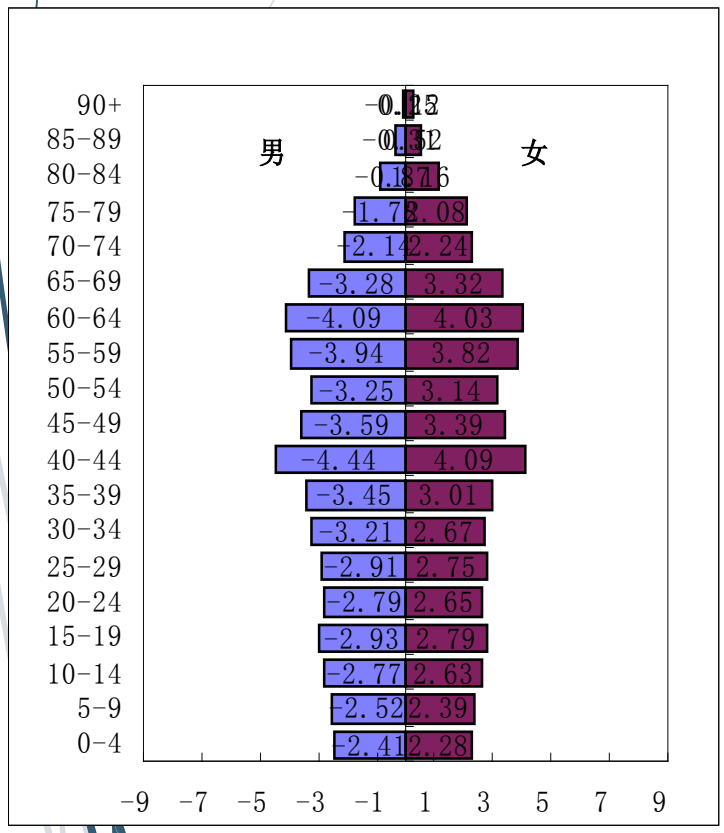
2010 China
(Projected)



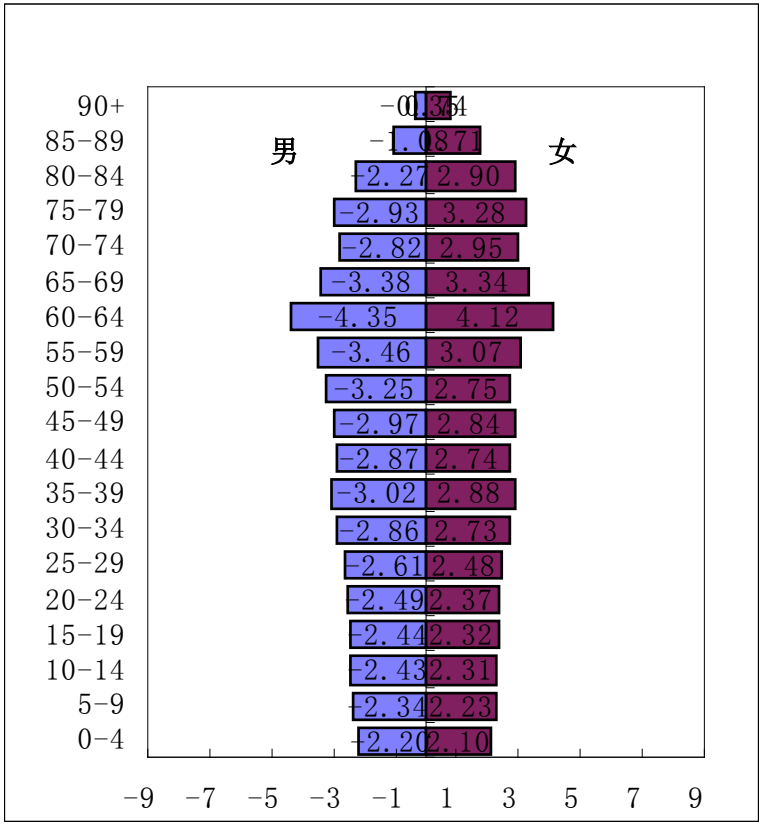
3. Trend of Age Structure Changes

(5) Population Pyramid

2030 China



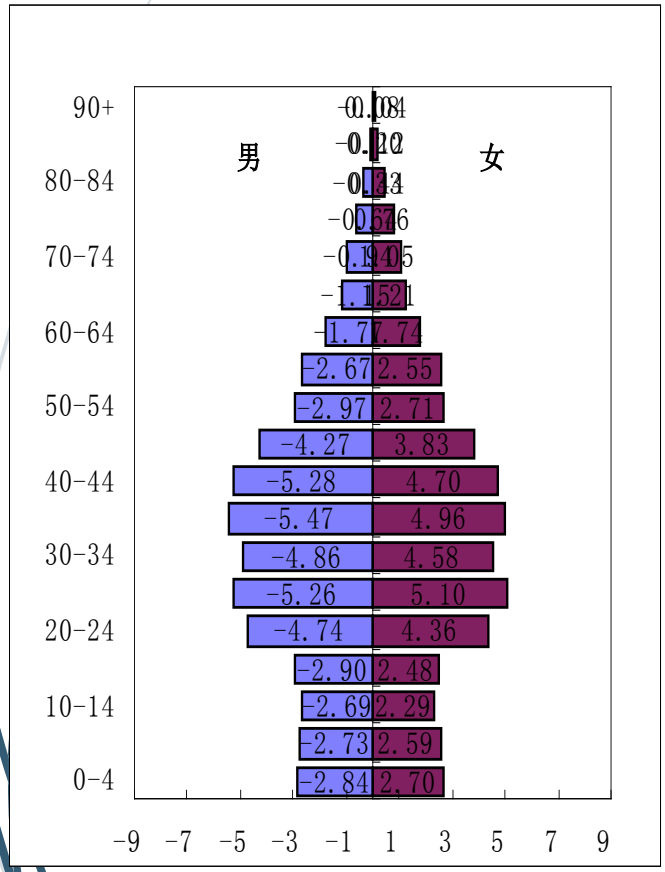
2050 China



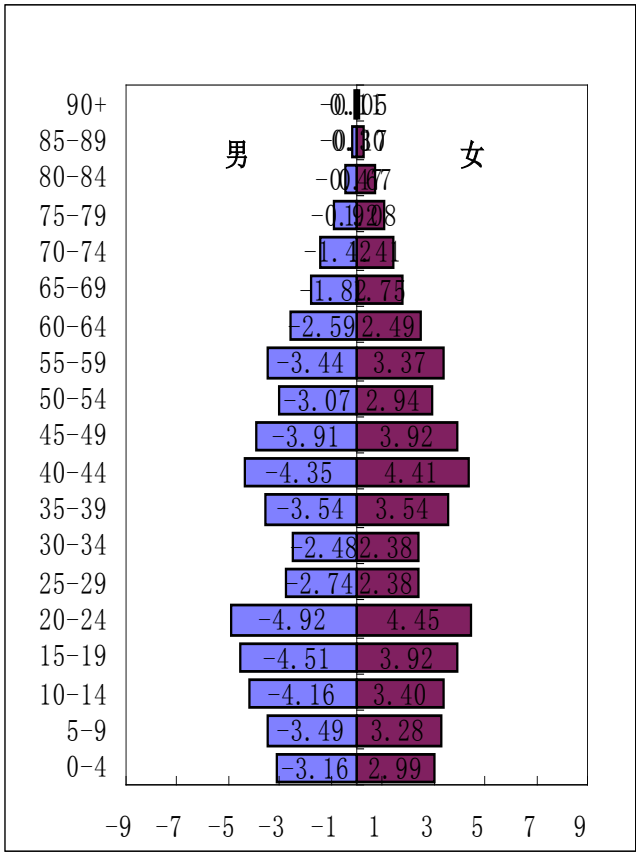
3. Trend of Age Structure Changes

(6) Urban and Rural Population Pyramid

2010 China Urban Population Age Pyramid (Projected)



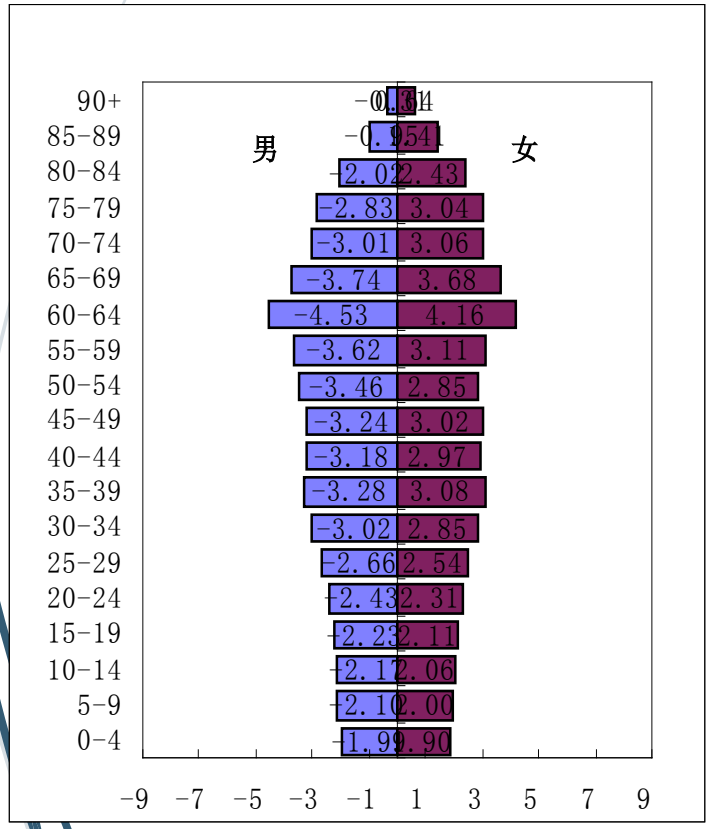
2010 China Rural Population Age Pyramid (Projected)



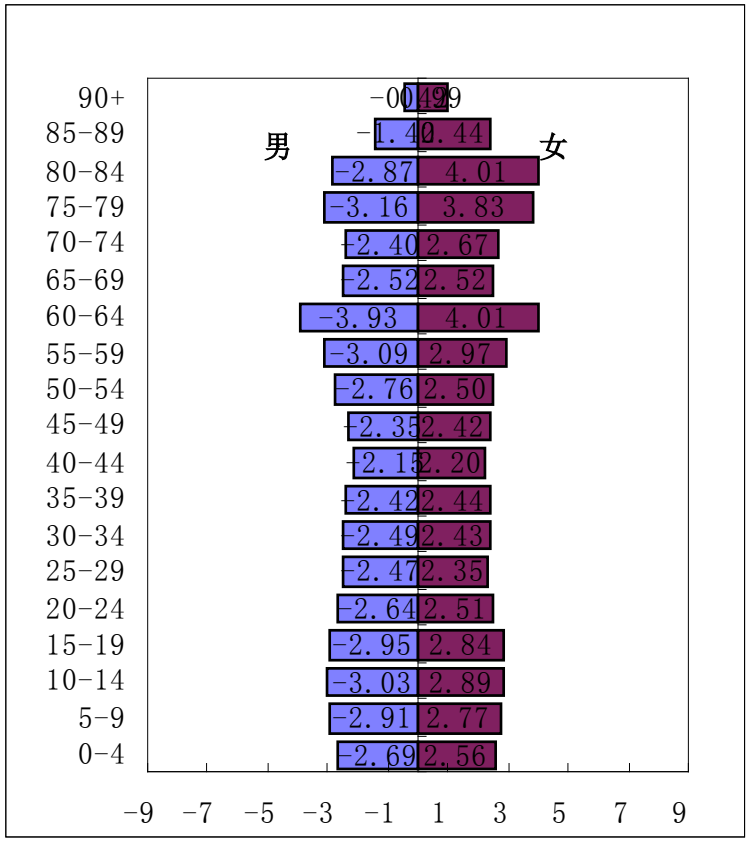
3. Trend of Age Structure Changes

(6) Urban and Rural Population Pyramid

2050 China Urban Population Age Pyramid



2050 China Rural Population Age Pyramid



IV. Population Projection Software

1. A computer program for making population projection

Spectrum(2007) system of policy models

(RUC Population Development Studies Center)

2. Multi-state Projection Model (developed by HASA9) adopted by PKU Institute of Population Research

3. NHFPC; CNCA

4. Self-developed projection programs

Q&A

Thank You