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ESTIMATES OF THE POPULATION SIZE AND OF THE BIRTH- AND DEATH-RATES IN JAPAN, 1865–1920

MASAAKI YASUKAWA AND KEIJIRO HIROOKA

I. PROBLEM

The population of Japan in 1868 (the early Meiji period) is said to have been approximately 35,000,000 and this is generally accepted today as the established theory. However, it is only since the first population census was taken in 1920 that the population came to be viewed in terms of a modern population survey. Therefore, it takes a special effort to estimate the population trend from the Meiji period (1868–1912) to the Taisho period (1912–1926) since the statistics prior to that time were incomplete in various aspects. Hence, many experiments have been carried out until today in efforts to clarify the population in this period.[1]

The Meiji-Taisho periods were the periods when Western civilization was introduced along with the Meiji Restoration, bringing about large changes in society, consequently the Industrial Revolution was experienced in the middle of the Meiji period and the country's economy made rapid progress. It is very interesting to investigate on how the population reacted to this economic development and how the transition took place during this period. Here, if we compare "the

[1] The following is the reference materials list on the population estimates of the Meiji period.

(1) "The Population of Japan since Meiji 5," by *The Cabinet Bureau of Statistics*, 1930, Tokyo.

(2) Takatsu, H., "Estimates of Population in Japan since 1872 (Meiji 5)," *The Statistics Bureau Study Report 1*, 1950, Tokyo.

(3) Honda, T., "Review of Japan's Vital Statistics since around the Meiji Restoration," Annual Reports of the Institute of Population Problems, No. 6, *The Institute of Population Problems*, 1961, Tokyo.

(4) Morita, Y., "An Analysis of the Population Growth in Japan in The Meiji Period," *An Analysis of Population Growth*, 1944, Chapter 8, Tokyo.

(5) Morita, Y., "An Estimation on the Actual Birth- and Death-Rates in the Early Meiji Period of Japan," *Population Studies*, Vol. XVII, No. 1, July, 1963, London.

(6) Okazaki, Y., "Population Estimates by Sex and Age from 1870's to 1920," *The Institute of Population Problems Research Series*, No. 145, February, 1962, Tokyo.

(7) Yasukawa, M., "Estimates of Annual Births and of the General Fertility Rates in Japan, 1890–1920—In Relation to 'The Demographic Transition Law—'," *Mita Journal of Economics*, Vol. 55, No. 5, 1962, Tokyo.

(8) Yasukawa, M., "Estimates of Annual Births and of the General Fertility Rates in Japan, 1890–1920 —To Make Allowances for the Effect of the 1918 and 1920 Influenza Epidemic—," *Mita Jounral of Economics*, Vol. 56, No. 8, 1963, Tokyo.

(9) Yasukawa, M., "Estimates of Annual Births and of the General Fertility Rates in Japan, 1890–1920—Derived by Projecting the Census Population of 1920 Backwards—", *Keio Economics Studies*, Vol. 1, 1963, Tokyo.

demographic transition" of Japan with that which Western developed countries experienced in the past, opinions would differ in many ways on whether the population changed in the same pattern as Western developed countries experienced or not. If so, it is considered to be significant in order to compare with many past estimated results as well as it is of our interest to give an actual proof and analysis for the study of the vital statistics of the Meiji-Taisho periods.

In order to estimate the population dating back to the Meiji period, there are, roughly speaking, two methods of classification. One of them is to estimate annual registration series of the population by setting the population in the original domicile that was initiated by the national census register table by prefectures in 1872 (Meiji 5) as a base, supplementing omissions in the census and calculating the number of births and deaths according to the vital statistics. Another method is to carry out inverse estimates of the population without depending upon the reported numbers of births and deaths, by setting the inverse survivorship ratio of the cohort obtained from the life table of the estimating period with the accurate population by age such as the 1920 census population as the starting point.[2] This study is according to the latter method. This method is called the inverse survivorship ratio method. In this method the major characteristics lie in the point that a highly accurate estimate is gained without depending upon the reported numbers of births and deaths, but only if the age-specific mortality rates[3] of the estimating period are grasped accurately.

Furthermore, as characteristics of this estimating work, we expect that our estimated results of the population of the Meiji-Taisho periods will satisfy the following four conditions:

(1) That the population size in the early Meiji period is at the level of 35,000,000.
(2) That the death rates are declining slightly and the birth rates are rising slightly.
(3) That the average life expectancy is not under the age level of 35.
(4) That the sex ratios at birth are not below 100 if the above three conditions are satisfied.

First of all, (1) is to have supported about the population of 35,000,000 in the early Meiji period which is generally accepted as the established theory today. (2) is that although it goes without saying that the death rates decline as the economy

[2] The reference materials (1)–(3) in note 1 are taking the first method, (4)–(9) the second method.

[3] The life table which explains about the oldest period among the existing life tables is the first one prepared by the Statistics Bureau of the Prime Minister's Office which explains the 1891–1898 periods. Accordingly, there is no material left on the age-specific mortality rates that explains the 1868–1891 period in order to give the age-specific mortality rates since the Meiji period, including this blank period, M. Yasukawa, first of all, prepared "The Model Life Tables for Japan" ("The Model Life Tables for Japan", Mita Journal of Economics, Vol. 64, No. 5, 1971, Tokyo.)

develops, however, with regard to the birth rates, we are of the opinion that it is possible that the birth rates rise in the early stages of the development depending upon the situation of the economy and society and the population trend before the development is initiated and we expect that this is found in the Meiji period. (3) is that if the average life expectancy in the early Meiji period was such a short one at less than 30 just as it is generally said, and moreover, if that short life expectancy persisted for a long time, the population growth of the Meiji period could not have been sustained unless the birth rates were at a fairly high level. Therefore, it is considered that the average life expectancy was not at such a low level. (4) is one of the powerful demographic check points with regard to the results of population estimates.

III. THE PROCEDURE OF ESTIMATING WORK

Estimates of the Population Size

In order to carry out the estimating work mentioned in the preceding section, the standard population which becomes the starting point and the life tables of 1868 (Meiji 1) onward are required. In this work the 1920 census population is used as the basic population and "The Model Life Tables for Japan" by M. Yasukawa is used in order to give the age-specific mortality rates in the estimating period. The estimating work is carried out with these two materials and the procedure of work is as follows:

(1) First of all, we prepare the first census population by sex and 5-year age gradation (Table 1).

TABLE 1. THE 1 ST CENSUS POPULATION OF 1920
—by Sex and 5-year Age Gradation—

Age	Total	Male	Female
	55,963,053	**28,044,185**	**27,918,868**
0– 4	7,457,715	3,752,627	3,705,088
5– 9	6,856,920	3,467,156	3,389,764
10–14	6,101,567	3,089,225	3,012,342
15–19	5,419,057	2,749,022	2,670,035
20–24	4,609,310	2,316,479	2,292,831
25–29	3,923,949	2,008,005	1,915,944
30–34	3,609,450	1,833,443	1,776,007
35–39	3,410,738	1,707,771	1,702,967
40–44	3,243,764	1,640,254	1,603,510
45–49	2,658,567	1,340,404	1,318,163
50–54	2,234,762	1,122,240	1,112,522
55–59	1,840,093	912,085	928,008
60–64	1,655,805	803,033	852,772
65–69	1,312,537	614,479	698,058
70–74	896,618	399,540	497,078
75–79	482,012	198,253	283,759
80 and over	250,189	90,169	160,020

But the population at age 75 and over is treated together because of the reason which will be explained later. The reason this is classified by 5-year age gradation is that as the life table is classified by 5-year age gradation, the inverse survivorship ratio which is set becomes the 5-year long age-specific mortality rate of the cohort classified by 5-year age gradation.

(2) "The Model Life Tables for Japan" is used as mentioned before in order to set the survivorship ratio that explains about every 5 years from 1865 to 1920 and on that occasion the standard of average life expectancy at birth ($\mathring{e}_0$) which corresponds to every 5 years must be decided beforehand.

(i) Out of the existing life tables, we pick out one which explains about the prewar time (Table 2), use the value of its $\mathring{e}_0$ as the annual registration series value and decide the $\mathring{e}_0$ levels which explains about every 5 years in the estimating period by applying the Gompertz curve (Figure 1).

If we see the transition of $\mathring{e}_0$ through the prewar and postwar periods, the application of the rising curve such as the logistic curve is considered. But if we see the movement more minutely it shows a slight rising in the prewar period, a drastic rising with the end of the war as the border line and a slight rising again after 1947. If we consider the year of the end of the war as the turning point, it shows the pattern of the unsymmetrical S-shaped growth. We considered the Gompertz curve would be appropriate in applying the curve that is suitable for such a growing process as this.

TABLE 2. The $\mathring{e}_0$ OF THE LIFE TABLES IN THE PREWAR TIME

Period		Male	Female
1891–1898	The Statistics Bureau's 1st Life Table	42.8	44.3
	Mizushima Reformed Life Table	35.29	36.86
	Matsuura Reformed Life Table	37.1	39.4
1899–1903	The Statistics Bureau's 2nd Life Table	43.97	44.85
	Mizushima Reformed Life Table	37.80	38.20
	Matsuura Reformed Life Table	37.1	40.9
1909–1913	The Statistics Bureau's 3rd Life Table	44.25	44.73
	Mizushima Reformed Life Table	40.22	40.80
1911–1912	Matsuura Reformed Life Table	41.3	42.6
1921–1925	The Statistics Bureau's 4th Life Table	42.06	43.20
1921–1922	Mizushima Reformed Life Table	41.48	42.49
1923	Mizushima Reformed Life Table	41.01	41.89
1924–1925	Mizushima Reformed Life Table	43.50	45.01
1926–1930	The Statistics Bureau's 5th Life Table	44.82	46.54
1935–1936	The Statistics Bureau's 6th Life Table	46.92	49.63

Materials:

1. Mizushima, H., "The Reformation of the Life Tables in the Early Period of Japan (The 1st–4th ones of the Statistics Bureau)" *Minzoku Eisei* Vol. 28, No. 1, January, 1962.
2. Matsuura, K., "Reformation of the Japanese Pre-census Life Table (The 1st–3rd ones of the Statistics Bureau)" *Kyushu Journal of Medical Science*, No. 9, 1958.

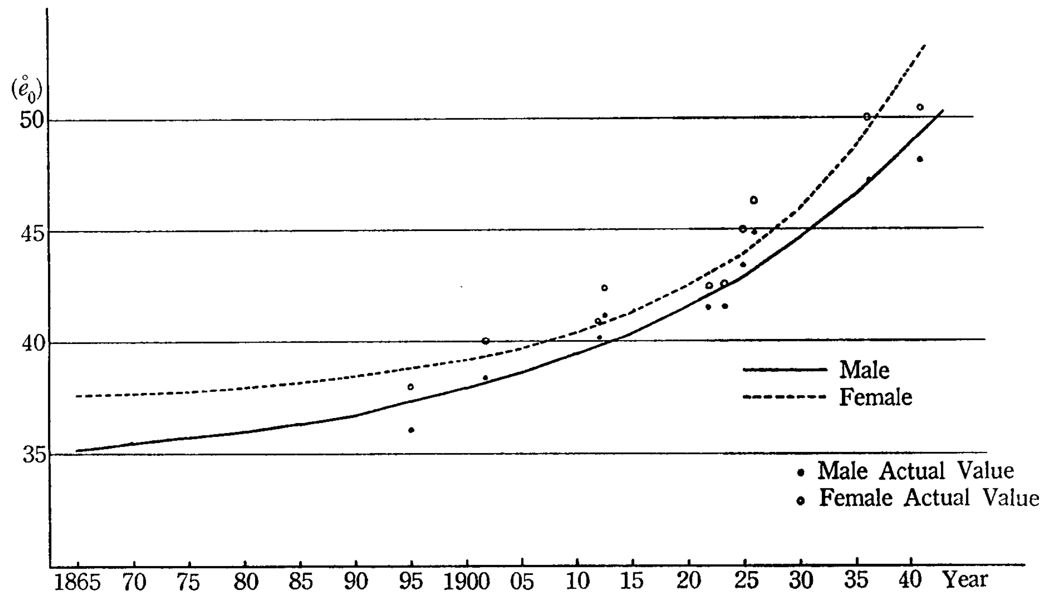

Fig. 1. The $\mathring{e}_0$ Levels by Year

The Gompertz curve is shown as $y = k \cdot g^{c^x}$ (x: time, y: dependent variable). And in order to apply this actually to the time series data and to decide the parameter, the continuous equally-intervaled data of the three groups are required. Therefore, we used the actual value of the selected $\mathring{e}_0$ mentioned above, estimated the annual $\mathring{e}_0$ of 1895–1942 by the interpolation, and applied the curve using this.[4]

The results of the application are as follows:

$$\text{Male:} \quad y = 33.688589 \times 1.11017519^{1.028533^x}$$

$$\text{Female:} \quad y = 37.303534 \times 1.04080192^{1.048415^x}$$

(where, x=0, 1895)

The estimated results of the annual $\mathring{e}_0$ levels by using these formulas are indicated in the Table 3.[5]

(ii) We decide the $\mathring{e}_0$ levels that explains about every 5 years by using that of each year decided in (1), pick out the corresponding mortality rate by 5-

[4] Life tables used are as follows:
The 3rd–6th Official Life Tables, the Cabinet Bureau of Statistics
Mizushima Reformed Life Tables
Matsuura Reformed Life Tables
When there were two values which explained about the same period, the average value was taken, finally ten values were used as the actual values and in regard to the rest of the years, and the values were estimated by the interpolation.

[5] If we look at the estimated results of $\mathring{e}_0$, we find the $\mathring{e}_0$ of females are always exceeding that of males and, furthermore, the higher the $\mathring{e}_0$ levels becomes, the bigger the difference becomes. And as the $\mathring{e}_0$ levels decreases, the difference between male and female before that period reverses and increases again with the level of $\mathring{e}_0$=40 (1915–1920) as the turning point. The study on this point would be a subject left for the later time.

TABLE 3. Estimates of the Annual $\mathring{e}_0$ Level since 1865

Year	Male	Female
1865	35.24	37.67
1870	35.48	37.76
1875	35.76	37.89
1880	36.08	38.04
1885	36.45	38.25
1890	36.89	38.50
1895	37.40	38.83
1900	37.99	39.24
1905	38.69	39.78
1910	39.51	40.46
1915	40.47	41.35
1920	41.61	42.50

year age gradation ($_5q_x$) from "The Model Life Tables for Japan", pick $_5L_x$ out in order to calculate the survivorship ratio and arrange them.

(iii) We calculate a series of the inverse survivorship ratios by using that $_5L_x$ and arranging them.

(3) By using the inverse of the census population by 5-year gradation in (1) and the inverse of the survivorship ratio in (iii) of (2), we estimate backwards the population by every 5 years one by one according to the following formulas.

$$({}_5P_x)_t = ({}_5P_{x+5})_{t+5} \times \left(\frac{{}_5L_x}{{}_5L_{x+5}}\right)_{t\sim t+5}$$

$({}_5P_x)_t$: the population at age $x \sim x+4$ in the year t

$\left(\frac{{}_5L_x}{{}_5L_{x+5}}\right)_{t\sim t+5}$: the inverse survivorship ratio explaining about the year $t \sim t+5$

(4) Treatment of the advanced age portion

In regard to the advanced age, we feel there is not much change in the age distribution of the Meiji-Taisho periods and assumed that the ratio of the advanced-aged population to the population size is certain. In a word, the following formulas are formed according to this period.

$({}_5P_{70})_t = \alpha \cdot ({}_{70}P_0)_t, \quad \alpha = \text{constant}$

$({}_+P_{75})_t = \beta \cdot ({}_{75}P_0)_t, \quad \beta = \text{constant}$

$({}_5P_{70})_t$: the population at ages 70–74 in the year t

$({}_{70}P_0)_t$: the population at ages 0–69 in the year t

$({}_+P_{75})_t$: the population at ages 75 and over in the year t

$({}_{75}P_0)_t$: the population at ages 0–74 in the year t

Direct Estimates of the Number of Births and the Birth Rates

The estimate of the number of births is the same with the estimate of the population size using the basic method, however, the difference in the actual work is that the estimate of the number of births is treated by each age group while the estimate of the population size are treated by the 5-year age gradation. That is to say, in order to estimate the number of births in 1865, the population at age 55 in 1920 and the survivorship ratio of the cohort born in 1865 during the 1865–1920 periods are required. In the same way, in order to estimate the number of births in 1870, the population at age 50 in 1920 and the survivorship ratio of the cohort born in 1870 during the 1870–1920 periods are required.

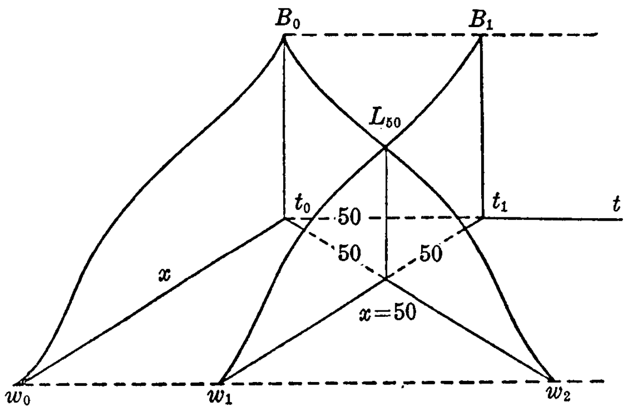

Fig. 2. The Transition of the Cohort (Model Figure)

Out of these things, let us show the basic forms of the structure and the change of the population in the cubic figure here (Figure 2). The three axes show age x, the number of births B and time t respectively. Suppose that we limit the population only to females, the age distribution of 1870 (t_0) is the plane (t_0, B_0, w_0) and the age distribution of 1920 (t_1) is shown in the plane (t_1, B_1, w_1). So, these two planes show the age distributions observed in two years respectively. And as the number of births B_0 (the population at age 0) in the time t_0 must be L_{50} in the time t_1 after 50 years, the population at age 50 in 1920 is the cohort of 1870. The cohort means the simultaneous birth group. Therefore, the plane (t_0, B_0, w_0) which proceeds to the right and this side obliquely shows the age distribution of the cohort which indicates the life course of the births group (B_0) born in 1970 (t_0). From this, it is possible to calculate the number of births by sex in 1870 dating back to the order of time from the population at age 50 in 1920.

Therefore, for example, the number of births in 1870 B_{1870} can be estimated in the following formula, if the population at age 50 in 1920 (${}_1P_{50}$) and the survivorship ratio of the cohort life table (${}_1L_{50}/l_0$) which is related to this are given.

$$B_{1870} = ({}_1P_{50})_{1920} \times \left(\frac{l_0}{{}_1L_{50}}\right)_{1870\sim1920}$$

The materials used here are the population by age in 1920 and the age-specific mortality rates explaining every 5 years and this can be also shown in the following procedure according to the order.

(1) It is not impossible to estimate the number of births by each year since we

can get the population by age out of the 1920 census. But as the work becomes complicated, we abbreviated and limited it to the estimate of the number of births by every 5 years here. So, we prepared the ages of multiples of 5 such as 0, 5, . . . etc. out of the 1920 census population (Table 4).

TABLE 4. THE POPULATION AT AGES 0, 5,. . . , 55 IN 1920
(The 1920 Census Population)

Age	Total	Male	Female
0	1,877,543	945,066	932,477
5	1,372,928	693,097	679,831
10	1,282,875	647,926	634,949
15	1,082,026	548,173	533,853
20	1,002,757	507,656	495,101
25	854,425	437,897	416,528
30	739,341	378,262	361,079
35	674,709	340,166	334,543
40	644,026	324,853	319,173
45	583,875	294,835	289,040
50	421,494	212,305	209,189
55	459,314	228,975	230,339

This is because "The Model Life Tables for Japan" is compiled every 5-year age gradation. Accordingly, ages 0, 5, . . ., 55 in 1920 as the basis, the number of births in every 5 years since 1865 are calculated.

(2) Next, we have to prepare the inverse survivorship ratio since 1865 onward, however, as ${}_5L_x$ is given in the above-mentioned model life table, it is required to turn this back to the number of survivorships by age ${}_1L_x$. Therefore, as ${}_1L_x$ is calculated from l_x in the life table, the series of ${}_1L_x$ is set using the following formulas.

$${}_1L_0 = 0.3\,l_0 + 0.7\,l_1$$

$${}_1L_1 = 0.4\,l_1 + 0.6\,l_2$$

$${}_1L_x = 0.9\,l_x + 0.1\,l_{x+5} \quad (x = 5, 10, \ldots, 55)$$

(3) Using ${}_1L_x$ calculated in (2), we calculate the series of ${}_1L_x/{}_1L_{x+5}$ and estimate the number of births in the following formulas (Tables 5 and 6).

Where,

B_{1865} is the number of births as of October 1, 1864–October 1, 1865.

$({}_1P_{55})_{1920}$ is the population at age 55 as of October 1, 1920.

$(1/p_0)_{1865}$ is the inverse survivorship ratio of the population at age 0 in 1865.

l_1 is the number of survivorship at age 1 in the life table.

$({}_1L_{50}/{}_1L_{55})$ is the inverse survivorship ratio of the population at ages 50 and 55 which explains the 1915–1920 period.

And we calculate further in the similar formula.

Where, ${}_1L_0 = 0.3\,l_0 + 0.7\,l_1$

$$_1L_1 = 0.4\, l_1 + 0.6\, l_2$$

$$p_0 = \frac{l_1}{l_0} = 1 - q_0$$

Indirect Estimates of the Number of Deaths and the Death Rates

The population growth is gained by the difference between the births and the deaths besides the migration. Therefore, the number of deaths is the difference between the number of births and the amount of growth. As the population size and the number of births are estimated every 5 years in this study, the number of deaths and the death rates can be estimated in the following way.

If we allocate the annual average of 5 years to the amound of growth in 1865 out of the two populations in 1865 and 1870, one fifth of the difference between two years becomes the amount of growth in 1865. Therefore, if we subtract this from the number of births in 1865, the number of deaths in 1865 is calculated. In this way, the number of deaths and death rates are estimated by using the population size and the number of births every 5 years. What can be said out of this work is that it is expected that the death rates follow the declining trend from the passage of the time series estimate of $\mathring{e}_0$ in accordance with Gompertz curve.

By using this method the indirect estimates of the number of births was carried out through the intermediary of the amount of growth in the population size with the number of births as the basis, the number of deaths in order to estimate the death rates is directly gained in the method which will be explained in the next section.

Direct Estimates of the Number of Deaths and Death Rates

The work up to the preceding section estimated the population of the Meiji-Taisho periods by using the backward estimating method of population and the number of births and the birth rates using the same method. But here, we applied the method to directly estimate the number of deaths in the Meiji-Taisho periods for the purpose of re-examining of the birth rates in 1870 which will be described later. That is to say, if the age-specific mortality rates of each year in the estimating period are given, the number of deaths is calculated by multiplying the estimated population of each year by this. The following is the summary of the work.

$_5q_x$ is put down in the life table that shows the age-specific mortality rates of each year, however, $_5q_x$ is originally calculated from the central mortality rate $_5m_x$ that shows the death possibility on the occasion of compiling the life table. This $_5m_x$ is shown as follows by the functions of life table $_5d_x$ and $_5L_x$.

$$_5m_x = \frac{_5d_x}{_5L_x}$$

Here, if we assume that $_5d_x/_5L_x$ is almost equal to $_5D_x/_5P_x$ in which $_5d_x$ is replaced by the mortality of the actual population by 5-year age gradation and $_5L_x$ by the the actual population by 5-year age gradation, the following formula can be formed.

TABLE 5. THE ESTIMATING FORMULA OF THE NUMBER OF BIRTHS FROM THE 1920 POPULATION

	1920	1915-20	1910-15	1905-10	1900-05	1895-1900	1890-95	1885-90	1880-85	1875-80	1870-75	1865-70	
$B_{1865}=$	$({}_1P_{55})_{1920}$	$\left(\frac{{}_1L_{50}}{{}_1L_{55}}\right)_{15-20}$	$\left(\frac{{}_1L_{45}}{{}_1L_{50}}\right)_{10-15}$	$\left(\frac{{}_1L_{40}}{{}_1L_{45}}\right)_{05-10}$	$\left(\frac{{}_1L_{35}}{{}_1L_{40}}\right)_{00-05}$	$\left(\frac{{}_1L_{30}}{{}_1L_{35}}\right)_{95-00}$	$\left(\frac{{}_1L_{25}}{{}_1L_{30}}\right)_{90-95}$	$\left(\frac{{}_1L_{20}}{{}_1L_{25}}\right)_{85-90}$	$\left(\frac{{}_1L_{15}}{{}_1L_{20}}\right)_{80-85}$	$\left(\frac{{}_1L_{10}}{{}_1L_{15}}\right)_{75-80}$	$\left(\frac{{}_1L_{5}}{{}_1L_{10}}\right)_{70-75}$	$\left(\frac{l_1}{{}_1L_{5}}\right)_{65-70}$	$\left(\frac{1}{p_0}\right)_{65}$
$B_{1870}=$	$({}_1P_{50})$	$\left(\frac{{}_1L_{45}}{{}_1L_{50}}\right)$	$\left(\frac{{}_1L_{40}}{{}_1L_{45}}\right)$	$\left(\frac{{}_1L_{35}}{{}_1L_{40}}\right)$	$\left(\frac{{}_1L_{30}}{{}_1L_{35}}\right)$	$\left(\frac{{}_1L_{25}}{{}_1L_{30}}\right)$	$\left(\frac{{}_1L_{20}}{{}_1L_{25}}\right)$	$\left(\frac{{}_1L_{15}}{{}_1L_{20}}\right)$	$\left(\frac{{}_1L_{10}}{{}_1L_{15}}\right)$	$\left(\frac{{}_1L_{5}}{{}_1L_{10}}\right)$	$\left(\frac{l_1}{{}_1L_{5}}\right)$	$\left(\frac{1}{p_0}\right)$	
$B_{1875}=$	$({}_1P_{45})$	$\left(\frac{{}_1L_{40}}{{}_1L_{45}}\right)$	$\left(\frac{{}_1L_{35}}{{}_1L_{40}}\right)$	$\left(\frac{{}_1L_{30}}{{}_1L_{35}}\right)$	$\left(\frac{{}_1L_{25}}{{}_1L_{30}}\right)$	$\left(\frac{{}_1L_{20}}{{}_1L_{25}}\right)$	$\left(\frac{{}_1L_{15}}{{}_1L_{20}}\right)$	$\left(\frac{{}_1L_{10}}{{}_1L_{15}}\right)$	$\left(\frac{{}_1L_{5}}{{}_1L_{10}}\right)$	$\left(\frac{l_1}{{}_1L_{5}}\right)$	$\left(\frac{1}{p_0}\right)$		
$B_{1880}=$	$({}_1P_{40})$	$\left(\frac{{}_1L_{35}}{{}_1L_{40}}\right)$	$\left(\frac{{}_1L_{30}}{{}_1L_{35}}\right)$	$\left(\frac{{}_1L_{25}}{{}_1L_{30}}\right)$	$\left(\frac{{}_1L_{20}}{{}_1L_{25}}\right)$	$\left(\frac{{}_1L_{15}}{{}_1L_{20}}\right)$	$\left(\frac{{}_1L_{10}}{{}_1L_{15}}\right)$	$\left(\frac{{}_1L_{5}}{{}_1L_{10}}\right)$	$\left(\frac{l_1}{{}_1L_{5}}\right)$	$\left(\frac{1}{p_0}\right)$			
$B_{1885}=$	$({}_1P_{35})$	$\left(\frac{{}_1L_{30}}{{}_1L_{35}}\right)$	$\left(\frac{{}_1L_{25}}{{}_1L_{30}}\right)$	$\left(\frac{{}_1L_{20}}{{}_1L_{25}}\right)$	$\left(\frac{{}_1L_{15}}{{}_1L_{20}}\right)$	$\left(\frac{{}_1L_{10}}{{}_1L_{15}}\right)$	$\left(\frac{{}_1L_{5}}{{}_1L_{10}}\right)$	$\left(\frac{l_1}{{}_1L_{5}}\right)$	$\left(\frac{1}{p_0}\right)$				
$B_{1890}=$	$({}_1P_{30})$	$\left(\frac{{}_1L_{25}}{{}_1L_{30}}\right)$	$\left(\frac{{}_1L_{20}}{{}_1L_{25}}\right)$	$\left(\frac{{}_1L_{15}}{{}_1L_{20}}\right)$	$\left(\frac{{}_1L_{10}}{{}_1L_{15}}\right)$	$\left(\frac{{}_1L_{5}}{{}_1L_{10}}\right)$	$\left(\frac{l_1}{{}_1L_{5}}\right)$	$\left(\frac{1}{p_0}\right)$					
$B_{1895}=$	$({}_1P_{25})$	$\left(\frac{{}_1L_{20}}{{}_1L_{25}}\right)$	$\left(\frac{{}_1L_{15}}{{}_1L_{20}}\right)$	$\left(\frac{{}_1L_{10}}{{}_1L_{15}}\right)$	$\left(\frac{{}_1L_{5}}{{}_1L_{10}}\right)$	$\left(\frac{l_1}{{}_1L_{5}}\right)$	$\left(\frac{1}{p_0}\right)$						
$B_{1900}=$	$({}_1P_{20})$	$\left(\frac{{}_1L_{15}}{{}_1L_{20}}\right)$	$\left(\frac{{}_1L_{10}}{{}_1L_{15}}\right)$	$\left(\frac{{}_1L_{5}}{{}_1L_{10}}\right)$	$\left(\frac{l_1}{{}_1L_{5}}\right)$	$\left(\frac{1}{p_0}\right)$							
$B_{1905}=$	$({}_1P_{15})$	$\left(\frac{{}_1L_{10}}{{}_1L_{15}}\right)$	$\left(\frac{{}_1L_{5}}{{}_1L_{10}}\right)$	$\left(\frac{l_1}{{}_1L_{5}}\right)$	$\left(\frac{1}{p_0}\right)$								
$B_{1910}=$	$({}_1P_{10})$	$\left(\frac{{}_1L_{5}}{{}_1L_{10}}\right)$	$\left(\frac{l_1}{{}_1L_{5}}\right)$	$\left(\frac{1}{p_0}\right)$									
$B_{1915}=$	$({}_1P_{5})$	$\left(\frac{l_1}{{}_1L_{5}}\right)$	$\left(\frac{1}{p_0}\right)$										
$B_{1920}=$	$({}_1P_{0})$	$\left(\frac{l_0}{{}_1L_{0}}\right)$											

TABLE 6. The ESTIMATED NUMBER OF BIRTHS

Male	$(Px)_{1920}$ × Inverse Survivorship Ratio $\left(\frac{L_x}{L_{x+5}}\right)$	Estimated Number of Births
B_{1865}	=228,975×1.1241×1.0869×1.0652×1.0531×1.0476×1.0495×1.0496×1.0399×1.0272×1.0364×1.1484×1.3293	=610,957
B_{1870}	=212,305×1.0808×1.0638×1.0520×1.0468×1.0473×1.0495×1.0399×1.0267×1.0358×1.1469×1.3270	=498,273
B_{1875}	=294,835×1.0663×1.0507×1.0459×1.0467×1.0495×1.0398×1.0261×1.0351×1.1449×1.3219	=630,652
B_{1880}	=324,853×1.0493×1.0448×1.0462×1.0495×1.0398×1.0255×1.0343×1.1429×1.3160	=646,990
B_{1885}	=340,166×1.0437×1.0455×1.0493×1.0398×1.0248×1.0333×1.1403×1.3092	=638,593
B_{1890}	=378,262×1.0383×1.0493×1.0349×1.0241×1.0323×1.1373×1.3016	=672,472
B_{1895}	=437,897×1.0557×1.0397×1.0275×1.0309×1.1341×1.2927	=735,995
B_{1900}	=507,656×1.0397×1.0221×1.0302×1.1307×1.2819	=801,019
B_{1905}	=548,173×1.0210×1.0281×1.1262×1.2681	=817,179
B_{1910}	=647,926×1.0268×1.1214×1.2522	=927,795
B_{1915}	=693,097×1.1160×1.0985	=948,350
Female		
B_{1865}	=230,339×1.0863×1.0681×1.0638×1.0615×1.0588×1.0579×1.0582×1.0491×1.0309×1.0373×1.1383×1.2721	=581,130
B_{1870}	=209,189×1.0663×1.0626×1.0608×1.0583×1.0575×1.0581×1.0490×1.0309×1.0370×1.1377×1.2711	=482,528
B_{1875}	=289,040×1.0611×1.0599×1.0575×1.0572×1.0563×1.0491×1.0307×1.0366×1.1373×1.2689	=621,288
B_{1880}	=319,173×1.0587×1.0565×1.0564×1.0577×1.0506×1.0305×1.0362×1.1367×1.2661	=642,289
B_{1885}	=334,543×1.0552×1.0554×1.0576×1.0489×1.0302×1.0356×1.1358×1.2625	=631,177
B_{1890}	=361,079×1.0538×1.0571×1.0489×1.0299×1.0348×1.1348×1.2579	=640,630
B_{1895}	=416,528×1.0535×1.0489×1.0294×1.0339×1.1335×1.2522	=695,547
B_{1900}	=495,101×1.0519×1.0289×1.0327×1.1318×1.2450	=774,943
B_{1905}	=533,853×1.0280×1.0313×1.1295×1.2358	=787,161
B_{1910}	=634,949×1.0298×1.1254×1.2246	=896,918
B_{1915}	=679,831×1.1202×1.2121	=917,767

$$_5D_x = {_5m_x} \times {_5P_x}$$

That is to say, if we multiply the population by 5-year age gradation of each year $_5P_x$ by $_5m_x$, the number of deaths by 5-year age gradation in each year is calculated. If we total this $_5D_x$ by age, the total number of deaths in each year is obtained. If we divide the total number of deaths thus obtained by the population size, the death rates are estimated.

Indirect Estimates of the Number of Births and the Birth Rates

Just as we estimated indirectly the number of deaths from the number of births, the indirect estimate of the number of births is aquired by adding the amount of growth to the direct estimate of the number of deaths. If we divide the result

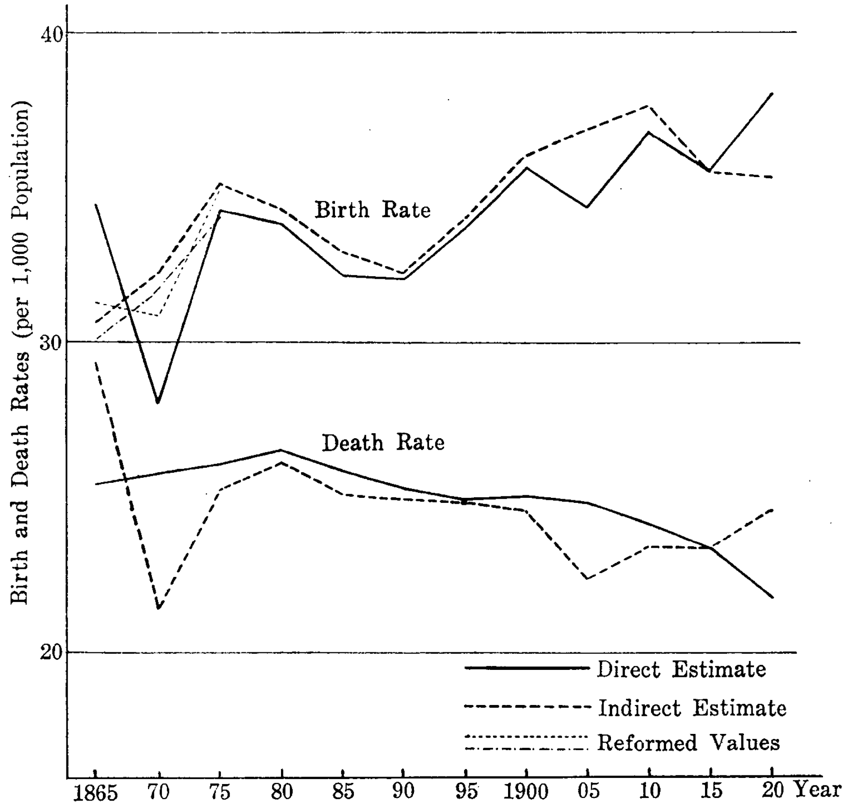

Fig. 3. The Comparison between Direct and Indirect Estimates of the Birth and Death Rates

by the population size, the birth rates are acquired. In paying attention to the fact that the estimated value of 1870 is calculated in an extraordinarily small scale compared to that of other years out of the number of births and the birth rates aquired by the indirect estimates, this estimating work was done for the purpose of re-examining this. And we decided to verifiy it by finding out to what extent this result and the result of the direct estimate corresponded. The result of this verification was, as we can see in the Figure 3, confirmed that they corresponded very well.

IV. THE REFORMATION OF THE BIRTH RATES IN 1865 AND 1870

It is found that the extraordinarily low value of the birth rates in 1870 is required to be reformed after comparing with and examining the indirect estimate acquired from the death rates. As the number of births in 1870 is calculated inversely with the population at age 50 in 1920 as the starting point, we carried out the following examination paying attention again to this population at age 50.

If we pick out the population at ages 45–59 out of the 1920 census population by age (Table 7), the population of both male and female at ages 49, 50 and 51 are

TABLE 7. THE POPULATION BY AGE IN 1920 (AGES 45–59)

Age	Male	Female	Birth Year	
45	294,835	289,040	Meiji 8	1875
46	284,428	280,639	7	1874
47	275,922	273,052	6	1873
48	255,836	250,014	5	1872
49	229,383	225,418	4	1871
50	212,305	209,189	3	1870
51	224,716	223,561	2	1869
52	255,192	254,180	1	1868
53	216,904	212,973	Keio 3	1867
54	213,123	212,619	2	1866
55	228,975	230,339	1	1865
56	212,156	211,913	Genji 1	1864
57	166,609	168,543	Bunkyu 3	1863
58	157,988	163,254	2	1862
59	146,357	153,959	1	1861

smaller compared to that at ages 46, 47 and 48. Especially the population at age 50 is shown extraordinarily small among them. Contrary to it, the population at age 52 is shown inversely large. Here, if we see the year of each birth, the population at age 48 was born in 1872 (Meiji 5), the population at age 50 was born in 1870 (Meiji 3) and the population at age 52 was born in 1868 (Meiji 1). Since 1870 was two years after Meiji 1, and Meiji 5 two years after that, was the year of population registration based upon the original domicile, it seems that there happened an extreme age heaping in that registration. And it is estimated that its effect is emerging in the population at ages 49–52 on the occasion of the 1920 census, the population at ages 49, 50 and 51 became small and the population at age 52 became large. Therefore, the following reformation was added in consideration to this point.

TABLE 8. THE REFORMED VALUES OF THE POPULATION AT AGES 50 AND 55 IN 1920

Age	Male	Female
55	207,553	207,278
50	235,486	232,472
(45	300,299	295,127)

First of all, we begin with the reformation of the population at ages 50 and 55 in 1920, and the important point is to take the moving average in order to remove the heaping by ages. That is to say, we estimate the population at age 50 averaging the population for 5 years from age 48 to age 52 and estimate the population at age 55 averaging the population for 5 years from age 53 to age 57. The result by sex is shown in Table 8. The population at age 45 is calculated in the same method for the comparison with indirect estimate.

The result of calculating the number of births in 1865 and 1870 by multiplying this value by the inverse survivorship ratios set in the indirect estimate of the number of births and calculating the birth rates by dividing it by the population size is the Table 9.

TABLE 9. THE REFORMED VALUES OF THE NUMBER OF BIRTHS AND BIRTH RATES IN 1865 AND 1870

Year	Number of Births	Birth Rate (per 1,000 Population)
1865	1,076,735	31.34
1870	1,088,929	30.90
(1875	1,276,715	35.08)

If we see this in Figure 3 it is found that the extreme decrease in 1870 is reformed and it shows a trend close to the indirect estimate.

As an another method of calculating the reformed values of the population at ages 50 and 55 in 1920, there is a method to use the population by 5-year age gradation shown in Table 1. That is to say, it is a method to figure out the population at age 50 from the population at ages 45–49 and the population at ages 50–54 and the population at age 55 from the population at ages 50–54 and the population at ages 55–59. The values reformed in this method are shown in Table 10.

TABLE 10. THE REFORMED VALUES OF 1865 AND 1870 ACQUIRED BY USING 5-YEAR AGE GRADATION

Year	Number of Births	Birth Rate
1865	1 037,079	30.18
1870	1,118,942	31.75
(1875	1,240,484	34.09)

This result is far nearer to the trend of indirect estimate of the birth rates than the reformed values by using the population by age mentioned previously. But as it is our purpose here to reform the age heaping by age rather than to smoothen the estimated result of the birth rates, we decided to adopt the reformed value by using the population by age (Table 9) as the figure to take for the final result.

We would like to mention that the reformation of the birth rates in 1865 and 1870, speaking from the procedure of the work, was proceeded from the fact that the trend of the reformed values shown in Table 10 corresponded well to the result of the indirect estimate to the examination of the above-mentioned age heaping.

At any rate, the work for check-up which estimated directly the number of births from the number of deaths came to find out the strong possibility of age heaping in the report of births in the early Meiji period and to clearly show the slight rising trend by the reformed value caused as the result.

V. THE CONSIDERATION OF THE NUMBER OF DEATHS BY INFLUENZA

In the estimating work described up to the foregoing section, the extraordinary number of deaths caused by diseases, such as the epidemic cholera in 1879 (Meiji 12) and 1886 (Meiji 19) and the influenza in 1918 (Taisho 7) and 1920 (Taisho 9) were not taken into consideration. Those are the factors which must be taken into consideration without fail in this kind of work, however, the work which took only the number of deaths by influenza in the latter part of the Taisho period into consideration was done here. The work which took into consideration of the number of deaths by influenza is carried out as follows. Provided that influenza did not happen in both 1918 and 1920, you calculate the population by sex and age in which the influenza deaths in these two years are estimated to have survived in 1920. In another word, it is calculated in the following formula.

$$D_{x-2_{1918}} \times (L_x/L_{x-2}) + D_{x_{1920}}$$

D_x: the number of deaths by influenza at age x,
L_x/L_{x-2}: the survivorship ratio

As the inverse survivorship ratio on that occasion, we gave the $\mathring{e}_0$ which explains 1918–1920 according to the Gompertz curve in Section 3 and used what were gained by compiling the life tables corresponding to it. Table 11 and Figure

TABLE 11. THE NUMBER OF DEATHS BY INFLUENZA
(According to the Statistics on Causes of Deaths, Japanese Empire)

Age	1918		1920	
	Male	Female	Male	Female
0– 1	3,375	3,103	5,041	4,276
1– 2	1,672	1,853	3,056	3 019
2– 3	1,459	1,734	1,620	1,907
3– 4	1,286	1,541	1,259	1,542
4– 5	1,092	1,451	991	1,327
5–10	2,440	3,628	2,278	3,305
10–15	968	1,420	999	1,709
15–20	1,807	2,104	3,412	4,401
20–25	2,748	3,048	4,909	6,360
25–30	2,611	3,003	5,273	6,485
30–35	2,624	2,447	5,553	5,355
35–40	2,393	1,895	4,297	3,400
40–45	1,961	1,378	3,435	2,530
45–50	1,438	875	2,464	1,498
50–55	1,295	824	2,161	1,572
55–60	899	600	1,586	1,252
60–65	1,113	940		
65–70	1,183	1,087	3,194	2,569
70–75	1,105	1,112		
75–80	660	724	1,761	1,908
80–85	239	360		
85–90	104	174	247	431
90–95	11	28		
95–	4	6	16	27
Unknown	1	1	3	—
Total	34,488	35,336	53,555	54,873

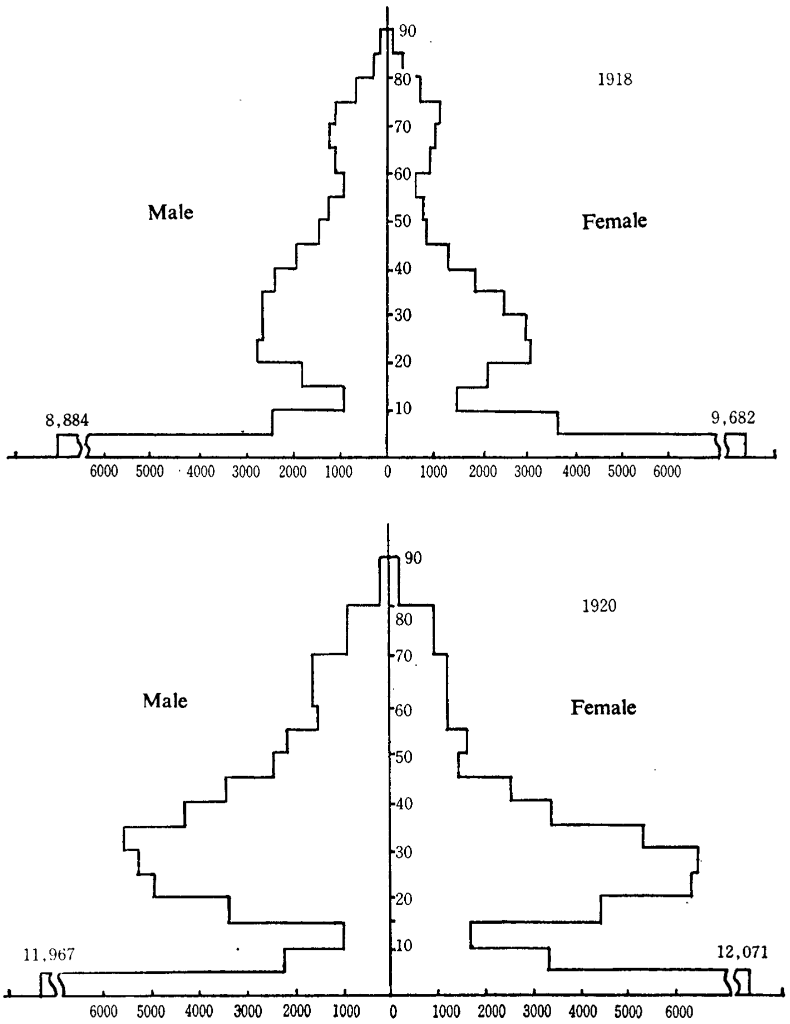

Fig. 4. The Number of Deaths by Influenza by 5-year Age Gradation

4 show the number of deaths by influenza in 1918 and 1920 respectively.

If we calculate in the procedure described in Section 3 with this value as the starting point, the estimating results in consideration of the number of death by influenza are gained. Table 12 is a list of the estimated results.

According to this result, the population in the early Meiji period was estimated as 35,030,000, which was the estimate quite close to the original standard of 35,000,000.

VI. THE SUMMARY OF THE ESTIMATED RESULTS

Table 12 is a list of the estimated results and let's examine this in comparison with other estimated results.

(1) In regard to the population size, the population size of the Meiji 1 (1868) is estimated as 35,030,000, and this can be said to be the figure that satisfies (1) in 4 conditions. According to this estimate, it seems to be in the later period of 1880's

that the population of Japan exceeded over 40,000,000. And by the later addition it reached to 50,000,000 a little bit after 1910. The comparison of this with other estimated results, is shown in Table 13 and Figure 5. The result of this study has become the values which locate in the middle of the Okazaki Estimate (6) and the Official Estimate (1) in the early Meiji period. In 1880's and 1890's the three

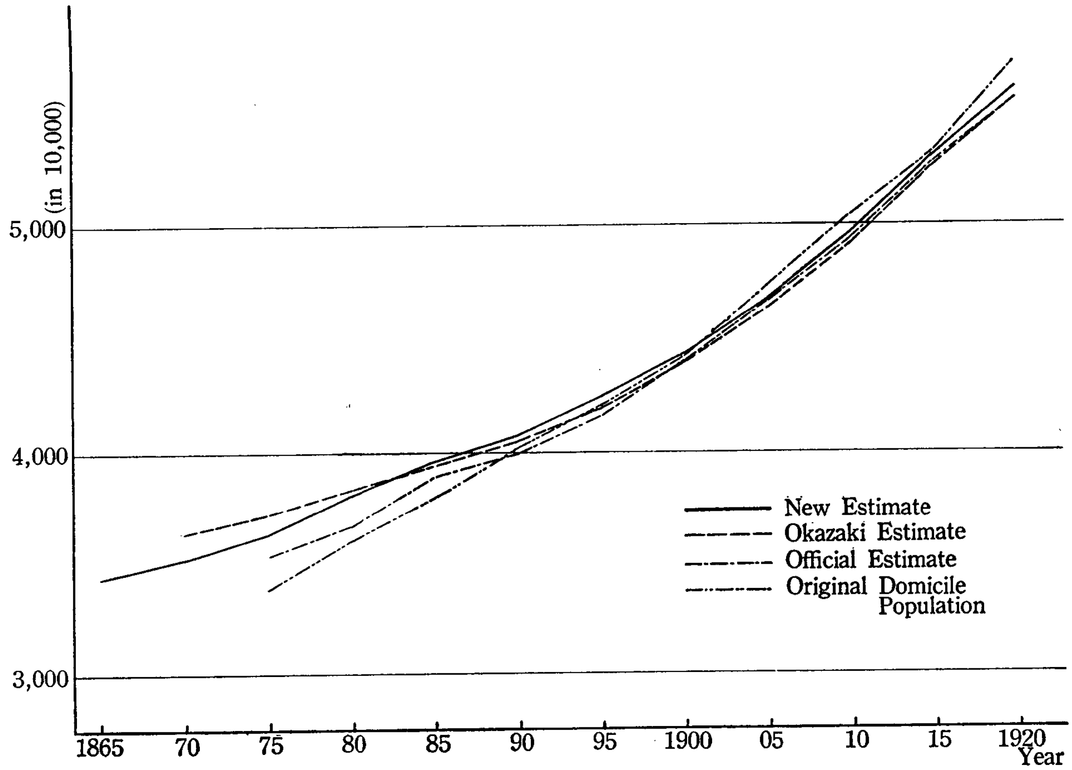

Fig. 5. The Transition of the Population Size before 1920 (Taisho 9)

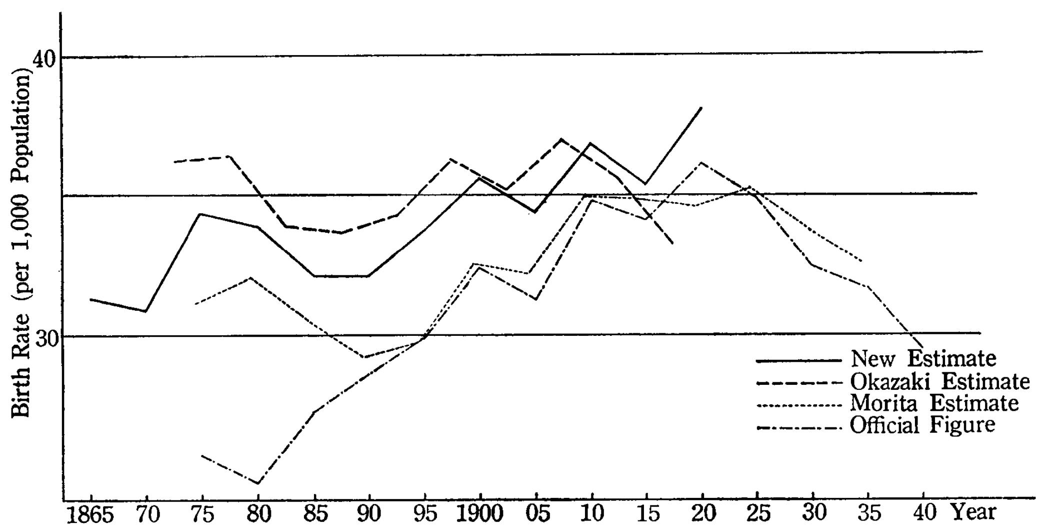

Fig. 6. The Transition of the Birth Rates

TABLE 12. THE POPULATION SIZE AND THE BIRTH- AND DEATH-RATES 1865–1920

Year	Estimated Population Size	Growth Rate (per 1,000) Population)	Estimated Number of Births (Direct Estimate)			Sex Ratio at Birth
			Total	Male	Female	
1865	34,505,292	5.09	1,079,397	555,378	524,019	105.984
		(5.10)	(1,194,749)	(612,542)	(582,207)	(105.210)
1868	35,032,551					
1870	35,384,057	6.46	1,091,736	554,395	537,341	103.174
		(6.47)	(983,608)	(499.982)	(483,626)	(103.382)
1875	36,527,630	9.02	1,255.290	632,646	622,644	101.606
1880	38,173,915	7.65	1,293,548	649,396	644,152	100.814
1885	39,634,096	6.99	1,274,964	641,347	633,617	101.220
1890	41,019,581	7.08	1,319,014	675,320	643,694	104.913
1895	42,471,664	9.04	1,437,305	738 615	698,690	105.714
1900	44,392,683	10.96	1,580,392	802,999	777,393	103.294
1905	46,824,939	12.02	1,606,837	818,243	788,594	103.760
1910	49,637,459	13.34	1,827,306	928 836	898,470	103.380
1915	52,948,710	12.45	1,872,135	951,046	921,087	103.253
1920	56,963,053	13.49	2,133,074	1,079,582	1 053,492	102.477

Note: The figures in parentheses are the figures not reformed as to the estimated results of

estimated values in Figure 5 (New Estimate, Okazaki Estimate and Official Estimate) are intersecting up and down mutually. There is almost no difference in these three estimates after that during the periods from 1900 to 1920, however, we find that the new estimate is a little bit higher than the other two estimates. Each difference between the periods ranging from the early Meiji period to the mid-Meiji period, can be said to be caused by the difference of the age-specific mortality rates set on the occasion of estimating.

TABLE 13. THE COMPARISON OF THE ESTIMATES OF THE POPULATION SIZE BEFORE 1920 (in 1,000)

Year	New Estimates	Okazaki Estimates	Official Estimates	Original Domicile Population
1865	34,505			
1870	35,384	36,288		
1875	36,528	37,198	35,316	33,878
1880	38,174	38,166	36,649	35,929
1885	39,634	39,245	38,313	37,869
1890	41,020	40,353	39,902	40,072
1895	42,472	41,789	41,557	41,813
1900	44,393	43,785	43,847	44,270
1905	46,825	46,257	46,620	47,220
1900	49,637	49,066	49,184	50,254
1915	52,949	52,500	52,752	54,142
1920	55,963	55,450	55,473	57,234

(Estimated Results, in Consideration of the Number of Deaths by Influenza)

Estimated Birth Rate (per 1,000) Population)	Estimated Number of Deaths (Direct Estimate)	Estimated Death Rate (per 1,000 Popula- tion)	Estimated Number of Births (Indirect Estimate)	Estimated Birth Rate (per 1,000 Popula- tion)	Estimated Number of Deaths (Indirect Estimate)	Estimated Death Rate (per 1,000 Popula- tion
31.28	878,146	25.45	1,053,899	30.54	903,644	26.19
(34.63)					(1,018,996)	(29.53)
30.85	912,239	25.78	1,140,954	32.24	863,021	24.39
(27.80)					(754,893)	(21.33)
34.37	953,699	26.11	1,282,956	35.12	926,033	25.35
33.89	1,017,118	26.64	1,309,154	34.29	1,001,512	26.24
32.17	1,025 086	25.86	1,302,183	32.86	997,867	25.18
32.16	1,036,080	25.26	1,326,497	32.34	1,028,597	25.08
33.84	1,057,471	24.90	1,441,675	33.94	1,053,101	24.80
35.60	1,109,355	24.99	1,595,806	35.95	1,093,941	24.64
34.32	1,162,909	24.84	1,725,413	36.85	1,044,333	22.30
36.81	1,199,881	24.17	1,862,131	37.51	1,165,056	23.47
35.36	1,236,482	23.35	1,874,463	35.40	1,234,154	23.31
38.12	1,219,482	21.79	1,974,236	35.28	1,378,320	24.63

1865 and 1870.

(2) If we see the trend of the birth rates, it starts from 31.28 per 1,000 population in 1865 putting aside 1870, shows a slight rising as a general tendency though there are some ups and downs because they are estimated by every 5 years, and continues to 38.12 in 1920 (Table 14, Figure 6).

This can be said to satisfy (2) out of 4 conditions. Contrary to this, it shows a sidling tendancy going up and down at the level of 35 per 1,000 population according to the Okazaki Estimate. According to the Morita Estimate (4), it seems to have

TABLE 14. THE COMPARISON OF ESTIMATES OF BIRTH RATES BEFORE 1920
(per 1,000 population)

Year	New Estimate	Okazaki Estimate	Morita Estimate	Official Figure
1865	31.28			
1870	30.85	36.3	Meiji (5– 9) 31.1	
1875	34.37	36.4	(10–14) 32.1	25.6
1880	33.89	33.9	(15–19) 30.5	24.6
1885	32.17	33.7	(20–24) 29.2	27.2
1890	32.16	34.3	(25–29) 29.7	28.6
1895	33.84	36.3	(30–34) 32.6	29.9
1900	35.60	35.2	(35–39) 32.2	32.4
1905	34.32	37.0	(40–44) 35.0	31.2
1910	36.81	35.6	Taisho (1– 5) 34.9	34.8
1915	35.36	33.2	(6–10) 34.6	34.1
1920	38.12			36.2

Out of the official figures the figures before 1900 are derived from the reformation of Y. Morita (Material (4) in Note 1).

been up and down at the level of 30 per 1,000 population before 1900, to have changed to the rising trend later and to have shown a peak of 36 in 1920. If we look at these three estimates and regard the Okazaki Estimate as the sidling trend and the Morita Estimate as the rising trend from the low level, this estimate can be said to show the slight rising trend threading its way through the middle of two estimates.

And if we compare it with the indirect estimate of the birth rates (Figure 3), it almost shows the corresponding results in the other years except 1865, 1870 and 1905. The difference of 1905 seems to be due to the influence of the Russo-Japanese war (1904–1905) and in regard to the decline in 1870, such a result emerges as far as it is based upon the population at age 50 in 1920. Therefore, we carried out the examination which is mentioned in Section 5 and decided to give a new reformation.

(3) If we further see the trend of the death rates, as we see in Figure 7, it is only slightly rising up to 1880 with 25.45 per 1,000 population in 1865 as a starting point, but on the whole, it shows a slightly declining tendency as it was expected in the beginning. And if we compare it with the results of the indirect estimates calculated from the number of births (Figure 3), we will find that this almost corresponds to it also except the years 1865, 1870 and 1905 as it did in the case of the birth rates. It is understood that the ups and downs by every 5 years in the result of the indirect estimate reflect directly the ups and downs of the number of births as it is estimated from the number of births.

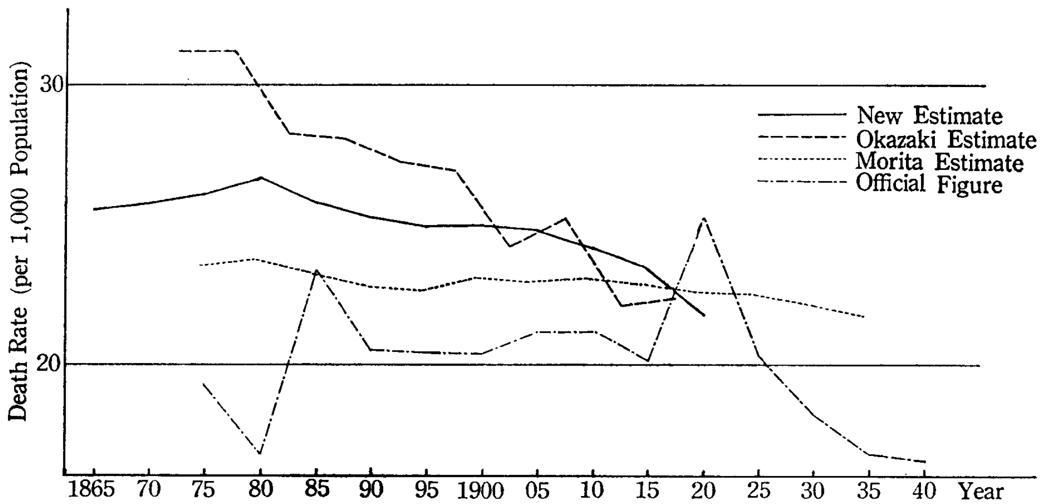

Fig. 7. The Transition of the Death Rates

If we see the trend of the death rates in the Okazaki Estimate, it is observed to have declined so drastically up to 1920 from the high value exceeding the level of 30 per 1,000 population, as you see in Figure 7. And according to the Morita Estimate, it almost shows a sidling trend going around the level of 22–23. The major differences caused by these three estimates can be said to be due to the setting

TABLE 15. THE COMPARISON OF THE ESTIMATES OF THE DEATH RATES BEFORE 1920 (per 1,000 population)

Year	New Estimate	Okazaki Estimate	Morita Estimate	Official Figure
1865	25.45			
1870	25.78	31.3	Meiji (5– 9) 23.6	
1875	26.11	31.3	(10–14) 23.7	19.3
1880	26.64	28.3	(15–19) 23.3	16.8
1885	25.86	28.1	(20–24) 22.8	23.4
1890	25.26	27.3	(25–29) 22.7	20.5
1895	24.90	27.0	(30–34) 23.1	20.4
1900	24.99	24.2	(35–39) 23.0	20.3
1905	24.84	25.3	(40–44) 23.1	21.1
1910	24.17	22.1	Taisho (1– 5) 22.9	21.1
1915	23.35	22.3	(6–10) 22.6	20.1
1920	21.79			25.4

Out of the official figures the figures before 1900 are derived from the reformation of Y. Morita (Material (4) in Note 1).

of the age-specific mortality rates in the estimating period (Table 15, Figure 7).

(4) According to the result of setting the $\mathring{e}_0$ levels by year, the value for males 35.38 and the value for females 37.72 in 1868 can be said to have shown the values which satisfy the conditions in the beginning respectively. As we already see in Figure 1, according to the estimate by applying the Gompertz curve, it can be said that both male and female showed only a slight increase up to around 1900, showed a little rising after 1900 and it was after 1925 that there was a rapid increase in $\mathring{e}_0$.

Looking at the results in comparison to 4 conditions set up in Section 4, we find they satisfy all the conditions. But if we look at the sex ratio at birth as the

TABLE 16. THE CHANGE OF THE AGE DISTRIBUTION (1865–1920) (%)

Year	Age Structure Coefficient			Ratio of Dependent Population
	Ages 0–14 (1)	Ages 15–64 (2)	Age 65 and over (3)	$\frac{(1)+(3)}{(2)}$
1865	31.34	63.37	5.29	57.8
1870	30.57	64.12	5.31	56.0
1875	30.68	63.97	5.34	56.3
1880	32.44	62.23	5.32	60.7
1885	33.31	61.37	5.31	62.9
1890	33.45	61.24	5.31	63.3
1895	32.65	62.02	5.33	61.2
1900	32.92	61.74	5.34	62.0
1905	34.05	60.60	5.34	65.0
1910	35.46	59.19	5.35	68.9
1915	36.52	58.16	5.32	71.9
1920	36.48	58.26	5.26	71.6

TABLE 17. THE ESTIMATED POPULATION BY 5-YEAR AGE GRADATION DURING 1865–1920

Age	1865	1870	1875	1880	1885
0–4	1,873,373	1,997,532	2,155,031	2,448,763	2,407,196
5–9	1,812,807	1,681,814	1,795,534	1,940,071	2,208,082
10–14	1,791,721	1,755,745	1,629,665	1,740,702	1,881,920
15–19	1,693,935	1,734,819	1,700,315	1,578,674	1,686,727
20–24	1,563,660	1,622,232	1,661,386	1,628,342	1,511,850
25–29	1,422,036	1,490,051	1,546,014	1,583,479	1,552,132
30–34	1,298,374	1,355,094	1,420,314	1,474,079	1,510,233
35–39	1,184,919	1,233,024	1,287,256	1,349,723	1,401,482
40–44	1,081,553	1,115,218	1,160,930	1,212,562	1,272,004
45–49	976,671	1,001,345	1,032,896	1,075,832	1,124,304
50–54	853,288	874,605	897,343	926,364	965,911
55–59	707,216	726,450	745,550	766,043	792,238
60–64	545,735	565,501	581,858	598,259	615,988
65–69	391,730	401,689	416,944	429,828	442,925
70–74	251,764	257,007	263,974	274,540	283,621
75–	181,991	185,780	190,817	198,454	205,018
Total	17,630,773	17,997,906	18,485,827	19,225 715	19,861,631

TABLE 18. THE ESTIMATED POPULATION BY 5-YEAR AGE GRADATION DURING 1865–1920

Age	1865	1870	1875	1880	1885
0–4	1,846,580	2,003,215	2,199,934	2,509,170	2,505,718
5–9	1,764,514	1,670,206	1,812,700	1,991,792	2,273,417
10–14	1,723,283	1,706,658	1,615,599	1,753,773	1,927,603
15–19	1,624,767	1,659,396	1,643,388	1,555,854	1,689,081
20–24	1,476,407	1,542,842	1,575,725	1,560,524	1,477,544
25–29	1,323,729	1,394,942	1,457,712	1,488,921	1,474,836
30–34	1,189,888	1,249,626	1,316,977	1,376,369	1,406,102
35–39	1,069,859	1,120,633	1,177,116	1,240,675	1,296,993
40–44	963,929	1,004,468	1,052,238	1,105,481	1,165,500
45–49	873,682	901,289	939,282	984,228	1,034,320
50–54	781,576	808,067	833,678	869,062	910,985
55–59	676,947	704,885	728,908	752,281	784,494
60–64	557,859	585,189	609,551	630,598	651,213
65–69	431,829	447,792	469,918	489,796	507,156
70–74	300,661	309,777	321,459	337,609	352,295
75–	269,009	277,166	287,618	302,067	315,208
Total	16,874,519	17,386,151	18,041,803	18,948,200	19,772,465
Population Size	34,505,292	35,384,057	36,527,630	38,173,915	39,634,096

(To Make Allowances for the Number of Deaths by Influenza)
Male

1890	1895	1900	1905	1910	1915	1920
2,461,080	2,568,504	2,813,328	3,176,658	3,447,621	3,769,202	3 752,627
2,174,915	2,228,835	2,332,247	2,562,463	2,903,179	3,164,116	3,467,156
2,143,561	2,113,004	2,167,284	2,270,048	2,497,041	2,832,923	3,089,225
1,824,096	2,078,504	2,049,669	2,103,138	2,204,144	2,425,960	2 749,022
1,615,329	1,747,051	1,990,714	1,963,096	2,014,500	2,111,249	2,316,479
1,441,367	1,540,316	1,666,080	1,898,993	1,873,183	1,922 783	2,008,005
1,480,901	1,375,744	1,470,890	1,592,050	1,815,828	1,792,691	1,833,443
1,436,539	1,409,576	1,310,357	1,402,183	1,519,132	1,734,647	1 707,771
1,321,529	1,355,609	1,331,170	1,238 640	1,326,820	1,439,253	1,640,254
1,180,186	1,227,160	1,259,860	1,238,413	1,153,726	1,237,590	1,340,404
1,010,610	1,062,274	1,106,347	1,137 777	1,120,736	1,046,653	1,122,240
827,616	867,923	914,728	955,477	985,942	975,062	912,085
638,593	668,997	703,912	744,589	781,129	810,008	803,033
457,202	475,391	499,736	527,868	560,896	591,540	614,479
292,998	303,325	316,463	333,959	354,345	378,498	399,540
211,797	219,262	228,759	241,406	256,142	273,602	288,422
20,518,319	21,241,475	22,161,544	23,386,758	24,814,364	26,505,777	28,044,185

(To Make Allowances for the Number of Deaths by Influenza)
Female

1890	1895	1900	1905	1910	1915	1920
2,466,828	2,517,003	2,842,099	3,128,501	3,386,058	3,696,641	3,705,088
2,272,348	2,239,517	2,288,393	2,588,668	2,856,296	3,100,786	3,389,764
2,200,791	2,200,821	2,170,285	2,218,940	2,512,294	2,774,719	3,012,342
1,856,678	2,120,018	2,120,456	2,091,438	2,138,737	2,422,189	2,670,035
1,604,066	1,763,227	2,013,695	2,014,302	1,986,737	2,032,054	2,292,831
1,396,412	1,516,274	1,667,039	1,904,383	1,905,678	1,880,845	1,915,944
1,393,063	1,319,361	1,433,151	1,576 396	1,802,028	1,805,132	1,776,007
1,325,261	1,313,467	1,244,563	1,352,540	1,488,852	1,703,401	1,702,967
1,218,749	1,245,663	1,235,158	1,171,133	1,273,698	1,403,386	1,603,510
1,090,884	1,141,151	1,167,116	1,158,142	1,099,139	1,196,860	1,318,163
957,615	1,010,546	1,057,797	1,082,768	1,075,640	1,022,170	1,112,522
822,708	865,367	913,942	957,629	981,568	976,612	928,008
679,510	713,289	751,056	794,387	833,881	856,666	852,772
524,242	547,771	575,883	607,700	644,481	678,780	698,058
365,281	378,268	396,103	417,609	442,285	471,146	497,078
326,826	338,446	354,403	373,645	395,723	421,546	443,779
20,501,262	21,230,189	22,231,139	23,438,181	24,823,095	26,442,933	27,918,868
41,019,581	42,471,664	44,392,683	46,824,939	49,637,459	52,948,710	55,963,053

overall final check, they are the values over 100 in any year as we see in Table 12, and we can confirm that they are the values at around 102–105 just as we sought in the inital goal.

Here if we show the age distribution every 5 years from the results of the population estimate, it is shown in Table 16.

And the estimated population by sex and 5-year age gradation during the 1865–1920 periods (the figure of 1920 is the census population) is shown in Tables 17 and 18.

VII. THE VITAL STATISTICS AND THE DEMOGRAPHIC TRANSITION IN THE MEIJI PERIOD

It was our interest in carrying out the foregoing estimating works to study if the transition of the vital statistics accompanied by the economic development during the Meiji period followed the same pattern as the Western experience or if it followed the pattern unique to Japan.

The Western experience is the law of experience known as the "demographic transition". It means that the changing process in which the vital statistics followed by the continuous economic development from the 19th century to the 20th century changes from a *high fertility and high mortality* pattern to a *low fertility and low mortality* pattern through a *high fertility and low mortality* pattern. Especially the turning point from high fertility to low fertility is called the beginning period of the demographic transition.

When the economic take-off is initiated in this kind of process, there is no problem especially in the quick decline of the death rates followed by it, however, the transition of the birth rates offers a problem to be discussed. That is to say, in the early stage of the economic development the birth rates are in the high level and keep sidling for a while after that. As the industrialization and urbanization go on and the population comes to concentrate on cities, the change of value system toward life brings about the dissemination of family planning (birth control at that time) and the birth rate declines. In England that period was since 1876. And it is the experience of Western Europe to have realized continuously the *low fertility and low mortality* pattern.

In the vital statistics during the Meiji period gained in this estimating work, the death rate decline slightly and the birth rate rise slightly. In other words, the transition of the birth rates of Japan during the Meiji period is different from the experience of "the demographic transition" in Western Europe.

The precise data is required for such a comparison and what can be considered about the difference in it is that it has much to do with in what circumstances the vital statistics were put in the early stage of the economic development. For example, the birth rates are considered to have already surpassed the level of 35 per 1,000 population from the end of 18th century to 19th century in England.[6]

[6] CarrSaunders, A. M., "World Population," London, 1936, pp. 60–65.

On the contrary, although the birth rates in the early Meiji period of Japan had been very high, it is considered to have changed the pattern of the "demographic transition" that the birth rate are estimated to have been below the level of 35.

To make another supplement, when we compare the "demographic transition", the circumstances in the early stages are considered to have been different between Western Europe and Japan. It is considered that the birth rates might have been high in both, however, the level of the birth rates had been different. If it is so, it is considered that the ceiling had been at around 35–40 per 1,000 population, judging from the maximum level of the birth rates in the past of the developing countries.

Therefore, it might be said in the countries where the birth rates are at the level of around 35–40 in the early stage of the development, it will not go up any higher and will keep sidling even though the economy starts to take off and that in the countries where the birth rate is below the level of 35 in the early stage of development, there will be a possibility for it to go up to the level of around 35–40. It is considered that the result of that difference was significant in the changing process of the vital statistics in Western Europe and Japan in regard to the "demographic transition".

To add further, as it was the tendency that the decline of the death rate was accelerated while the high birth rates kept sidling from the early stage of development in the Western experience, the population growth in the early period of the 19th century was rapid. Judging from the fact that the birth rate remained at a certain level, it is important to notice that the birth rate as a molecule had been increasing in order to match the growth of the population size as a denominator.

Contrary to it, as both the rise of the birth rate and the decline of the death rate had transited slowly, the natural growth rates of the difference had been below 1% in Japan. According to the estimated result, it was only after 1900 that the natural growth rate had exceeded 1%. It is characterized by the conclusion that the vital statistics of Japan follows the unique passage that the population growth in the Meiji period took the slight transition in this way.

The law of the demographic transition mentioned here as the Western experience was mainly made up by European and American demographers with the vital statistics of England since the end of the 18th century and in recent days the study on the history of population is carried out actively by European and American economists and especially they are making special efforts in analyzing the vital statistics of the Industrial Revolution period of England.

According to their study, the view has become dominant that the population growth in the Industrial Revolution period in England was mainly due to the rise of the birth rate, and not due to the decline of the death rate. If it is so, the fact that the population growth is rather due to the rise of the birth rates than the slight decline of the death rates in the changing period from the conventional society to the modern society shows that the vital statistics of the Industrial Revolution period in England and that of the Meiji period in Japan followed the same type of course. If it is so, the estimated result can be said especially interesting in comparison to the vital statistics of the Industrial Revolution period in England.

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