

POPULATION PROJECTIONS OF INDIA AN ALTERNATIVE APPROACH

BISWATOSH SEN GUPTA*

Abstract

REPLACEMENT index J , a measure of the true rate of natural increase has been utilised here to adopt an alternative method of population projection. An attempt has been made to find out a relation between the replacement index J and the population P for India and this relation has been used to forecast future population for India up to 1991. The relation $P = 281269.7674 J - 108103.3899$ is applicable only for India as the estimates of the constants are based on the Indian data. The above relation should not be used for projecting future population at distant period of time.

Introduction

The idea regarding future population at the same specified time is necessary to the administrator for planning and for various other purposes where the decisions are affected by the extent of population. For example to estimate the future supply of goods and services, demand forecasting is the first pre-requisite and this, in its turn, depends upon reliable estimates of population growth. Thus the importance of population projection in connection with planning for economic and social progress can hardly be ignored. So the estimation of the future population, on the basis of available information of the present and past population is necessary in our life. In fact it is extremely difficult to predict the future events which do not follow any strict mathematical laws. It is quite likely therefore that these forecasts may differ from the real situation. In particular for human population the estimation of the future population is a difficult one

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as the future growth depends on motivation of the individual apart from the other important factors. Various methods of population estimation or projection are known to the demographers. Which method will be applicable for a particular population and what reasonable assumptions and judgements are to be made is demographers' consideration. On the variation of the assumptions viz. level of fertility is high or medium or low the estimated values will differ. In fact it is not possible to forecast uniquely the future population in such a manner so that it may well represent the actual situation. In this paper an attempt has been made to adopt an alternative method to project Indian population.

Methodology

Definition of Replacement Index

The Replacement index J is determined by dividing the number of female children in a given age group in the actual population by the number of women in the corresponding higher age group in the actual population who would have been in the reproductive period when these children were born and dividing this quotient by the corresponding quotient in the life table population derived from current mortality rates. For instance, taking the junior age group of females as 0-4 and so the corresponding senior age group as 20-44, the replacement index would be,

$$J = \frac{\int_0^4 c(x) dx}{\int_{20}^{44} c(x) dx} \div \frac{\int_0^4 c'(x) dx}{\int_{20}^{44} c'(x) dx}$$

where $c(x)$ and $c'(x)$ are the coefficients of age distribution for the actual and life table population so that $c(x)dx$ and $c'(x)dx$ are the proportions of the actual and life table population comprised within the age limit x to $x + dx$, respectively. We can write J for our practical use as follows where P_x and L_x are the number of females between

POPULATION PROJECTIONS OF INDIA

$$J = \frac{\sum_{x=0}^{44} P_x}{\sum_{x=20}^{44} P_x} \div \frac{\sum_{x=0}^{44} L_x}{\sum_{x=20}^{44} L_x}$$

ages x and $x + dx$ in the actual and life table population respectively. If the junior age groups are 5-9, 10-14, 15-19, 20-24 etc. the corresponding senior age groups are 25-49, 30-54, 35-59, 40-64 etc. respectively.

Applicability of Replacement Index:

Replacement index J , an alternative measure of the true rate of natural growth has been utilised here for population projections of India. Since the fertility and mortality situation of the population is involved in the replacement index, without any loss of generality we may consider that the extent of population is also related to J . Hence if we can find some relation between J and P and also, if we know the values of J for future we can get future population.

In order to find the relation between J and P , the population for each single year from 1951 to 1961 has been estimated using the relation $P_t = P_0 (1 + \rho)^t$ where ρ is the annual growth rate of the actual population between 1951 and 1961. Also the values of J have been estimated by least square method for each single year using the known values of J . Then the estimated population has been plotted against the estimated values of J and, as the scatter obtained in graph 2 is smooth enough to fit a linear curve, a 1st degree curve has been fitted by the method of least square. From the obtained relation using the estimated values of J for future, population projection has been made.

Computation of Replacement Index

Computation of replacement index J requires certain prior consideration. For India as a whole the assumptions are more or less applicable. Of course here the values of J have been directly taken from authors "Differential in net reproductivity of India by state" where much has been discussed about the considerations and compu-

BISWATOSH SEN GUPTA

tation. The values of the replacement indices for successive higher age groups for females in India have been given in Table 1.

Table 1 : REPLACEMENT INDEX FOR SEVERAL JUNIOR AGE GROUPS

<i>Junior age group</i>	<i>Senior Age group</i>	<i>Replacement index</i>	<i>Average year of birth</i>
(1)	(2)	(3)	(4)
0—4	20—24	1.8920	1959
5—9	25—29	1.7505	1954
10—14	30—34	1.6311	1949
15—19	35—39	1.5451	1944
20—24	40—44	1.4897	1939

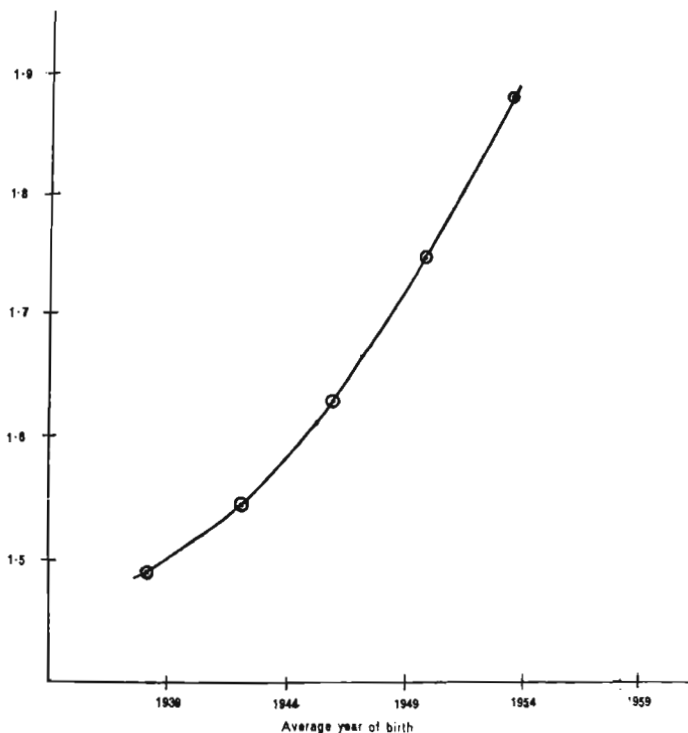
The figure in column (3) of Table 1 very clearly exhibits a shift of replacement index towards lower values as we trace backward in time, indicating lower potential growth in the earlier calendar years which implies an upward trend in net natural increases as we move from 1939 to 1959. The figures however for remote years can be taken only as a very rough measure.

Trend of the Replacement Index

The trend of replacement index has been studied with the help of second degree curve. The values of J have been plotted against average year of birth on the graph 1 and since the graph indicates a smooth curve like parabola, a second degree curve $J = a + bt + ct^2$ have been fitted by the method of least square and the estimated parameters are $a = 1.6337$, $b = .101$ and $c = .01425$, so that the curve is $J = 1.63 + .1t + .14t^2$ where $t = 0$ for 1949 and $-2, -1, 2$ for 1939, 1944, 1954 and 1959 respectively. The estimated values have been shown in the table 2 which indicates that the actual values and the estimated values of J are exactly or nearly equal up to second place of decimal.

If the economic, social and political structure remains more or less constant, this trend will predict the higher values of J for the future i.e. a generation will be replaced by a bigger one. It will be, however, misleading to predict the values of J for a distant future because it is obvious that there will be various changes viz. the moti-

POPULATION PROJECTIONS OF INDIA



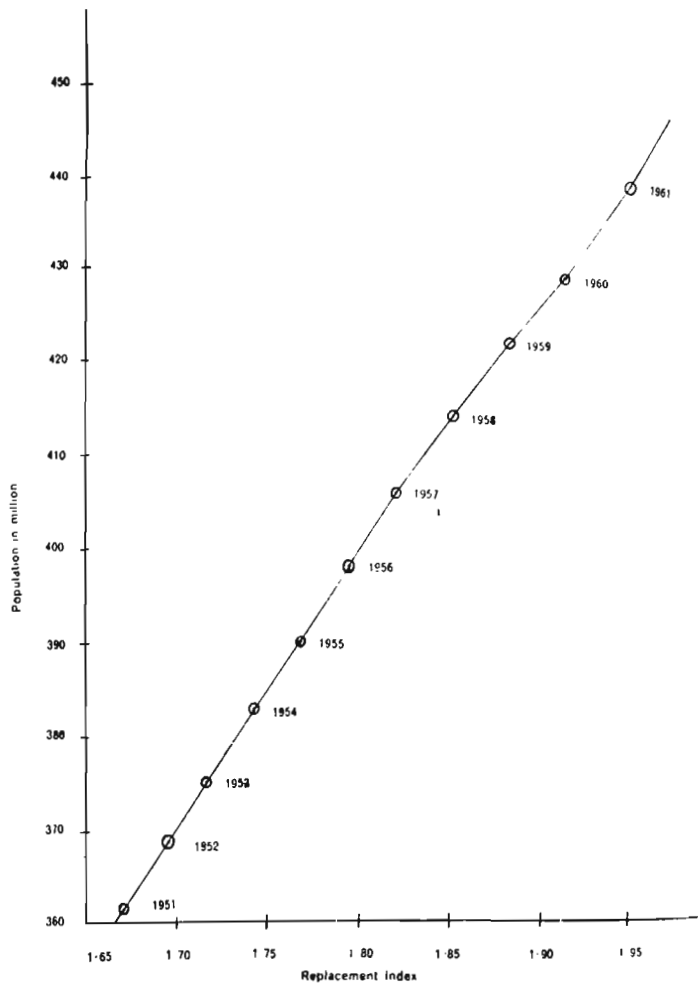
Graph 1. Trend of replacement index with average year of birth.

vation of our dynamic life, economic situation (which may be better or worse), natural conditions (due to calamities like earthquake, war, epidemic etc.). So it will be unwise to select a particular curve for predicting the values of J for any and every period in future.

Population Projection

The estimated values of J and the estimates of the actual population from 1951 to 1961 for each single year have been given in Table 3. The scatter obtained between J and P is shown in graph 2.

BISWATOSH SEN GUPTA



Graph 2. Population trend with replacement index during 1951 to 1961

POPULATION PROJECTIONS OF INDIA

Table 2 : ACTUAL AND ESTIMATED VALUES OF J FOR AVERAGE YEAR OF BIRTH

Average year of birth	Actual value of J	Estimated value of J
(1)	(2)	(3)
1939	1.4897	1.4860
1944	1.5451	1.5440
1949	1.6341	1.6300
1954	1.7505	1.7440
1959	1.8920	1.8860

Table 3 : ESTIMATED REPLACEMENT INDEX AND ACTUAL POPULATION BETWEEN 1951 AND 1961

Year	Replacement index	Population
1951	1.6722	361088
1952	1.6950	368237
1953	1.7180	375532
1954	1.7446	382970
1955	1.7702	390409
1956	1.7974	398280
1957	1.8258	406152
1958	1.8554	414204
1959	1.8860	422401
1960	1.9178	430778
1961	1.9506	439235

As the scatter is smooth enough to fit a linear curve, a 1st degree curve by the least square method has been fitted. The relation between J and P thus obtained is $P = 281269.7674 J - 108103.3899$. From the above relation population up to 1991, has been estimated taking estimated value of J from the curve $J = 1.63 + .014t^2$.

The Table 4 represents the values of J, actual population estimated by the above relation, census estimated population, the U.N. estimated population for higher fertility rates and NCAER estimated population for 1951 to 1981.

The Table 5 gives the estimated values of the population for each single year from 1951 to 1991.

BISWATOSH SEN GUPTA

Table 4 : REPLACEMENT INDEX, ACTUAL POPULATION AND ESTIMATED POPULATION

Year (1)	Replace- ment Index (2)	Actual population (3)	Estimated population in millions			
			using a* (4)	b** (5)	c*** (6)	d**** (7)
1951	1.6722	361.09	362.25	356.9		361.30
1956	1.7074	398.28	397.46	384.2		392.09
1961	1.9506	439.24	440.55	423.6		431.50
1966	2.1318		491.52	473.4	494.8	475.49
1971	2.3410		550.36	531.9	559.6	526.52
1976	2.5782		617.08	600.6	630.2	574.91
1981	2.8434		691.67	681.6	694.9	

- * Estimated population using replacement index
- ** U. N. estimated population
- *** Registrar General estimated population
- **** National Council of Applied Economic Research's estimated population

Table 5 : ESTIMATED POPULATION OF INDIA FROM 1951 TO 1991

Year	Population (in 000)	Year	Population (in 000)
1951	362247	1971	550360*
1952	368660	1972	563074
1953	375388	1973	576102
1954	382431	1974	589446
1955	389789	1975	603104
1958	397462	1976	617078
1957	405450	1977	631366
1958	413753	1978	645970
1959	422371	1979	660888
1960	431304	1980	676122
1961	440553	1981	691670
1962	450116	1982	707534
1963	459994	1983	723713
1964	470187	1984	740206
1965	480695	1985	757015
1966	491519	1986	774139
1967	502657	1987	791577
1968	514110	1988	809331
1969	525879	1989	827400
1970	537962	1990	845784
		1991	864482

The provisional Census figures for 1971 have already been announced. The population for the year is 546,956 thousand as against the above forecast. The final figure is still awaited. — Editor.

POPULATION PROJECTIONS OF INDIA

Summary and Conclusion

The possibility of projecting future population with the help of replacement index has been explored. It has been observed that the population of India is increasing at a rapid rate as expected. In spite of non-availability of sufficient or satisfactory data the present method appears to be quite reasonable for projecting future population, and at least for India perhaps more accurate than the United Nations method of prediction. Of course it is not known how far the estimated values will be applicable in future as the estimate of J for a distant future is not sound. A still better relation between the replacement index and the population can be obtained by fitting an exponential curve.

The relation between J and P as obtained earlier is not applicable to other countries as the estimates of the constants are based on Indian data. For other countries the relation will be different; may be linear, as here, or second degree or exponential as the nature may be. Therefore the relation between J and P will differ from country to country and, also from time to time for the same country, while using the current knowledge of the replacement index. The relation as obtained here should not be used also for projecting future population of India at too distant a period, as the projected values of J then may not tally with the real situation.

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