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Comparative Study of India's Population Projections Based on the 1981 Census

Introduction

THE importance of reliable population estimates and projections, along with vital statistics, for national and subnational units needs no emphasis. These ire particularly essential for countries where economic and social development s pursued through central planning. Both private and public agencies in Sorth America and Europe have recently generated a fast growing demand for jrofessional demographers. With their rapid transition from the industrial to information societies, the need for demographic knowledge and analysis is just exploding.

The variety of purpose served by the national and subnational population projections may be grouped into three broad categories : *(a)* military planning, political *representation,* ard tax revenue estimation: *(b)* socioeconomic planning, such as education, health, manpower, etc.; and (c) assessment of probable demographic trends. The subnational projections are equally important for regional development, for example, in infrastructure investment, including transport and communications, electricity, irrigation, etc.

India has enjoyed an unbroken record of decennial population census-taking since 1872. The question of tracing the plausible paths of the future size and composition of the national population continues to challenge researchers both at home and abroad. Perhaps the first formal attempt to project the national population (in what was then British India) was made when the 1921 census results were published (Russell, 1927 : 613-29). Two further attempts were made to project the national totals based on the 1931 census results (Raja, 1937 : 1183-91; and Swaroop and Lal, 1938 : 100-121). During the next decade

of the 1940s, only one set of population projections was made {Davis, 1951 : 88-90). However, for post-independent India, the interest in the estimation of future national population increased significantly with the establishment of the National Planning Commission in 1950. With every successive census result, several *sets* of projections were attempted by the official *national agencies,* individual researchers at home and abroad, and international agencies. So far forty-three studies have been published on India's population projection : four based on censuses prior to 1951, eleven on the 1951 census, six on the 1961, fifteen on the 1971, and seven, so far, on the 1981 census results. Reviews of the literature on the subject were provided by Davis *(1951 : 247-48),* Coale and Hoover (1958 : 29-54), Agarwala (1966 : 33-49 and 1972 : 55-69), Cassen and Dyson (1976 : 101-36), Cassen (1978 : 127-32), Premi (1982 : 103-24), Natrajan (1982 : 189-216), and Chaudhry (1982 : 73-114 and 1983 : 397-404).

This paper discusses the following seven sets of projections based on the latest J98I census results. The total population estimates and their demographic components, methodologies, and underlying assumptions of future behaviour of fertility and mortality are compared. These projections are ;

(i) The Economic and Social Commission for Asia and the Pacific, Bangkok, Thailand (K. S. Natrajan, **1982);**
(ii) The World Bank, Washington, D. C. (Vu and Zachariah, 1983);
(iii) The World Bank, Washington, D. C. (Vu : December 1984);
(iv) The Registrar General of India (March, 1984);
(v) S. Guha Roy, Indian Statistical Institute (1984);
(vi) The United Nations Population Division, Ninth round as assessed in 1982 (1984);
(vii) The Bureau of the Census, United States Department of Commerce, Washington, D. C. (updated May, 1983).

Section II describes different methodologies and assumptions arc described. Section III gives a compative analysis of selected projections in terms of total size, replacement level fertility, Gross Reproduction Rate, Net Reproduction Rate, crude birth and death rates, and expectancy of life at birth are compared and analyzed. Finally, Section IV presents concluding remarks.

II Methodology and Assumptions,

Nearly two centuries ago, the Reverend Thomas Robert Malthus (1766-1834), eloquently expressed his anguished concern over the question of over-population. His celebrated hook, *An Essay on the Principle of Population as It Affects the Future Improvement of Society,* nrst published as an anonymous treatise, destroyed the fond hopes of a harmonious and progressive society. Since then, an active search has continued to formulate a relatively simple "law" of popu-

lalion growth, such as would suffice to predict the future changes under varied circumstances. But such a "law" has remained as elusive today as it was about 150 years ago when Verhulst, a Belgian mathematician, originally developed a logistic curve to describe the growth of human population (Verhulst, 1838 : 112-21). Numerous methods of calculating the future population may broadly be classified into three categories : (i) mathematical; (ii) economic; and (iii) component methods.

Mathematical Methods

The simplest method is to assume a given rate of increase as a function of time. It is called mathematical because it rests on the formulation of an equation expressing the rate of change as a function of time. Calculations can be elaborated by assuming that the future growth proceeds not at a constant rate but at varying rates. These rates are determined by a curve of a regular form. For example, a straight line postulates uniform change with time,an exponential assumes a constant percentage change with time, and a logarithmic form represents a varying rate of change. These curves allow the population to exhibit a tendency to move towards infinity. The most commonly used curve is called a logistic curve which proceeds in a symmetrical S-shaped fashion from the lower limit, zero, to an assumed upper limit. It represents a trend of growth with increasing annual increments until a point is reached where growth is at a maximum; beyond that point it progressively diminishes to become negligible. In order to achieve greater conformity with observed past trends, various adjust meats have been devj'sed for modifying *the* shape of *the logistic* curve *(Pearl,* 1940 : 448-70).

Economic Methods

Population growth is assumed to be a function of expected changes in some socioeconomic variables, such as the total gross national product, the per capita income, the educational level of males and/or females, and social status. A projection by this method is most obviously appropriate for an area subject to unrestricted in-migration and out-migration. However, it may be noted that fertility and mortality rates are responsive to economic changes only moderately and in the long run, and remain virtually constant over short and medium terms. For example, the relationship between income and fertility may be positive in the pre-demographic-transition stage, negative in the transition stage, and positive again in the post-transition stage.

Component or Cohort-component Methods

These methods involve the separate projection of fertility, mortality and net migration by age-sex groups, The application requires reliable information on :

(a) the base population distributed by sex and age, usually in five-year age groups; *(b)* current mortality rates by sex and age; (c) current fertility rates classified by age of mother; and *(d)* international migration, if applicable (United Nations ESCAP, 1975 : 17-23).

The use of the component method demands, relatively speaking, a large amount of quality data, which are in short supply in developing countries. India is no exception. In spite of this data-limitation, most projections made for India during the 1960's, 1970's and 19SO's have made use of the component method.

Earlier sets of projections prepared by Russell (1927), Raja (1937), Swaroop and Lal (1938), and Davis (1951) were derived by fitting the logistic carve. The use of mathematical models, that is, fitting a straight line or other simple curves, is made by Gopalaswami (1954 : 173-188), and the United Nations Population Division in their first three rounds of assessment of the world population prospects in 1951, 1954, and 1957, respectively (December, 1951 : 1-12; 1955 : 283-26; and 1958 : 1-20).

As is well known, population projections are the numerical consequences of a selected set of assumptions as to future fertility and mortality behaviour. Therefore, forecasts estimate or predict the most likely future size and structure of the population. The various methods and assumptions based on the medium (most plausible) variant adopled by the authors in the selected seven studies are outlined below.

United Nations Population Division (1984)

During the past three decades, the United Nations Popu/ation Division (UNPD) in its periodic *World Population Prospects Assessments* has made short-term (20-30 years) and long-term (50-75 years) projections for India. As expected, with the increased availability of the latest census and other survey data, such as the National Sample Survey, the Fertility Surveys of 1972 and 1979 and the Sample Registration Scheme, the population estimates and projections are regularly revised, updated, and expanded in coverage. In all, nine such global assessment reports have so far been issued.

For purposes of estimation and projection of population and other vital statistics, the UN Population Division divides the world into five major areas and twenty-four subregions. These are further classified into five 'Types', according to the demographic situation measured in terms of fertility and mortality levels. Type 1 represents high birth rates and high death rates. Type 2 represents high birth rates and declining (though still rather high) death rates, and &u un, India is included in the Central South Asia subrcgion, comprising Afghanistan, Bhutan, Sri Lanka, Nepal, Pakistan and Bangladesh, and is characterized as Type 2.

Three or four variants—Low, Medium, High, and Constant Fertility—of

population projections are presented in each assessment report. The Medium series are **described as the "most** likely **course** of future **population," whereas the "Low" and "High" provide** the lower and **upper bounds. The constant** fertility series provide the necessary **bench-mark information for examining** changes over time.

During the 1950's the first three assessments made, in 1951, 1954 and 1957 respectively, estimated India's future population based on the Ratio Method. The projection for the subregion as a whole was made on an assumed rate of population growth. In the subsequent assessments, Fourth (1963) through Ninth (1982), India's projections were based on the Cohort Component Method.

A preliminary analysis of the various projection series made for India over the last three decades suggests that, in general, the UN Population Division short-term projections made during the 1950's and 1960's turned out to be significantly on the low side when compared with the actual census counts. But the projections made in the I970's appear to be somewhat on the high side (Chaudhry, 1985 : forthcoming).

The latest round of assessments, made in 1982 (published in December, 1984), follows the same methodology and assumption as adopted in the earlier reports. Fertility level is assumed to decline with economic and social development in the broad framework of the demographic transition theory, and with family planning policies. For countries with a currently high fertility level, such as India, the Eighth Assessment Report (1980) stated :

> Fertility assumptions take into consideration past and present fertility trends in each country. For countries with currently high fertility, it is generally assumed that *(a)* fertility will decline as economic and social development takes place, *(b)* existing or anticipated government policies and programmes as well as non-governmental activities aimed at such a goal will expedite the process of fertility decline, and (c) once the decline begins, it will begin slowly, gain momentum, and then slow down its speed again. [United Nations Population Division, 1981 : 3].

In terms of specific demographic measures, it was assumed that in the period 1970-2000, the Gross Reproduction Rate would be reduced by 30 percent, 40 percent, and 50 percent according to the High, Medium, and Low series, respectively (United Nations Population Division, 1977 : 7-10).

Mortality, measured in terms of expectation of life at birth, is assumed to increase at 2.5 years per quinquennial until it reaches 55 years. Thereafter the rate of gain in expectation of life is projected to slow down.

UN ESCAP (K. S. Natrajan, 1982)

Three projections for the next two decades, 1981-2001, High, Medium, and

Low variants, based on the component method, are given. While determining the future fertility trends, the impact of the family planning programme on the level of use of contraceptive methods by eligible couples is considered as the only exogenous variable. Tn other words, the influence of other socio-economic factors is not explicitly considered. It may be noted that Srinivasan had earlier prepared similar estimates based on the 1971 census "with explicit accounting of changes in family planning and nuptiality patterns" (Srinivasan, 1979 : 89-135). The "High" series assume that the family planning program will maintain its past (1966-1981) rate of annual increase of 1.33 percent in the level of contraceptive use in the country. The statistics compiled by the Family Planning Department suggest that the use of contraceptives increased from less than 3 percent in 1966 to 23 percent in 1981. The "Medium" series assume that the rate of achievement of the family planning targets of 76 percent, experienced during the past decade, 1971-1981, will be maintained in the future. In terms of annual increase in the level of contraceptive use, the projected rate is 1.8 percent. It is estimated 51 percent of all the eligible couples will be using some form of contraception by the end of the century. The "Low" series assume that the population policy target recommended by the Working Group of the Planning Commission, the NRR of unity by the year 1996 for the country as a whole, will be fully achieved. Further, it is assumed that the level of effective contraceptive use in the country will increase from 23 percent in 1981 to over 60 percent in 1996. The annual rate of increase in the projected level of contraceptive use is estimated to be 2.5 percent, almost twice the past fifteen years trend of 1.3 percent.

Against three different fertility rates, only one mortality decline assumption is made. Differential annual linear gains in the expectation of life at birth for males (0.50 year) and females (0.55 year) are assumed. Both males and females are projected to reach the same level of expectation of life of 62.6 years by the turn of the century. The empirical support for this differential gain in the expectation of life is drawn from the fact that, the 1981 census for the first time recorded a reversal of the declining trend in the sex ratio (males per 1,000 females). It declined, though marginally, from 107.5 in 1971 to 106.9 in 1981.

Apart from the related demographic measures of vital statistics, the author provides separate estimates of the future urban and rural population. The proportion of urban population is projected to increase from 25,82 in 1981 to 32.79 percent by the year 2001. However, the exponential growth rate of the urban population is projected to decline from 3.76 in 1986 to 3.09 in 2001.

Registrar General (March 1984)

The Registrar General's latest series of the population projections for 1981-2001, like the earlier estimates produced by the Expert Committee on Popula-

tion Projections set up by the Planning Commission in 1958 under the chairmanship of the Registrar General, are based on the Component Method. Three variants—High, Medium and Low—are presented. In general, the "Medium" series are recommended for official use (Report of the Expert Committee on Population Projections, 1979 : 10). **In** this study the "Low" series are perhaps meant to indicate the plausibility of the future course of population growth, based on the population policy target recommended by the Planning Commission.

Three fertility decline assumptions are made, depending upon the projected level of contraceptive use by eligible couples. "High" series assume that the present level of contraceptive protection will be maintained in the future. "Low" series are based on the policy target of reaching a Net Reproduction Rate of one by the year 2001. The Seventh Five Year Plan, 1985-1990, recommended a two-child norm per couple as essential for the achievement of this target (Planning Commission, July, 1984 : 23). In terms of contraceptive protection, the proportion of eligible couples will have to increase from 28 percent in 1983-84 to 62 percent in 2000-01 (Registrar General, 1984 : 34). It is estimated that the level of contraception used will have to increase by 2 percent annually. "Medium" series are based on the assumption that the rate of annual increase of 1.3 percent, as observed during the past decade or so, will continue in the future. In the terminal year 2000-01, half of the eligible couples will have effective contraceptive protection.

The female population, 15-44 years old, is projected to increase by 2.85 percent during 1981-1986, and by 2.83 percent during 1986-1991, compared with 2.68 percent during 1971-1981. However, during 1991-2001 the rate of increase for this group will experience a marginal dec!in°. But the number of married females 15-44 years old is projected to increase at a slightly lower rate on account of increasing mean age at marriage. During the last decade, 1971-1981, the proportion of married females in the age groups 15-19 years and 20-24 years has declined by 21.5 percent and 4.9 percent, respectively.

There is only one mortality assumption in terms of linear gain (0.5 years) in the expectation of life at birth for both males and females. Females will continue to enjoy a slightly higher life expectancy in the terminal year (64.7 years) than that of males (64.1 years) just as they did in the base year.

The World Bank (1984}

As a part of its annual publication, the *World Bank Development Report* published from 1978 onwards, the Bank's Policy and Research Unit of Population, Health and Nutrition Department prepares short-term and stationary level population projections for its member countries. The summary results are included in the Annex, 'World Development Indicators,' in each Report. These estimates and projections are not as influential and as widely used as those

made by the UN Population Division. But the Bank's projections appear to be methodologically somewhat *more* sophisticated; they are based on an elaborate use of various regression models. Detailed projections for India are available from mimeographed studies made in 1972 (Zachariah and Cuca), in 1979 (Zachariah and Vu), in 1983 (Vu and Zachariah). However, the latest study is available in print (Vu; December, 1984). The projections are based on the component method.

A preliminary analysis of the recent reports of the World Bank, issued between 1979 and 1984, suggests that the date of reaching the replacement level of fertility in India is fast advancing. In the 1979 Report, it was projected that the Net Reproduction Rate of unity will be reached sometime during the second half of the third decade of the next century (2025-2030). Four years later the 1983 Report advanced the replacement-level fertility period by ten years (NRR = 1, during 2015-2020). The latest Report (December, 1984) has further advanced the date by five years (NRR = 1, during 2010-2015).

The year in which NRR is likly to reach unity is determined by fitting a regression equation. It is formulated as a function of the following four factors :

(i) the expectation of life at birth for females during 1975-1980;
(ii) the current level of fertility—total fertility rate during 1975-1980;
(iii) recent rate of fertility change—birth rate decline during 1965-1975;
(iv) the status of the family planning program determined on the basis of percentage of married women 15-44 years old using contraception.

Having determined the year in which NRR = 1 is reached (in India's case during 2010-2015), the value of TFR in that year is estimated on the basis of the corresponding mortality level. Further, an exponential curve is fitted to the estimated value of TFR during 1975-1980 and the year in which NRR = 1 is reached. Then the value of TFR for 1985-1990 is estimated with the help of the above exponential curve. Finally, a reverse geometric curve is fitted to the first segment up to *1985-1990 to ensure a* slower decline in the beginning of the projection period, when the fertility rates are relatively higher, and a geometric curve is fitted in the second segment, that is beyond 1985-1990, to ensure faster rate of decline at the intermediate level of fertility.

Mortality decline in the earlier studies prior to the Fourth Report (1981) was determined by the current level of GNP per capita of a country. All member countries were divided into three groups according to GNP per capita. For any given level of life expectancy at birth, the annual increment was highest for the high income countries, lowest for the low income group, and intermediate for the middle income group.

The recent data collected at the Bank suggest that the level of female education directly affects the level of child mortality and hence the value of life expectancy.

Therefore an attempt is made to correlate the current mortality levels with the corresponding female educational levels, measured either as primary school enrolment or female education ten years ago. For developing countries the advantage of educational level as an explanatory variable turned out to be significantly higher than of the previously used variable of GNP per capita. The estimated value of the correlation for the current female primary enrolment of $R^2 = .4991$ is strikingly higher than that for GNP per capita of $R^2 = .1431$. The rate of projected mortality decline in terms of life expectancy is estimated by fitting a non-linear (inverted-U curve) to the international sample data for 1965-1970.

Over the twenty-year period from 1980-85 to 2000-05, the estimated values of the total fertility rate will decline from 4.80 ro 2.72. Though it is a significant decline (43.3 percent), it is yet a far cry from reaching the replacement-level fertility target by the end of the century.

S. Guha Roy (1984)

Roy prepared two sets of short-term population projections for India and its major states for 1971-1986 and 1981-1991. He described the long-term projections as "merely academic" in nature. He recommended those based on the "focal-length" of the base data, as being less likely to be "fallible and more illuminating." His projections are based on the historical trends and the current estimates of population. The base-year population, $P_{(0)}$, is expected to grow exponentially, expressed as a linear compound of a long-run constant growth, u, and the accelerated parameter, f, as follows :

$$P_{(t)} = P_{(0)} \exp. (ut + ft^2)$$

Expressing dissatisfaction with the usual graduation methods of the base-year population, the author developed a mathematical model to "generate an approximately corrected age structure under consistent sets of estimated values of the components of growth" (p. 169) He fitted the above quadratic exponential curve to the national totals of the 1951, 1961, and 1971 censuses, and estimated the future population over the next 15 years.

He also adjusted the 1981 census count and projected the national population for 1986 and 1991. The mortality level is projected to decline at half the rate considered in the United Nations Model Life Tables. The fertility decline, in terms of birth rate (35.5 during 1981-1985 and 33.3 during 1986-1990), is based on the negative exponential curve developed for the earlier sets of projections for 1971-1986.

Roy's projected figures for 1981 turned out to be just marginally higher (3.7 million) than the actual count of the 1981 census. In order to make a similar statement about the 1991 projections, we must wait for the next census results.

The United States Bureau of the Census (May, 1983, revised)

As part of its periodic assessment of the global demographic situation, the United States Bureau of the Census publishes *Demographic Estimates for Countries and Regions of the World,* covering those countries with a population of 10 million or more. The estimates of India's population regularly feature in these reports. In addition, in the series on Country Demographic Profiles, a report (No. 17) was issued on *India* in November, 1978. The long-term projections were published in *Illustrative Projections of World Population to the 21st Century* (January, 1979). For purposes of comparison, the latest set of updated projections based on the 1981 census results are taken into account here.

Three sets of estimates and projections, High, Medium and Low, are based on the Component Method. The fertility decline assumptions are made on "a judgemental basis by demographers who have worked with the demographic and related socioeconomic data for the individual countries for a number of years" (US Census Bureau, January, 1979 : 15). The following facts were considered :

(i) current *levels* and recent trends in fertility;
(ii) current levels and recent trends in social and economic development;
(iii) current status and past performance of family planning and public health programs;
(iv) Government policy on population related matters;
(v) recent fertility trends in countries with similar cultural, social, and economic conditions and prospects;
(vi) expressed 'desired family size' in the population;
(vii) fertility assumptions made by international agencies. In terms of the total fertility rate (TFR), from an estimated level of 4.93 in 1981, the **"High"** series assumed a decline to 4.25, the "Medium" to 3.75, and the "Low" to 3.25 in the year 2000.

The mortality decline was estimated in one of two ways. Either a target life expectancy at birth was chosen for the year 2000 and the figures were graphically interpolated between the base-year and the terminal-year; or the pattern and degree of change in mortality from year to year was assumed with the eventual life expectancy in the year 2000 resulting from the projection process. In both these methods, consideration was given to the prevailing national trends and levels. In terms of life expectancy for both sexes, an annual increase of 0.35 year was projected during 1981-2000.

Ill Comparative Analysis ; Selected Demographic Measures

For purposes of comparison, the twenty-year period from 1981 to 2001 is the focus. It is neither too far away, nor as short as the Seventh Plan (1985-

1990). Thus it helps to identify differences and agreements as to the future demographic oath for India and offers attractive features from the policy formulation point of view. The demographic trends in India during the next two or three decades will exercise the collective as well as the individual professional judgements of the national and international agencies. Perhaps this concern can be summarized by asking : When is India most likely to reach replacement level fertility (NRR = 1)?

After reaching replacement-level fertility, the time taken for the national population to become stationary (zero growth, with unchanging age composition) depends on its age structure at the time and the fertility patterns of preceding decades. For many low-income economics with GNP par capita of less than U. S. $410 in 1981, the estimated period of reaching stationary population, though admittedly speculative and highly stylized, ranges from 85 years (Sri Lanka) to 120 years (Pakistan). However, China, with GNP per capita of U. S. $300 in 1981, presents a unique exception to this projected pattern; she is hypothesized to reach the stationary population in 35 years (2040 A. D.), after reaching NRR = 1 in 2005. In contrast, India is expected to reach replacement-level fertility in 2020 and attain stationary population 120 years later in 2140 (World Bank Report, 1983 : Table 19, pp. 184-85). In other words, the population momentum, that is, the tendency for population to continue to grow beyond the achievement of replacement-level fertility, for this group of 34 low-income countries ranges from 1.7 (China) to 2.1 (Kenya). It is pertinent to investigate the very long-term population trends in India. In terms of higher population totals, the consequences of reaching replacement-level fertility at different points in time can be identified.

First we discuss the future population size at the turn of the century, as well as in the longterm and very longterm. It is followed by discussion of replacement-level fertility in terms of GRR and NRR. Further, the fertility and mortality behaviour assumptions are detailed in terms of crude birth and death rates and of expectation of life at birth.

Tolal Population

It is customary to ask : Will India's total population reach the billion mark by the turn of the century? Perhaps at present it can be answered with some greater degree of accuracy and confidence than was possible a decade or so ago. But a precise answer remains elusive. According to the six projection series ("Medium"), three indicate that the billion mark will be exceeded, while the other three suggest otherwise. Similarly, eight projections based on the 1971 census results were equally divided on this question. The estimates with more than a billion people included ; (0 1,003 million (Medium variant, Ambannavar, 1975 : Table 2.11, p. 54); (ii) 1,034 million (slow fertility decline assumption, Operations Research Group, 1974; (iii) 1,021 million (plausible assumptions,

US Census Bureau, 1979 : 17-18); and (iv) 1,037 million ("Medium" variant, the Seventh round of assessment made in 1978, UN Population Division, January, 1979 : Table 1-A, p. 4). In contrast, four studies projected that not only will the total population not reach the billion mark, but it will miss it by a margin of 60 to 80 million : (i) 945 million (Medium 2, Raghavachan, 1974 : Table 3, p. 437); (ii) 922 million (moderate fertility decline, "F'$_3$ and M_1" assumption, Cassen and Dyson, 1976; Table 7, p. 114);(iii)951 million (Tsui and Bogue, 1977 : Table III-B); and (iv) 961 million (medium variant, the Eighth round of assessment made in 1980, UN Population Division, 1981 : Table A-2, p. 19). The range between the lowest and the highest estimates in the two sets of projections has been reduced to nearly half its size over the last ten years from 115 millions to 68 millions. However, part of these observed differences must be attributed to the base-year data (Table 1). The World Bank, the UN Population Division, and the US Census Bureau adjust upward the Indian census figures for the reported under-enumeration as revealed by the post-census checks surveys. Therefore, for a more meaningful comparison, figures are presented in terms of projected absolute increase in the total population during the next two decades (lower panel, Table 1).

Over the next twenty years, an increase of 269 millions is projected by the UN Population Division. It is the lowest increase among the selected series. In contrast, an absolute increase of 346 millions over the same period is projected by the US census Bureau. This is the highest estimate. The World Bank's latest projections lie between these two extremes. It is only the "Medium" variant of the Registrar General's estimates—and *not* the "Low" based on the Planning Commission's population policy target—which comes close to the World Bank's figure of 305 millions. It is equally interesting that the various estimates of absolute increase in total population over a shorter span of one decade, 1981-1991, differ rather widely, with a range of 23 millions. Again, the lowest estimate of the absolute increase during this decade is made by the UN Population Division. Both Roy and the US Census Bureau project the highest increase of 165 millions during the same ten year period. The World Bank's estimates of the increase are marginally higher by five millions than those projected by the Registrar General. It is needless to say that the art of making population projections, even for a decade or so, is not without its intellectual challenges.

There are notable differences in the projection patterns in terms of size and rates of increases in the total population for 1981-1991, and 1991-2001. The UN Population Division, for example, projects a significantly lower increase of 10.6 percent in the second decade over the first. The World Bank (1984) estimates depict the same pattern. But the US Census Bureau projects a higher increase of 9.6 percent in the second decade over the first.

The World Bank (1984) estimates that India will attain a stable population of 1,699 million in the twenty-second century, in the year 2150. For

TABLE 1—SELECTED POPULATION PROJECTIONS AND ABSOLUTE INCREASES, INDIA, 1980-2001

Year	*United Nations ESCAP (Natrajan)*	*World Bank (1983; Vu and Zachariali)*	*Registrar General (March, 1984}*	*World Bank (1984; Vu)*	*S. Guha Roy, (1984)*	*United Nations Popula-tion Division (1984)*	*United States Census Bureau (1984)*
			Medium Variant : Millions				
1980		675		687		689	
1981	684	691*	685	703*	685	703*	700
1985		754		765		761	
1986	759		758		766		779
1990		836		844		832	
1991	834	853*	836	859*	850	845*	865
1995		919		920		899	
1996	905		915				955
2000		1001		994		962	1028
2001	978	1017*	991	1008*		972*	1046
			Absolute Increase (Millions)				
1981-1991	150	162	151	156	165	142	165
1991-2001	144	164	155	149	—	127	181
1981-2001	294	326	306	305	—	269	346

*Straight line interpolation

perspective planning purposes, the immediate future of 40-50 years is of direct relevance. The estimates of India's future population in the year 2025 differ by a wide margin of 120 million : The World Bank predicts a total population of 1,309 million, while the UN Population Division suggests a much lower figure of 1,189 million for the same year. As noted earlier, the very long-term (stationary population) projections are inherently speculative in nature; yet the broad magnitudes of the size do provide useful information about the distant future.

Replacement Level Fertility

The present objective of the Indian Population Policy is the achievement of replacement-level fertility, i.e. the Net Reproduction Rate (NRR) of unity. The NRR is defined as "the average number of daughters that would be born to a woman if she passed through her lifetime from birth conforming to the age-specific fertility and mortality rates of a given year" (Haupt and Kane, 1980 :31).

India's population policy target was expressed in terms of NRR for the first time by *the* Working Group on *Population Policy of the Planning Commission.* in its Interim Report (March, 1979). The Final Report, issued a year later, noted that "the Group strongly recommends that the nation commit itself to achieving the long-term goal of NRR of unity by the year 1996 on an average and by the year 2001 for all the States" (Planning Commission, May 1980 : 18). In terms of family size this precise policy target meant an average of 2.3 children per couple, with national crude birth and death rates of 21 and 9 per thousand, respectively, by the year 1996. It may be noted that the same Report estimated the prevailing national birth and death rates as 33.2 and 14.1 per thousand, respectively, for 1978.

The population projections published under the auspices of the United Nations Economic and Social Commission for Asia and the Pacific, Bangkok, which were prepared by K. S. Natrajan, assumed the target recommended by the Working Group for its 'Low' series. The estimated NRR of 1.48 in 1981 was projected to reach unity over the next 15 years by 1996. In terms of crude birth and death rates, it translates into reaching a level of 24.7 and 8-9, respectively, by the same year.

Two years later, the Ministry of Health issued a 'Statement on National Health Policy' shifted the target year for achieving replacement-level fertility for the country as a whole by four years. The NRR of unity is to be achieved by 2000 A.D. (Ministry of Health and Family Welfare, 1982 : 16). The Planning Commission has recently accepted this revised target and incorporated it in its 'Approach' to the Seventh Five Year Plan (Planning Commission, July 1984: 23). The Registrar General's latest estimates of the future national population ("Low" series) are based on the revised population policy goal.

The World Bank and the UN Population Division also publish their estimates of future trends in Gross and Net Reproduction Rates (Tables 3.2 and Glossary). The World Bank evaluation of the demographic changes in India has undergone rather drastic revisions during the last five years. For example, the estimates and projections published in 1979 were based on the assumptions that India would reach the NRR — 1 in the year 2020 (World Development Report 1979, Table 17, pp. 158-59). In the latest annual Report, the World Bank has advanced this date of attaining replacement-level fertility in India, by ten years, to 2010 (World Development Report 1984, Table 19, pp. 254-55).

Similarly, the view of India's demographic changes has undergone revisions by the UN Population Division. The estimated value of GRR during 1995-2000, for example, has been revised downward by 17.6 percent between the Sixth (1973) and the Ninth (1982) rounds of assessments. This further supports the view that the rate of fertility decline in India is expected to accelerate over the next 15-20 years. In more specific terms, the latest UN Population Division estimates suggest that the NRR of unity will be reached during 2000-2005 (Table 2).

As expected, there are significant variations in the base-year estimates of GRR and NRR in various studies (Table 2). These may be attributed partly to diffe rent sources of primary data and partly to the modifications and adjustments made to "smooth" the raw data. For 1981, the estimated values of NRR range from 1.48 (Registrar General) to 1.89 (World Bank, 1984). It may be noted that the World Bank estimates, in general, are of the higher order, and that of the UN Population Division lie somewhere between the extreme values.

The same pattern emerges in terms of crude birth-rate decline over the next twenty years. The projected declines are : 36.2 percent by the UN Population Division, 33.8 percent by the World Bank (1984), and 20.6 percent by the US Census Bureau. None of these studies estimate a crude birth rate of below 20 per thousand by the turn of the century (Table 3).

In terms of crude death rate, the highest decline is projected by the Registrar General (5.0 points) and the lowest (3.6 points) by the US Census Bureau, over the twenty-year period, 1981-2001. The projections of future mortality behaviour over the same period made by the two international agencies, the UN Population Division and the World Bank, arc in close conformity and cover the middle ground (Table 3). The future mortality trend is further Outlined in terms of expectation of life at birth, separately for males and females (Table 4). Males in India can expect an increase of a full 10 years in the expectation of life at birth over the twenty-year period, if we accept the Registrar General's estimates, but only 8 years if the future reality turns out to be closer to the estimates prepared by the two international agencies.

The question of different rates of annual increase in the expectancy of life at birth for males and females remains a matter of interpretation. The ESCAP projections assumed a 10 percent higher rate of annual increase for females than for males, both reaching the same level of expectation of life of 63.3 years in 2001. However, the Registrar General's projections modified the above assumption and projected identical rates for both males and females, with of an annual increase of 0.5 years. In other words, males will continue to have a slight edge in terms of expectation of life at birth. According to the UN Population Division estimates, males will enjoy a slightly longer expectation of life at birth in the year 2001 (60.4 years for males and 59.8 years for females). However, the World Bank estimates a reverse trend : 61.4 years for males and 62.6 years for females. Further research in mortality behavior will provide the necessary

TABLE 2—SELECTED **PROJECTIONS OF GROSS AND NET REPRODUCTION RATES, INDIA,** 1980-2025

Year / Period	*United Nations ESCAP (1982; Natrajan)*	*Registrar General (1984)*	*World Bank (1983; Vu and Zachariah)*	*World Bank (1984; Vu}*	*United Nations Population Division (1984}*
			Net Reproduction Rate		
1981	1.48	1.48	1.82*	1.89*	1.63*
1980-1985			1.76	182	1.58
1985		1.34			
1985-1990			1.62	1.67	1.40
1990		1.17			
1990-1995			1.51	1.47	1.25
1996	1.00				
1995-2000			1.40	1.31	1.13
2000		1.00	1.36*	1.25*	1.08*
2000-2005			1.30	1.17	1.00
2005-2010			1.20	1.04	—
2010-2015			1 10	1.00	—
2015-2020			1.00		
			Gross Reproduction Rate		
1980-1985			2.30	2.34	2.15
1985-1990			2.05	2.07	1.85
1990-1995			1.84	1.76	1.60
1995-2000			1.65	1.53	1.40
2000-2005			1.49	1.33	1.20
2005-2010			1.34	1.15	—
2010-2015			1.20	1.09	1.05
2015-2020			1.08	1.07	1.00*
2020-2025			1.06	1.06	0.95

*Straight line interpolation.

TABLE 3—SELECTED **PROJECTIONS OF CRUDE** BIRTH **AND** DEATH RATES, INDIA, 1981-2001

YearlPerhd	*United Nations ESCAP (1982; Natrajan)*	*World Bank (1983; Vu and Zacharlah)*	*Registrar General (1984)*	*World Bank (1984; Vu)*	*United Nations Population Division (1985)*	*United States Census Bureau 1985*
			Medium Variant			
			Crude Birth Rates			
1981	34.2*	36.3*	33.5*	35.5*	34.5*	35.4
1980-1985		35.2		34.2	33.2	
1981-1986	32.5		32.5			
1986						34.1
1985-1990		32.4		31.0	29.9	
1986-1991	29.2		30.5			
1991						32.3
1990-1995		29.8		27.5	26.6	
1991-1996	25.6		27.6			
1996						30.2
1995-2000		27.1		25.0	23.7	
1996-2001	23.9		24.4			
2000						28.5
2001	23.0*	25.5*	22.5*	23.5*	22.0*	28.1
			Crude Death Rates			
1981	12.5*	13.3*	12.9*	13.1*	13.7*	13.9
1980-1985		13.0		12.7	13.3	
1981-1986	11.8		12.2			
1986						126
1985-1990		11.9		11.3	12.1	
1986-1991	10.4		10.8			
1991						11.9
1990-1995		10.9		10.1	11.1	
1991-1996	9.3		9.6			
1996						11.0
1995-2000		9.9		9.4	10.2	
1996-2001	8.4		8.5			
2000						10.4
2001	7.9*	9.1*	7.9*	8.8*	9.5*	10.3*

*Straight line interpolation.

TABLE 4-SELECTED PROJECTIONS OF EXPECTANCY OF LIFE AT BIRTH, MALES AND FEMALES, INDIA, 1981-2001

Year / Period	*United Nations ESCAP (1982; Natrajan)*	*World Bank (1983, Vu and Zachariah)*	*Registrar General (1984)*	*World Bank (1984; Vu)*	*United Nations Population Division (1985)*	*United States Census Bureau J98S*
			Medium Variant : Years			
			Male			
1981	54.0	52.1*	54.3*	54.9*	52.9*	52.0
1980-1985		52.5		55.5	53.0	
1981-1986	55.1		55.6			
1986						53.6
1985-1990		54.2		57.4	55.0	
1986-1991	57.6		58.1			
1991						55.2
1990-1995		56.0		59.4	57.0	
1991-1996	60.1		60.6			
1996						56.7
1995-2000		57-8		60.6	59.0	
1996-2001	62.6		63.1			
2000						57.9
2001	63.3*	59.0*	64.1	61.5*	60.4*	5S.1»
			Female			
1981	52.9*	52.5*	55.0*	53.7*	51.4*	51-4
I9SO-I985		53.2		54.4	42.0	
1981-1986	54.3		56.2			
1986					54.0	53.5
1985-1990		55.6		56.8		
1986-1991	57.1		58.7			
1991						55.5
1990-1995		58.0		59.2	56.0	
1991-1996	59.8		61.2			
1996						57.4
1995-2000		60.4		61.1	58.3	
1996-2001	62.6		63.7			
2000						58.9
2001	63.3*	61.4*	64.7	62.6*	59.8*	59.2*

*Straight line interpolation.

direction for tracing future trends in the separate expectations of life at birth for males and females.

IV Concluding Remarks

The burden of evidence indicates that India will most likely reach replacement-level fertility (NRR = 1 or TFR — 2.3 or so) somewhere during the first decade of the next century. If the focus is further sharpened, I would lean towards the World Bank's latest estimate of NRR = 1 by the year 2010. A stronger case can thus be made for the "Medium" projections of the Registrar General. On the other hand, a very high degree of optimism is demanded by the "Low" variant's claim to represent the most plausible path for the national demographic future. The available past record simply fails to inspire such optimism.

The future demographic changes in India *will be* strongly influenced by three inter-related factors : (i) the family planning program; (ii) age at marriage for females: (iii) the national educational level in general and of females in particular. There is ample statistical evidence at home and from other developing countries to argue that the extension of the family planning services is not the sole explanatory variable in the determination of fertility decline. The effecti veness of the family planning program is largely influenced by the corresponding level of socioeconomic development (Das, 1980 : 31-39; Mauldin and Berelson, 1978 : 89-148; and World Bank Report, 1984: 106-54). Therefore the "supply-side" emphasis of India's population policy is, at best, a partial solution.

Equally, there is ample evidence, statistical and otherwise, to suggest that Jhe increasing age at marriage does not result in any meaningful reduction in the fertility level unless the increase is substantial. Various national and international studies indicate that the age at marriage for females will have to be either in the early twenties or, at least, beyond 22 or 23 years foe anyJong-term fertility reductions (Registrar General, 1980 : 25; Cassen, 1978 : 52-53; and Henry and Piotrow, 1979 : M105-106). No doubt some gains have been made in India in this direction over the past decades. The Sarda Act of 1930, amended in 1949 and 1956, raised the minimum age at marriage for females from 14 to 15 and then to 16 years. Historically speaking, from 1891 to 1961, the estimated mean-age at marriage (singulate mean-age estimated by Hajnal's method, 1953 : 111-36) for females gradually increased from 12.8 to 15.5 years for females, and from 19.6 to 21.3 years for males (Agarwala, 1977 : 31). The recent Marriage Act of 1978 has further raised the minimum age at marriage to 18 years for females and to 21 years for males. However, by and large, the implementation of this social legislation remains ineffective, particularly in the rural areas. During the last decade, nevertheless, the estimated mean-age at marriage for females increased from 17.8 years in 1971 to 18.7

years in 1981. The corresponding increase for males was 22.6 to 23.4 *years,* The number of eligible couples (currently married females in the age group 15-44 years) per 1,000 population declined marginally from 170 to 169 over the same decade (Padmanabha, 1983 : 12-13). A similar order of increase in mean age at marriage was recorded during 1961-1971 : from 16.1 to 17.2 years and from 21.4 to 22.2 years for females and males, respectively (Goyal, 1975 : 337). Even if full compliance with the latest Marriage Act is assumed during the next 10-15 years in rural India, still a giant social step would be required for further raising the age at marriage for females to beyond 22 or 23 years. However, age at marriage today is less important than it used to be in the past. The single most important factor in determining the family size is the availability and use of contraceptives.

There is a growing appreciation of the inverse relationship, curvilinear or linear, between the educational level of mothers and their reproductive behavior (Registrar General, 1976 : 7-8; Mukherjee, 1976 : 24-25; Cochrane, 1979 : 11-52; and World Bank Report, 1984 : 109- HO). The level of female literacy in India jumped from 0.69 percent in 1901 to 24.82 percent in 1981. But in the rural areas only 17.6 percent of adult females (15 years and above) were counted as literate in 1981, compared with 12.9 percent in 1971. The progress in 'school enrolment is equally modest : only 29 percent of rural females in the age group *10-14* years were actually attending school at *the time of the 1981* census-taking (Padmanabha, 1983 : 15-20).

No doubt the future is uncertain; much can happen in the next quarter century (1985-2010). However, a very broad view of the contemporary demographic and socioeconomic scene in India does not suggest that replacement-level fertility will come easily by the year 2010. Even for this rather delayed goal, a redoubled national effort will be needed.

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