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## **Demographic Determinants of the Aging Process : A Cross-Country Analysis**

### **Introduction**

THIS study purports to analyse cross-country variations in the incidence of aging at apex in 1985, characterised by the percentage of population aged 65 and over. In the process the study intends to highlight threshold levels of fertility and mortality which may initiate the aging process. Thereby, the study attempts to highlight the relative significance of different factors influencing the aging process in different stages of demographic development. Furthermore, the component and interaction effects of the two basic demographic determinants viz. fertility and mortality, on the aging process are proposed to be highlighted. The data base for econometric analysis is primarily drawn from the World Resources (1986) for all the 144 countries, inclusive of both developed as well as developing countries, ranging in different stages of demographic development.

### The Aging Process

Aging of population is generally described as an increase in the proportion of elderly persons in the population. Alternatively, a decline in the proportion amounts to younging or rejuvenation of the population. It has often been contended that the present age composition of a population is wholly determined by the past trends of fertility, mortality and migration. The structural linkages between the age composition and its basic demographic determinants can certainly help in explaining the past trends in the aging process.

Mortality decline in the initial stages of demographic advancement has often led to younging of population in the past. The process of rejuvenation in the initial stages basically stem from improvements in health conditions with relatively larger incidence on infants and mothers in the process of bearing and rearing children. Since mothers and infants constitute the most vulnerable sections of the society exposed to the risk of death in high mortality conditions in pre-transitional stages, improvements in health condition will have relatively larger incidence on infant and maternal mortality, compared to overall mortality. This relatively larger improvement in health conditions of children and women over reproductive age span helps in the younging of population in the initial stages of the demographic advancement.

Thereafter, fertility decline, triggered by prior mortality decline, helps in the process of aging through shortening the base of the age pyramid. The declining fertility and improved chances of survival of children bring about shrinkage in the base and bulges in the middle sections of the pyramid. This process of decline in the proportion of persons in younger age groups and relatively larger increase in the adult age groups is described as aging from below. Thereby, sustained decline in fertility and mortality leads to increase in the proportion of elderly persons known as process of aging at apex of the pyramid. Historically, aging at apex has generally been preceded by aging from below in the initial stages and accompanied by it in the later stages of demographic advancement.

The effect of international migratory movements on the age structure of a population depends on the age pattern of immigrants/emigrants and obviously on the scale of migration in proportion to the population of a country. Migratory movements, in general, are dominated by male working members in the younger and adult age groups in the initial stages. Thus, immigration is expected to have the younging effect on the population in the short-run. This short-run younging effect of immigration cannot continue for long since volume of such large scale international migratory movements cannot be maintained and moreover the movements cannot go unchecked. However, such large scale international migrations have not taken place over the recent past and thus its impact on the age structure can be ignored for the period under the purview of the present study.

The aging transition can be basically interpreted as a structural shift in the age composition from a conically shaped age pyramid with a wider base and rapidly narrowing off towards its apex, characterising high fertility and mortality conditions in pre-transitional stages, towards a barrel-shaped age pyramid resting on a relatively shortened base and slowly tapering off towards its apex, characterising low fertility and mortality conditions in the advanced stages of demographic advancement.

#### Trends in The Aging Process

The pace of transition obviously depends upon the pace of shifts in its basic demographic determinants viz. fertility, mortality and migration. The aging transition in most of the presently demographically advanced countries occurred over a much longer span of time of over a century or two in the past. It has occurred at a much faster pace and over a much shorter span of 25 to 30 years over the recent past in some of the countries like Japan and China. Obviously, the quickening of the process has basically resulted from faster pace of declines in fertility and mortality in the absence of any large scale international migration.

Several studies have anticipated a still faster pace of aging transition in several developing countries due to possible acceleration in mortality decline, as a result of import of advanced medical technology from advanced countries, and fertility decline resulting from family planning programmes and non-programme factors. However, this anticipated large-scale and rapid aging process in most of the developing countries is expected to occur at a relatively much lower levels of economic development because of their larger population base. The anticipated phenomenon is causing concern because of the social and economic problems associated with the aging process, especially with the aging at apex of the pyramid.

Nevertheless, the coincidence of declining fertility and the aging process in the past and the stability of the age structure in countries with high fertility led to a basic premise that

the aging process stems from fertility declines. Though fertility decline has been playing a crucial role in the aging process, yet the role of mortality in the aging process is no less important. Its role in the initial stages in terms of triggering fertility decline and later when further fertility decline becomes less probable may be more crucial. Rather, aging at apex in advanced stages of demographic development could occur only because of further declines in mortality. Already, mortality has begun to play its role in aging at apex in demographically advanced countries (Linda 1989). Before we get into the structural analysis for highlighting the relative impact of different determinants, let us briefly review the social and economic implications of the aging process.

### Social and Economic Implications of the Aging Process

Social and economic implications of the aging process result from the structural linkages between age composition and patterns of consumption, participation in the economic activity, and maintenance and support network required for the aged persons. Certainly, needs of elderly persons in terms of food, housing, doctors, medicines, and other consumption goods are different than children and adults. Thus, aging of populations, especially at the apex of the pyramid, calls for different production patterns to meet the specific demands of the elderly persons. Furthermore, the aging of populations has implications for the relative proportion of population in the labour force and thus has production implications in the economy. Older people are generally considered to be non-productive consumers and need to have the maintenance support either by the family or community or some institution or government. Thus, along with aging of the population the strengthening of the support network becomes imminent. The western experience of the erosion of the family support system for the older people and thereby having serious budget implications for the governments in terms of social security system for the older people in the society can be a matter of serious concern for the large scale and rapid aging of populations in developing countries in the near future.

Strong linkages between socio-economic structure and demographic factors have often been suggested in the literature. Nevertheless, the impact of social and economic factors on the age structure gets channelised through their influences on the basic demographic factors, such as changes in births, deaths or migrational movements. This study attempts to highlight linkages between the aging process and its basic demographic determinant viz. fertility and mortality.

### Selection of Variables

The concepts of population aging and an appropriate age of aging for an individual have been discussed in several studies (UN 1983; Tout 1989). This study characterises the aging of population at apex of the pyramid by the percentage of elderly persons aged 65 and over to the total population (PPO). The aging index pertains to the year 1985 and its lagged value to the year 1960 (PPOL). Other age-structural variables included in the study are percentage of population over younger age groups of less than 15 (PPC), in working age groups over 15 to 64 (PPW). The ratio of persons in working age groups to younger age groups (WCR) pertains to the year 1965 and characterises the extent of aging from below. The lagged value of WCR pertains to the year 1960 (WCRL).

Total fertility rate (TFR), depicting average number of children which a woman is expected to bear during her reproductive career as per current age-specific fertility schedule operative in the society. The fertility variable characterises the reproductive behaviour and pertains to the period 1980-85 and its lagged value pertains to the period 1960-65 (TFRL). The ratio of TFR to TFRL reflects the country-specific change in fertility conditions over the 20 years span (CTFR).

The health conditions in a society are characterised by variables such as expectation of life at birth (ENN) and infant mortality rate (IMR). These variables refer to the period 1980-85 and their lagged values pertain to the period 1960-65. The ratio of ENN to ENNL reflects the country specific change in the mortality conditions over the 20 year span (CENN). Similarly, ratio of IMR to IMRL reflects the change in infant mortality conditions (CIMR).

Certain other socio-economic development variables presumed to exert strong influence on fertility and mortality conditions have also been included in the study. The variables are enrolment ratios among school age population (ERT), percentage population living in urban areas (URB), percentage of couples over reproductive age span using contraception (CUS), per cent of population with access to clean drinking water facility (PPADW), with access to sanitational services (PPASS), daily calorie supply as percentage of nutritional requirements (DCS), and calories domestically produced as percentage of total supply (CDP). These variables characterise the social, economic, nutritional and sanitary conditions in the society and are expected to have strong bearing on the fertility and mortality conditions in a population.

A summary of the selected variables is given in Appendix Table 1, alongwith the description. A broad spectrum of dispersion of the selected variables over 144 countries is provided in Appendix Table 2. Before we get into the structural linkages among these interrelated variables, let us briefly review the cross-country variations in the incidence of aging at apex in 1985.

### **Cross-Country Variations in the Aging At Apex in 1985**

Perusal of cross-country variations in the incidence of aging at apex in 1985, characterised by the percentage of population in elderly age groups, reveals that the incidence is maximum in Sweden (17) followed by Switzerland (15.7) in which the fertility levels are much below replacement levels and expected longevity of life at birth over 75 years. The incidence is much lower in most of the developing countries over the Asian and African regions ranging from 1.5 per cent in Kuwait to 9.9 per cent in Japan. Furthermore, the percentage in most of the developing countries is ranging between 1.5 to around 5 per cent. It has often been contended that this initial heavy phase of rejuvenation in most of the developing countries, resulting from a faster pace of improvements in health conditions, will be followed by a heavy phase of aging because of accelerated pace of fertility declines, as has already been depicted by Japan and China in the recent past. Some projection exercises based on some probable assumptions of fertility and mortality conditions over the coming years anticipate the incidence to be around 35 per cent in China by the turn of the century (Zeng Yi 1988).

Before we look into these alarming projections, let us get into the structural analysis for highlighting linkages between the aging process and its basic demographic determinants.

### **Factors Relevant to Aging at Apex**

The varimax-rotated factor structure evolved out of the 21 selected variables is presented in Appendix Table 3. Perusal of the factor structure reveals that aging process is strongly associated with fertility and mortality conditions operative in the past as well as in the present alongwith other age-structural variables. Furthermore, the structure clearly reveals strong linkages between social, economic, demographic and age-structural variables as depicted by the relatively higher factor loadings on the first and second elicited factors. The overall associations among these variables turns out to be consistent with the general expectations. Since socio-economic factors affect the age structure only through their influence on the basic demographic factors of population growth, so this study examines the linkages between the aging process and its proximate demographic determinants.

Among the health variables, we find that expectation of life at birth (ENN) and infant mortality rate (IMR) depict strong association with the age structural variables. Perusal of the factor structure reveals that the health conditions and variables bearing impact on health conditions alongwith the age-structural variables have relatively higher factor loadings on the first two factors. Furthermore, the direction of association among these variables is also in conformity with the general expectations. Such as, higher levels of ENN, depicting better health conditions, is associated positively with the aging at apex (PPO). Similarly, higher levels of IMR, reflecting poorer health conditions, is associated inversely with PPO.

The fertility variable TFR, depicts strong association with the aging at apex (PPO). The direction of association is also consistent with the general expectations such as higher levels of TFR, depicting higher levels of reproductive performance is associated negatively with the aging at the apex (PPO).

Among age-structural variables, we find that proportionate population in the younger age groups (PPC) as well as in working age groups (PPW) depicts strong association with the aging at apex (PPO). The direction of association is also consistent with general expectations, such as higher proportion of population in the elderly age groups is inversely related with the proportionate population in the younger age groups and positively with the percentage in the adult age groups. Rather, it provides an indirect support to earlier laid down hypothesis that increases in the proportion of the old have usually been preceded, and at a later stage accompanied by an increase in the proportion of adults (UN 1956:13). In other words, the aging at the apex is generally preceded by the aging from below, characterised by the proportionate increase in population in the adult age groups. Thus, the process of aging at the apex being preceded by aging from below at the expense of proportionate decline in the younger age groups also gets reflected by the positive association between proportionate population in the elderly age groups (PPC) and the ratio of persons in working to younger age groups (WCR). In other words, incidence of aging from below (WCR) is associated positively with the aging at apex. Furthermore, we find that lagged value of WCR i.e. WCRL, depicts a still stronger association with the aging at apex because of its relatively higher factor loadings on the common factors. In other words, higher is the extent of aging from below, higher would be incidence of aging at the apex in the following period.

Among the demographic factors, we find that fertility, mortality, and the extent of aging from below depict a strong association with the aging at apex. The structural analysis in the forthcoming sections will attempt to highlight the relative significance of these factors towards the aging process in different stages of demographic advancement. Also the study intends to highlight the threshold values of these basic demographic determinants beyond which the process gets triggered. Furthermore, the interaction effects alongwith the component effects of the determinants, if any, will be looked into.

### Determinants of Aging At Apex

The parametric estimates of the regression coefficients, of the linear and non-linear models, where percentage of elderly persons in the total population (PPO) is regressed over linear and non-linear forms of variables such as total fertility rate (TFR), expectation of life at birth (ENN), infant mortality rate (IMR) and persons in working to younger age groups (WCRL), are presented in Appendix Table 4. Perusal of regression 1 in the table reveals that fertility and mortality conditions account for almost 70 per cent of the cross-country variations in the incidence of aging at the apex. Also, we find that the only regression coefficient corresponding to fertility (TFR) turns out to be statistically significant. An oversimplified interpretation could be that it is only fertility which bears significant impact on the aging at apex. However, this obvious simplification should not rule out the specification bias or non-linear nature of association between the aging process and its basic demographic determinants.

Perusal of regression 2 in the table reveals that the nature of association between the aging at apex and the basic demographic determinants viz. fertility and mortality turns out to be parabolic. The regression coefficients corresponding to the quadratic form of TFR and ENN turn out to be statistically significant and the explanatory power of the model characterised by the values of  $R^2$  improves significantly.<sup>1</sup> Thus, the parabolic formulation of the model accounts for almost 83 per cent of the cross-country variation in the incidence of aging at apex.

### Threshold Levels of Fertility and Mortality Initiating Aging At Apex

The parabolic specification of the model implies that there is a decrease and then an increase in the expected value of PPO in response to declines in fertility and mortality. The elicited

1. Details of F-statistic for testing the significance of contribution of additional explanatory variables towards explanation of variations in the regressand are provided in several text books including Kamanta (1972: 371). The value of the appropriate  $F$  statistic based on  $R$  values of the new and original specification of the model turns out to be as follows :

$$F_{2,139} = \frac{R_2^2 - R_1^2}{1 - R_2^2} \times \frac{144 - 5}{5 - 3} = 53.1$$

The value is considerably higher than the tabulated value of 5.49 at 1 per cent level of significance. Thus the null hypothesis that additional explanatory variables do not influence the expected value of PPO stands rejected. The evidence suggests that the addition of quadratic forms of TFR and ENN contributes significantly towards the explanatory power of the model.

parametric estimates of regression 2, in which TFR and ENN have been introduced in quadratic form, helps in highlighting the threshold values of fertility and mortality beyond which the aging at apex gets initiated. The threshold value of fertility (TFR) for triggering the process turns out to be 6.03.<sup>2</sup> Similarly, the threshold level of mortality characterised by ENN turns out to be 56<sup>3</sup> years. Thus, the process of aging at apex seems to be initiated with fertility and mortality declines beyond these threshold values. In other words, the fertility and mortality declines uptill these threshold levels help in the process of rejuvenation at younger and adult age groups, implying an increase in the percentage of population over these age groups. Thereby, the process of aging at apex gets accelerated with further declines in fertility and mortality. It may be of interest to note that the expected value of percentage of elderly persons at these threshold values of fertility and mortality turns out to be around 2.27, around which most of the developing countries over Asian and African regions are hovering. Furthermore, the expected value of PPO at the threshold values of TFR and ENN turns out to be minimum, since the second order partial derivatives of PPO w.r.t. TFR and ENN turn out to be positive.

### Impact of Infant Mortality on The Aging Process

Perusal of regression 3 in the table reveals that addition of IMR variable in the model equation 2 neither improves the explanatory power of the model nor the regression coefficient corresponding to IMR turns out to be statistically significant. An alternative interpretation could be that the effect of IMR on the aging at apex is being captured by the already introduced mortality variable ENN in the specification. However, the rejuvenating effect of mortality declines on the aging process uptill the threshold value of mortality variable (ENN) could be basically because of relatively larger impact of improvements in health conditions on infant mortality in the initial stages of advancement. Thus the impact of IMR seems to be captured by the parabolic specification with regard to ENN in the model. Thus, addition of infant mortality variable in the model has not contributed anything towards explanation of variations in the incidence of aging at apex.

2. From the model equation 2 the change in the value of PPO due to TFR can be derived by equating the first order partial derivative to zero i.e.,

$$\frac{\partial PPO}{\partial TFR} = -5.322 + 2 \times 0.441 TFR = 0$$

The equation provides the threshold value of TFR around 6.03. Furthermore, the second order partial derivative being positive implies that the point of inflexion turns out to be the point of minima. In other words, the aging at apex is minimum when the level of TFR is around six and starts increasing with further declines in fertility.

3. Equating the first order partial derivative of PPO w.r.t. ENN to zero provides the threshold level of ENN to be 55.6 years. Furthermore, the point of inflexion turns out to be the point of minima.

4. The appropriate F-statistic value testing the additional contribution towards explanation of the explanatory variable by the additional regressor in the model turns out to be 2.87, which is much lower than the tabulated value signifying that the additional variable has not contributed anything significant in the influence of the model. In other words, the influence of the additional value in the original specification, turns out to be insignificant.

## Interaction Effects of Fertility and Mortality on Aging At Apex

It may be quite reasonable to presume that the aging process in different countries at different levels of fertility/mortality may respond differently to changes in mortality/fertility. The simplest formulation of such a model highlighting such interaction effects is obtained by introducing a so-called interaction term, defined as a multiple of the two explanatory variables, into the multiple regression equation. The parametric estimates of the multiple regression equation including the interaction term are presented in regression 4 of Appendix Table 4.

Perusal of the estimates reveals that the introduction of the interaction term in the model has rendered the mortality variable ENN to be insignificant whereas the coefficient corresponding the interaction term (TFRENN) turns out to be statistically significant. The presence of the interaction term in the regression equation has an important implication for testing of hypothesis that an explanatory variable does not influence the expected value of the explained variable. The implication is that unless all the coefficients of regressors involving the variable turn out to be insignificant the variable cannot be declared as insignificant in influencing the regressand. Thus, testing of hypothesis that mortality does not influence the aging process amounts to testing the hypothesis that all the coefficients corresponding to all the regressors involving the variable ENN are jointly zero.<sup>5</sup> The appropriate testing of the composite hypothesis reveals that the null hypothesis concerning the impact of ENN on the aging process gets rejected and thus the mortality variable ENN depicts significant impact on the aging process, inspite of the fact that the coefficients corresponding to ENN and ENN<sup>2</sup> turn out to be statistically insignificant.

However, the results clearly suggest that though the component effects of mortality on the aging at apex turn out to be statistically insignificant, but its interaction effect together with fertility turns out to be highly significant. In other words, the force of mortality on the aging at apex turns out to be significant through its interaction with the fertility variable. Thus, the basic premise that fertility plays the crucial role in the aging process, whereas mortality does not, seems to be incorrect. Rather, there are mortality declines in the initial stages of demographic advancement which trigger fertility declines and which in turn depict significant component as well as interaction effect alongwith mortality declines on the aging process. However, the mortality declines together with fertility declines depict significant interaction effect on the aging at apex. In other words, the significant interaction effect implies that the aging process in countries at different levels of mortality respond differently to a change in fertility conditions. Also, the process of aging at apex may become insert to change in fertility at some critical level of mortality. It is only after the critical level of

5. The null hypothesis that ENN does not influence the expected value of PPO can be formally put as :

$$H_0: B_3 = B_4 = B_5 = 0$$

$$H_A: H_0 \text{ is not true}$$

where  $B_3$ ,  $B_4$  and  $B_5$  are the regression coefficients corresponding to ENN, ENN<sup>2</sup> and TFRENN in the regression equation. The alternate formulation having remaining regressors in the model and its parametric estimates are provided in regression 5 in Appendix Table 4. The value of the appropriate F-statistic testing the null hypothesis turns out to be 18.4 which is considerably higher than the tabulated value of  $F(3, 38)$  being 3.78 at the 1% level of significance.

mortality is reached that fertility declines become operative in helping the aging process. Still further, over advanced stages of demographic advancement where further fertility declines become less probable, it will be only mortality decline which can play any role in furthering the process of aging at apex. So, it is fertility alongwith mortality which seems to play the crucial role in triggering and furthering the process of aging in a population. Rather mortality and fertility declines uptill the threshold values depict the younging effect on population and thereafter the relative impact of the two will vary in different stages of demographic advancement. Also, we find that the interaction effect of fertility alongwith mortality turn out to be much higher than the component effect of fertility, which also turns out to be statistically significant. Thus, the results clearly suggest that the aging process gets triggered and accelerated because of the interaction of fertility and mortality over different stages of demographic development. Though, fertility declines depict significant component effect on the aging process, but the interaction effect of fertility alongwith mortality turn out to be relatively much higher. Thus, it is interaction between the two which seems to play the crucial role in the aging process and not only fertility or mortality.

However, the introduction of the interaction term in the parabolic formulation of the model does not contribute anything additional towards the explanatory power of the model. The marginal improvement in the value of  $R$  turns out to be statistically insignificant. Possibly, some further specification analysis may suggest some appropriate transformation of variables which may help in highlighting the exact specification of the model. Nevertheless, the parabolic formulation of the model is considered appropriate for having an insight into the perspectives on aging at apex at different levels of fertility and mortality.

#### **Impact of Aging From Below on Aging At Apex**

Parametric estimates of regression equation 6, in which WCRL has been additionally introduced to the parabolic formulation are provided in Appendix Table 4. Perusal of the estimates reveals that the introduction of WCRL characterising the extent of aging from below, in the parabolic formulation of the model has contributed significantly towards the explanatory power of the model. The appropriate  $F$  value turns out to be 97.4 which is much higher than the tabulated value of 6.63, signifying that the improvement in  $R^2$  value from .83 to .95 is quite substantial. Also, we find that regression coefficient corresponding to WCRL turns out to be highly significant. Thus, aging at apex gets significantly influenced by the extent of aging from below. Alternatively, higher incidence of aging from below results into a structural potential in the age composition for a higher incidence of aging at apex in the ensuing period. However, incidence of aging from below seems to have strong bearing on the aging at apex.

In summarising, the overall process of aging gets initiated by fertility and mortality declines beyond the threshold levels of TFR of around 6 and ENN level of around 56 years. The nature of relationship between the aging at apex and its basic demographic determinants viz. fertility and mortality, turns out to be parabolic depicting that fertility and mortality declines uptill the threshold values, help in rejuvenating the population in initial stages of demographic advancement. Thereby, the declines in fertility and mortality beyond these threshold levels help in the process of aging at apex of the pyramid. Though, fertility depicts

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significant component effect on the aging at apex, but its interaction effect along with mortality turns out to be relatively much more stronger. Thus, the process of aging at apex being triggered by fertility and mortality declines beyond threshold levels, gets accelerated basically because of the interaction between the two. So it is neither fertility nor mortality, but the two together that influence the process of aging at apex. Rather in advanced stages of demographic advancement, it will be only mortality declines, if possible, which can further the process of aging at apex.

### Perspectives on Aging at Apex

Some projection exercises on the aging at apex based on reasonable assumptions about fertility and mortality declines over the coming years predict the incidence to be around 35 per cent in China by 2050 (Zeng Yi 1980), around 20.3 in Japan by 2025 (Horiuchi 1988) and between 10 to 15 per cent in most of the East Asian countries by the turn of the century (UN 1986). A perusal of the estimates provided in the World Resources (1986) reveals these percentages to range between 2.3 in Bahrain to 14.9 in Japan over the Asian region, from 2.1 in Botswana to 5.6 in Gabon over the African region, around 20.6 per cent in Switzerland and most of the European countries ranging between 10 to 15 per cent by the turn of the century.

The projected percentages of the elderly persons, aged 65 and over, as per the parabolic formulation of the model in regression 2 in Appendix Table 4, for different levels of fertility and mortality are provided in Appendix Table 5. It may be of interest to note that the maximum percentage of the elderly persons under very low levels of fertility and mortality characterised by TFR level of 1.0 and ENN level of 100 years, turn out to be around 21. The projected percentage for replacement level of fertility (TFR around 2.05) and expected longevity of life at birth around 64 years, as targeted for India (GOI, 1987), turns out to be 9.5, which is quite close to the UN estimate of 9.7 by the turn of the century. The alarming projections about aging at apex in some of the exercises such as 35 per cent in China by 2050 (Zeng Yi 1988) fall much above the upper bound predicted by the present exercise. However, the past experience of Sweden where the incidence of aging at apex, is around 17 per cent in 1985, with low levels of fertility, which is much below the replacement level, and lowered mortality with ENN level of around 75 years, depicting quite advanced stages of demographic development seems to provide a situation where the process of aging transition is about to be completed. However, further declines in mortality over coming years in Sweden may further increase the percentage of older people marginally. Thus the percentage reaching the upper bound of 21 over coming years seems to be quite reasonable and provides credence to our projected upper-bound. However, the alarming projections about aging at apex beyond the upper-bound and especially around 35 seems to be very unreasonable. Thus, the alarming projections about aging at apex beyond the upper-bound of 21 under any situation of fertility and mortality conditions need to be reconsidered. However, the study does not intend to belittle the importance of policy issues pertaining to the social and economic problems of the aging process, but the results clearly suggest that the incidence of aging at apex in percentage terms seems to be bounded by the upper limit of say 22 per cent.

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## APPENDIX

TABLE 1 : SELECTED VARIABLES

<i>Variable No.</i>	<i>Abbreviated Name</i>	<i>Description</i>
1.	PPO	Percentage of total population in older age group of 65 and over and refers to the period 1985.
2.	PPOL	Lagged level of PPO in 1960.
3.	TFR	Total fertility rate refers to the period 1980-85.
4.	TFRL	Lagged level of TFR in 1960-65.
5.	ENN	Expectation of life at Birth and refers to the period 1980-85.
6.	ENNL	Lagged level of ENN in 1960-65.
7.	IMR	Infant mortality rate (per 1000 live births) and refers to the period 1980-85.
8.	IMRL	Lagged level of IMR in 1960-65.
9.	PPC	Percentage of total population in the younger age group of (0-14) years and pertains to the year 1985.
10.	PPCL	Lagged level of PPC in 1960.
11.	PPW	Percentage of total population in the working age group of 15 to 64 years and pertains to the year 1985.
12.	PPWL	Lagged level of PPW in 1960.
13.	WCR	Working to children ratio depicts ratio of PPW to PPC in the year 1985.
14.	WCRL	Lagged level of WCR in 1960.
15.	DCS	Daily calorie supply as percentage of requirement.
16.	CUS	Contraception use status depicts percentage married couples of childbearing-age using contraception and refers to the period 1982.
17.	ERT	Enrolment ratio in the combined primary and secondary school enrolment as percentage of school-age population and refers to 1980.
18.	URB	Urbanization refers to the period 1985.
19.	PPADW	Percentage of total population with access to clean drinking water facility.
20.	PPASS	Percentage of total population with access to sanitational services.
21.	CDP	Calories domestically produced as percentage of total supply.

\* Includes calories from all sources viz. domestic production, international trade, stock drawdowns, and foreign aid, and refers to the period 1980-82.

TABLE 2 : SPECTRUM OF DISPERSION OF THE SELECTED VARIABLES OVER 144 COUNTRIES

Variable No.	Abbreviated Name	Indices		
		Mean	Standard deviation	Coefficient of Variation
1.	PPO	5.51	3.84	69.87
2.	PPOL	4.77	2.69	56.54
3.	TFR	4.58	1.95	42.57
4.	TFRL	5.47	1.68	30.76
5.	ENN	59.77	11.80	19.75
6.	ENNL	47.97	12.69	26.46
7.	IMR	73.11	51.61	70.59
8.	IMRL	110.97	59.69	53.78
9.	PPC	36.71	9.69	26.41
10.	PPCL	39.16	7.19	18.38
11.	PPW	57.77	6.39	11.06
12.	PPWL	-0.5	4.88	8.71
13.	WCR	1.79	0.84	47.02
14.	WCRL	1.52	0.52	34.27
15.	DCS	103.51	32.32	31.22
16.	cus	19.98	26.90	134.64
17.	ERT	61.04	31.05	50.87
18.	URB	47.05	24.75	52.61
19.	PPADW	32.78	33.27	101.49
20.	PPASS	24.06	31.85	132.37
21.	CDP	89.72	32.11	35.79

TABLE 3 : VARIMAX ROTATED FACTOR STRUCTURE

Item	Variable	Factor Loadings			Communality
		I	II	III	
1.	PPO	-.67	.69	.11	.94
2.	PPOL	-.56	.72	.08	.83
3.	TFR	.82	-.41	-.21	.88
4.	TFRL	.60	-.72	-.13	.90
5.	ENN	-.93	.10	.09	.89
6.	ENNL	-.89	.33	.12	.92
7.	IMR	.92	-.10	-.13	.88
8.	IMRL	.89	-.24	-.17	.89
9.	PPC	.78	-.56	-.03	.94
10.	PPCL	.48	-.85	.03	.96
11.	PPW	-.74	.44	-.02	.82
12.	PPWL	-.40	.85	-.09	.90
13.	WCR	-.79	.61	-.01	.92
14.	WCRL	-.49	.83	-.05	.93
15.	DCS	-.34	.12	.68	.59
16.	CUS	-.47	.00	.38	.37
17.	ERT	-.67	-.09	.19	.50
18.	URB	-.78	.15	-.14	.65
19.	PPADW	-.20	-.82	-.20	.75
20.	PPASS	-.30	-.78	-.11	.71
21.	CDP	.06	.04	.86	.74
Eigen Value		12.45	3.00	1.47	
Percent E. V.		59.32	14.29	6.98	
Cum. percent		59.32	73.61	80.59	

TABLE 4 : DIFFERENT FACTORS AS PREDICTORS OF PPO : 1985

Item		Multiple Regression					
		1	2	3	4	5	6
Multiple	R <sup>2</sup>	.69	0.82	0.83	0.84	0.80	0.94
	R <sup>2</sup>	.70	0.83	0.84	0.85	0.79	0.95
Regression Coefficients and t- Values							
Intercept	IC	11.681	30.737	25.566	9.117	20.626	7.105
		(5.54)	(7.55)	(5.16)	(0.99)	(25.12)	(2.250)
Regressors	TFR	-1.564	-5.322*	-5.508*	-1.715	-5.997*	-2.191*
		(10.29)	(9.91)	(10.15)	(1.16)	(13.83)	(5.73)
	TFR2		0.441*	0.451*	0.312*	0.498*	0.168*
			(8.16)	(8.37)	(4.32)	(10.17)	(4.60)
	ENN	0.017	-.446*	-.336**	-0.027		-0.122
		(.67)	(2.60)	(1.86)	(0.12)		(1.13)
	ENN2		.004*	0.004*	0.002		0.001
			(2.56)	(2.21)	(1.26)		(1.46)
	IMR			0.015			
				(1.80)			
	TORENN				-0.038*		
					(12.61)		
	WCRL						4.100*
							(16.0)
F-Ratio		162	174	141	146	332	379

TABLE 5 : PROJECTED PERCENTAGE OF THE ELDERLY PERSONS AGED 65 AND OVER UNDER DIFFERENT FERTILITY AND MORTALITY CONDITIONS

Levels of		Expected value of PPO
TFR	ENN	
7.0	40	3.652
6.5	45	2.806
6.0	50	2.381
5.5	55	2.376
5.0	60	2.792
4.5	65	3.628
4.0	70	4.885
3.5	75	6.562
3.0	80	8.660
2.0	85	12.847
1.5	90	16.006
1.5	95	17.476
1.0	100	21.256