ORIGINAL RESEARCH PAPER

Volume-7 | Issue-6 | June-2018 | PRINT ISSN No 2277 - 8179

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

COHORT-COMPONENT METHOD FOR PROJECTION OF POPULATION OF INDIA

Statistics

Pandurang V. Thatkar* Research Scholar, Department of Statistics and Mathematics, NES Science College, Nanded *Corresponding Author

Kishor Y. Ingale Assistant Professor of Statistics, Dept. of Mathematics and Statistics, NSB College, Tarasingh Market, Nanded

D. D. Pawar Professor & HOD, Department of Statistics, NES Science College, Nanded

KEYWORDS

Introduction:

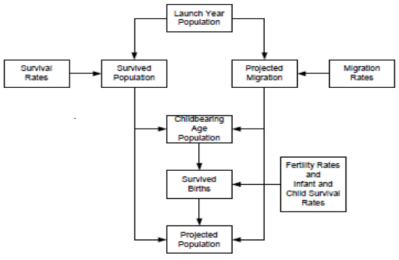
The cohort-component method was introduced by Cannan (1895), subsequently used by Bowley (1924), and later re-discovered independently by Whelpton (1928). It is the most popular and widely used method for producing projections of population at national-level. In cohort-component method, the launch-year population is divided into age sex groups called Fas cohort and a separate rates of the fertility, mortality, and migration are considered for each cohort as it passes through the horizon of projection. This method is very powerful and flexible and hence it can be used in implementing theoretical models. This method provides in-depth knowledge on the dynamics of population figures. Also the cohort-component method is useful at any level of geographical area (from the world as a whole to nations, states/provinces, districts and sub-districts) and it can consider a wide range of assumptions. This method also allows to consider the differences in mortality, fertility, and migration rates among different age groups at a particular time, and to consider how rates change over time for individual cohorts. In implementing the cohort component method, age groups are typically divided by sex followed by further subdivision according to the race or ethnicity.

In cohort-component methods, the cohorts are generally use either single years or 5-year groups (called as cohorts). The extreme age group is generally or always "open-ended," (such as 75+ , 85+, or 90+). Age groups are generally divided by sex followed by further subdivision according to race, ethnicity, and other characteristics.

In cohort- component method, the first step in the process of projections is to start with the launch year population and to estimate the number of persons in it who survive to the end of the interval of projection. This can be done by using age-sex-specific survival rates to each age-sex group in the population at launch. The next step is to estimate the age-sex wise net migration during the interval of projection. The migration rates are introduced so that one will be able to project (according to age-sex groups) he number of persons moving into or out of an area during the interval of projection. The third step is to estimate the number of births that occurred during the interval of projection. This can be achieved by applying age-specific birth rates to the population of females in each age group. The fourth and final step in the process consists of adding total births (according to males and females in each age groups) to the rest of the population. Thus the cohort-component method provides population projections by age and sex at the end of the projection interval. This projected population figure thus serves as the starting point for the next projection interval. This process is repeated till the population projection for final target year is reached.

The illustrative steps in the Cohort-component method are as follows:

Figure: Steps in Cohort-Component Method



Above figure illustrates the possible steps in this process followed in cohort-component method. This figure is just for the purpose of the illustration of the method. Not all applications of the cohort-component method follows the steps shown in it.

Projecting Mortality

The projections of mortality rates required in the cohort-component method of population projections can be derived using number of ways. The simplest way is to presuppose that age-specific rates will remain constant at present levels. This will be reasonable for the short term horizons. For longer or large term horizons, however, this assumption is generally not valid and hence the use of method that which incorporate variable rates becomes inevitable. These methods include various extrapolation techniques, techniques in which mortality rates of one population are tied to those in another, and structural models based on changes in mortality rates according to the socioeconomic variables.

Generally for the mortality projections, extrapolation techniques are commonly used for mortality projections. This may include use of simple extrapolation method or more complicated procedures like ARIMA time series models.

When mortality rates follow stable or constant path, the use of simple extrapolation technique becomes inevitable.

The technique of tied mortality rates can be used to project the mortality rates in a population. Generally, the "targeting" approach depends upon the consideration that mortality rates in the population under consideration will converge to the mortality rate observed in target population. A target population is selected in such a way that it will provides a set of mortality rates believed to be realistic for the population to be projected. This can be done based on homogeneity in cultural socio-economic, and other characteristics such as levels of medical technology; and primary causes of death (Olshansky, 1988: 500).

The other techniques like "ratio" approach, or "Trend Extrapolation can also be used to project mortality.

Another source of mortality rates is Life tables which are easily available for the parts of the world and can be used as a base for projection of mortality rates. Life tables are prepared by the vital statistics agencies in most countries. In India, Sample registration system under Registrar General, India publishes SRS bulletin at regular intervals along with the national life tables are published annually.

Projecting Fertility

For projecting total births, the following techniques can be used. Period perspective, A cohort perspective, combination of the above two methods.

The first method "period perspective" mainly focuses on the births to women during a certain time period like one year. The second method cohort perspective is longitudinal and it focuses on the pattern of fertility of a cohort of women as they pass through their childbearing years. However, the cohort perspective is better process for some

analytical purposes, it becomes very tedious to implement while projecting population projections. Because of these missing data problems and the complexity of the method, a period perspective method is assumed to be superior to the cohort perspective method for the estimation of fertility projections.

Different approaches of fertility projections can be used to estimate fertility rates while using the period fertility perspective.

1. One approach is of holding current age specific birth rates (ASBRs) constant throughout the horizon of projection (Day, 1996; Treadway, 1997). These rates are generally derived from the data of the most recent year or it can also be based on an average of data for the number of recent years.
2. Another approach is to extrapolate past (historical) trends which is useful for the countries passing through the demographic transition from high to low fertility rates, but not useful for the countries which had already completed the transition.
3. The next approach is to use time series techniques. These technique are regularly used to develop non-linear models for projecting ASBRs (Carter and Lee, 1992; Land, 1986; Lee, 1993; Lee and Tuljapurkar, 1994).
4. Another approach which uses projected ASBRs which are created by taking ratios of birth rates in one area to those in another. These ratios are then applied to the birth rates that are already projected for the area of interest.
5. Finally, structural models can be developed used to predict the fertility rates. Generally these models are used for projecting fertility rates at the national level (e.g., Ahlburg, 1999; Sanderson, 1999), but hardly ever been used at the subnational level (Isserman, 1985).

Projecting Migration

Migration has a measurable effect/impact on population growth at the national and subnational levels. The migration can be explained in two different ways for the purpose of projection of population.

1. Gross migration and
2. Net migration.

Gross migration refers to the migration of people into and out of a given area while the net migration refers to the difference between the migration of people into and out of the given area..
That is:

Net Migration = (In migration) - (Out migration).

For projecting population movement, each of the above has its merits and demerits. Generally gross migration models require more data and are more complicated to apply than net migration models (Smith and Swanson, 1998). Both approaches are useful for population projections.

There are two basic techniques of the gross migration as given below.

1. The first approach depends upon the application of out-migration rates and in-migration proportions for each area under consideration to be projected. for this purpose, out-migration rates by age and sex are estimated for each area using out-migration data from the decennial census as the numerators and area populations by age and sex (five years earlier) as the denominators. These rates are then applied to the launch year population to provide a projection of the total "pool" of inter-area out-migrants for all areas. These migrants are allocated to each areas according to the proportion of interstate migrants each area received during the base period (by age and sex).
2. The second approach for projecting gross migration is based on "multi-regional models" (Rogers, 1985, 1995). These models sees migration as part of an integrated system of fertility , mortality, and other population characteristics by age and sex. For example, interstate migration in a multi-regional model for India could be denoted by a 29 by 29 cross-table showing the number of members migrating from each state to every other state, by age and sex.

The net migration also can be used to project migration instead of gross migration. Net migration is generally projected using three approaches.

1. top-down,
2. bottom-up,
3. Combination of above two.

The first approach to projecting net migration based on the top-down method which differentiates between the two components of population growth viz. natural increase and net migration. It also focuses on estimates of total net migration and not the separate estimates according to age-sex cohort. There are two steps in this approach.

a. First, projections of total net migration are made, based on recent levels, historical trends, structural models, or some other procedure.
b. Second, these projections are made by age-sex categories, based on distributions observed in the past.

The second approach to projecting net migration is based on the formulation of separate net migration rates for each cohort of age-sex in the population. This method is called as "bottom-up" approach because the estimates of migration figures for the broad categories are derived from those available for the subcategories; In this approach, the total estimation of the net projected migration for an area is the total of the individual values projected for each cohort of age-sex.

One demerit of the net migration approach is that they are not base migration rates on the population at risk. As a result, net migration may create irregularity in projections for a group of areas.

The simplified version of cohort-component method can be created by combining estimates of the net migration and mortality. (Hamilton and Perry, 1962). In this method, for each age-sex cohort in the population, cohort change ratios (CCR) that covers the time interval between the two most recent censuses are calculated which are also known as census survival rates and expressed as for each age-sex cohort in the population for each age-sex cohort in the population for each age-sex cohort in the population for each age-sex cohort in the population for each age-sex cohort in the population for each age-sex cohort in the population and are expressed as:

$nCCRx = nPx+y / nPx$
where,

nPx+y: is the population aged x+y to x+y+n in the year of the most recent census;

nPx :is the population age x to x+n in the second most recent census; x is the youngest age in an age interval;

n : is the number of years in an age interval and
y : is the number of years between these two successive censuses.

Cohort-change ratios also can be calculated for different race/ethnic groups. Projections can then be made by multiplying these ratios by the launch-year population in each age-sex group:

$nPx+y, t = nCCRx (nPx, l)$
where
nPx+y,t :is the population age x+y to x+y+n in year target year t.

In many situations, like projecting population projections for small areas, unique events and special populations must be taken into account while developing assumptions about migration. Where unique events are the events which have significant but short-term impact on an area's size and pattern of migration. The unique event may be: an economic boom or bust that may have occurred during the base period. Special populations are groups of people who are in an area because of an administrative or legislative action these include military personnel, refugees, prison inmates, and college students. While implementing cohort-component method, it is necessary to account the special populations (if any) if the changes in those special populations are significant (Smith et al., 2001: 239-277). Generally, Migration is noticeably vulnerable than changes in the fertility or mortality to changes in transportation conditions, economic conditions, housing patterns, neighborhood characteristics, and employment opportunities. In small areas, Social and cultural conflicts, natural disasters, and government policies typically have more impact on migration rates than on mortality and fertility rates. Hence, migration is likely to be more difficult to estimate accurately than mortality or fertility. Hence, In general for the smaller area the difficulty in developing accurate migration forecasts is difficult.

References:

1. Bennett, N., and Olshansky, S. 1996. Forecasting U.S. age structure and the future of social security: The impact of adjustments to official mortality schedules. Population and Development Review, 22, 703-727.
2. Budlender, D. and R. Dorrington. 2002. ASSA AIDS and demographic models: user guide. Cape Town, South Africa: Center for Actuarial Research, University of Cape Town.
3. Horiuchi, S., and J. Wilmoth. 1998. Deceleration in the age pattern of mortality at older ages. Demography, 35, 391-412.
4. Olshansky, S., Carnes, B., and C. Cassel. 1990. In search of Methuselah: Estimating the upper limits to human longevity. Science, 250, 634-640.
5. White, K., and S. Preston. 1996. How many Americans are alive because of improvements in mortality? Population and Development Review, 22: 415-429.
6. Ahlburg, D. 1982. How accurate are the U.S. Bureau of the Census projections of total live births. Journal of Forecasting 1: 365-374.
7. Ahlburg, D. 1983. Good times, bad times: A study of the future path of U.S. fertility. Social Biology, 30: 17-23.
8. Akers, D. S. 1965. "Cohort Fertility Versus Parity Progression as Methods of Projecting Births." Demography 2: 414-428.
9. Bhrolchain, M. 1992. Period paramount? A critique of the cohort approach to fertility. Population and Development Review, 18: 599-629.
10. Bloom, D., and J. Trussell. 1984. What are the determinants of delayed childbearing and permanent childlessness in the United States? Demography, 21: 591-611.
11. Bongaarts, J., and G. Feeney. 1998. On the quantum and tempo of fertility. Population and Development Review, 24: 271-291.
12. Bumpass, L. and C. Westoff. 1969 "The Prediction of Completed Fertility." Demography 6: 445-454
13. Easterlin, R. 1987. Birth and fortune: The impact of numbers on personal welfare. (2nd ed.). Chicago, IL: University of Chicago Press.
14. Friedman, D., M. Hechter, and S. Kanazawa. 1994. A theory of the value of children. Demography, 31: 375-401.
15. Golini, A. 1998. How low can fertility be? An empirical exploration. Population and Development Review, 24: 59-73.
16. Lee, R. 1974. Forecasting births in post-transition populations: Stochastic renewal with serially correlated fertility. Journal of the American Statistical Association, 69: 607-617.
17. Lee, R. 1976. Demographic forecasting and the Easterlin hypothesis. Population and Development Review, 2, 459-468.
18. Lesthaeghe, R., and P. Wilhems. 1999. Is low fertility a temporary phenomenon in the European Union? Population and Development Review, 25: 211-228.
19. Mason, K. 1997. Explaining fertility transitions. Demography, 34: 443-454.
20. Ryder, N. 1988. Observations on the history of cohort fertility in the United States. Population and Development Review, 12: 617-643.
21. Clark, D., and J. Cosgrove. 1991. Amenities versus labor market opportunities: Choosing the optimal distance to move. Journal of Regional Scienc, 31: 311-328.
22. Clark, D., and Murphy, C. 1996. Countywide employment and population growth: An analysis of the 1980s. Journal of Regional Scienc, 36: 235-256.
23. Clark, D., Knapp, T., and White, N. 1996. Personal and location-specific characteristics and elderly interstate migration. Growth and Change 27: 327-351.
24. Cushing, B. 1987. A note on the specification of climate variables in models of population migration. Journal of Regional Scienc, 27: 641-649.
25. DaVanzo, J. 1978. Does unemployment affect migration? Evidence from micro-data. Review of Economics and Statistic, 60: 504-514.
26. Edmonston, B., and J. Passel, J. 1992. Immigration and immigrant generations in population projections. International Journal of Forecastin, 8: 459-476.
27. Evans, A. 1990. The assumption of equilibrium in the analysis of migration and interregional differences: A review of some recent research. Journal of Regional Scienc, 30: 515-531.
28. Graves, P. 1980. Migration and Climate. Journal of Regional Science 20: 227-237.
29. Graves, P., and P. Mueser. 1993. The role of equilibrium and disequilibrium in modeling growth and decline. Journal of Regional Science 33: 69-84.
30. Greenwood, M. 1981. Migration and economic growth in the United States: National, regional and metropolitan perspectives. New York, NY: Academic Press.
31. Greenwood, M. 1997. Internal migration in developed countries. pp. 647-720 in M. Rosenzweig and O. Stark (Eds.), Handbook of Population and Family Economics. Amsterdam, Holland: Elsevier Science B.V. Lee, E. 1966. A theory of migration. Demography 3: 47-57.
32. Long, L. 1988. Migration and residential mobility in the United States. New York, NY: Russell Sage Foundation.
33. Long, L. 1991. Residential mobility differences among developed countries. International Regional Science Review 14: 133-147.
34. Massey, D. 1999. International Migration at the dawn of the twenty-first century: The Role of the States. Population and Policy Review 25: 303-322.
35. Massey, D., J. Arango, G. Hugo, A. Kouaouci, A. Pellegrino, and J. Taylor. 1998. Worlds in Motion: Understanding International Migration at the End of the Millenium. Oxford, UK: Oxford University Press.
36. McHugh, K., Hogan, T., and Happel, S. 1995. Multiple residence and cyclical migration: A life course perspective. Professional Geographer 47: 251-267.
37. Meuser, P., and White, M. 1989. Explaining the association between rates of in-migration and out-migration. Papers of the Regional Science Association 67: 121-134. Mohlo, I. 1986. Theories of migration: A review. Scottish Journal of Political Economy 33: 396-419.
38. Morrison, P. 1971. Chronic movers and the future redistribution of population: A longitudinal analysis. Demography 8: 171-184.
39. Nam, C. and D. Sly. (Eds.). 1990. International Handbook on Internal Migration. New York, NY: Greenwood Press. Plane, D. 1989. Population migration and economic restructuring in the United States. International Regional Science Review 12: 263-280.
40. Plane, D. 1993. Demographic influences on migration. Demography 27: 375-383. Rogers, A. 1992. Elderly migration and population redistribution in the United States. pp. 226-248 in A. Rogers (Ed.), Elderly migration and population redistribution. London, UK: Belhaven Press.
41. Rogers, A., and Castro, L. 1984. Model migration schedules. pp. 41-88 in A. Rogers (Ed.), Migration, urbanization and spatial population dynamics. Boulder, CO: Westview Press.
42. Smith, S., and H. Fishkind. 1985. Elderly migration in rapidly growing areas: A time series approach. Review of Regional Studies 15: 11-20.
43. Steinnes, D. 1982. 'Do people follow jobs' or 'do jobs follow people'? A causality issue in urban economics. Urban Studies 19: 187-192.
44. Vijverberg, W. 1993. Labor market performance as a determinant of migration. Economica 60: 143-160.