1. Objective

Mortality forecasting is as important to national/regional policy making as the fertility rate projections because the expected number of deaths and its possible future pattern would exert significant bearing on a nation's objective for intergenerational resource transfer and socio-economic-demographic policy decision. Deaths instantly put pressure on resource generation and distort future vision of resource allocation. For a more practical and anarchist's reason, simple (or old age) deaths are always not as important as the deaths of capable beings suddenly retiring to infinity. That is because the economy's resource value and planning go awry, and that the failure to stop deaths of capable is surely a failure of a nation's vision and scientific ability. Three aspects of 'counting of deaths and its patterns' emerge from the above. First, forecasting mortality rate is important for socio-economic-demographic reasons. Second, it is necessary to embed the uncertainty of life-expectancy (based on say educational pattern) in the forecasting model. Third, even if the basic theoretical mortality model remains the same, the empirical treatment of the error term widely differs.

A wide range of empirical model specifications as examined in the literature, point to the fact that the theoretical mortality model can be estimated in the classical as well as Bayesian tradition with both parametric and non-parametric specifications. The idea of each modeling technique lies in best utilizing the past (ir)regularities as a guide to the prediction of future mortality although the functional specification of the relational pattern between mortality and its co-moving components are either imposed or are left to be computed from the model. It may also be the case that instead of seeking directly the forecasts with classical (parametric or non-parametric) techniques, it would be worthwhile to ask: what is the probability that certain forecast value of mortality would occur at date *t*? Or that based on the computed probability of the past occurrence of regularities in mortality (or demographic pattern), how one would compute a forecast based on a tight confidence and precision? This is a Bayesian technique for forecasting mortality. In view of the above, in this paper we propose to compare various forecasting methods and show their relative performance against each other using both Bayesian and classical domains. We also propose a criterion that combines the effective patterns of the past, employs the prior information and forms a pattern of uncertainty whose functional specification is not determined a priori. That is, we would like to propose a forecasting method that combines Bayesian idea with non-parametric specification and history dependence properties.

2. Methodological overview

The basic Lee-Carter method (1992) provides a interesting way of using historical mortality data to estimate probability distributions of future life expectancies. Undoubtedly, due to transparency of assumptions, it has attracted considerable attention and has had various applications in stochastic forecasts for the United States and other countries. Lee-Carter's projections capture the implications of a continuation of past exponential trends in age-specific mortality rates, uncomplicated by expert opinion or assumptions about medical advances, delay of deaths by cause, or ultimate levels of life expectancy. Lee and Carter claim that "variation in a single parameter can generate the main outlines of the observed pattern that meets Keyfitz's (1981) criterion of parsimony in representing the mortality profile. Let's take note of the following model of Lee-Carter (1992) where M is the mortality rate for generation x and k is the mortality index where the last component is the error term.

$$\ln(M_{x,t}) = \alpha_x + \beta_x k_t + \varepsilon_{x,t}$$
$$k_t = k_{t-1} + c + \varepsilon_t$$

In this equation, the β coefficients capture the rates of change in each age-specific mortality rate, relative to change in the mortality index, k_t. There are disadvantages to mortality forecasts that are straight projections of individual age-specific central death rates. One concern is that if each age-specific rate is allowed to change at its own individual rate, the projected age-profile of mortality may depart from plausible, historically observed patterns (Keyfitz, 1981).[1] Among different ways to modeling the above equations for forecasting, one is to employ the parametric, non-Bayesian time series techniques and use a class of autoregressive moving average (ARMA) architecture while allowing the heteroscedastic (that is ARCH-GARCH) error specifications. The next task is to perform forecasts taking into account error volatility and strength of correlations over time. The second approach to forecasting mortality could be adopting non-parametric or semiparametric specifications. In case of the former, the functional specification is intended to be estimated and with the estimated specification a parametric forecast method would be employed. The third approach would be to go for Bayesian modeling where the question is asked about the probability of occurrence of a specific uncertainty or a range of values in future.

A natural question arises: which of the models perform better and is more informative? Performance of a model can be gauged by its accuracy and minimized uncertainty. However, high performance does not always guarantee high information content. Similarly, high information may sometimes inflate forecast uncertainty, although it is expected that better information content should compress the magnitude of uncertainty. Therefore, it is necessary to strike a balance between embedding richer information and achieving higher accuracy. This is precise the main motivation of the proposal. Our methodology would rely on model comparisons using stochastic simulation techniques by formalizing a general type data generation process. Sub-specified models will be generated from the general type in parametric domain. Bayesian model averaging technique and adaptive regression will be also be used.

3. Expected results

From the experience and expertise of the authors, we expect that the simulated model of general type will provide important clues about model choice under differing demographic and economic scenarios. Forecasting method comparisons is itself a major

[1] Evidence of this outcome is seen in Lee and Carter's figure, in which the projected profiles for 2030 and 2065 are characterized by several irregularities.

and important task when the forecast of the candidate variable in question is a major determinant for future sustainability. Our method is expected to offer forecasters and policy makers a necessary tool for model choice.

4. References

Lee, R. D. and L. Carter, 1992. Modeling and Forecasting the Time Series of U.S. mortality. *Journal of the American Statistical Association* 87: 659—71.

Keyfitz, N. 1981. The limits of population forecasting. Population and Development Review 7:579–593.