Using simple but flexible stochastic population forecasts to extend official population forecasts

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Official agencies often have the need to extend population projections beyond the period for which they had originally been given. These are requested by the public sector as the basis of social and economic planning. In Europe, for instance, there is a strong interest in projections on a long-term horizon related to economic and financial consequences of population ageing. In particular, Working Group on Ageing, an organization directly referring to ECOFIN, requires long-term projections in order to check the observance of economic, financial and social parameters fixed by European Union.

Setting a complete population projection is generally a quite complex and time-consuming activity. So it would be very useful to have a procedure able to extend easily and quickly enough previously given projections, without any need to repeat the whole machinery, but at the same time preserving a complete and precise set of projection results.

Our proposal is based on a simple population projection method developed by Billari, Graziani and Melilli (2008). This methods lies in the framework of the so-called random scenario approach, discussed for instance by Lutz et al (1998, 2003, 2004), in which the probabilistic behavior of each vital rate, in the forecast time span, is specified by means of a stochastic process to be specified on the ground of experts opinions. More precisely, a gaussian process is defined for each vital rate; the parameters of the process are specified on the basis of a series of subsequent conditional evaluations on the rate provided by experts given the values of the rate at some previous point. For simplicity we consider only two equally spaced time points t_1 and t_2. Let us call (Rt_1, Rt_2) the random vector representing the generic vital rate R at time points t_1 and t_2 respectively. We model (Rt_1, Rt_2) through a gaussian (bivariate) distribution; since this distribution is characterized by 5 parameters, we need 5 (independent) conditions in order to fully specify it. Four conditions are obtained from experts evaluations; precisely, experts give evaluations on medium and high scenarios for the rate R at time point t_1 and conditional forecasts for Rt_2 given medium and high scenarios for Rt_1. The fifth condition derives from assumption of equality of the conditional variance of Rt_2 given Rt_1 and the variance of Rt_1; such assumption seems reasonable since intervals ($0, t_1$) and (t_1, t_2) have the same length.

Given the distribution of (Rt_1, Rt_2), an extension to other time points of the forecast interval by (for instance linear or quadratic) interpolation completely determines the distribution of the stochastic process.

The method described above makes it possible to specify a stochastic process for each of the following vital rates: total fertility rate, mean age at childbearing and life expectancy. These vital rates are assumed to be independent. Migration, on the contrary, is not modeled as a random variable.

Age specific fertility rates and age specific mortality rates needed to apply the cohort component method are derived using quite standard methods. Then, by means of the usual renewal population equations, fully probabilistic population projections (by age and sex) are produced for each point of the projected time horizon and immediately extended to subsequent time points. In particular, point and interval estimations for total population or for usual population indices (such as the dependency ratio) become available.

Hence the proposed projection method can produce and extend in time flexible fully probabilistic forecasts, while retaining at the same time the simplicity of the procedure and the immediacy of the expert opinions.

In the following we give some results concerning the extensions until 2065 of the projections for Italian population released in 2007 by the Italian Statistical Institute (ISTAT) for the period 2007-2050. Two series of forecasts at 2065, both for males and females, are shown: the first includes net migration (based on ISTAT expert evaluation), the second assumes a migration balance equal to zero. Each estimate is accompanied by the corresponding 90% confidence interval. Projections at 2065 for elderly dependency ratio (here defined as the ratio of the population over 65 to the population 15 to 64) are also given, with a comparison of the "with migration" versus the "without migration" cases.

Table 1: Male projected population (thousand)

YEAR		without migration	with migration
2050		30257	
2065	ESTIMATE	27051	28462
	90% CONFIDENCE INTERVAL	(26193,27835)	(27608,29286)

Table 2: Female projected population (thousand)

YEAR		Without migration	with migration
2050		31355	
2065	ESTIMATE	27920	29270
	90% CONFIDENCE INTERVAL	(27048,28770)	(28376,30084)

Table 3: Total projected population (thousand)

YEAR		without migration	with migration
2050		61611	
2065	ESTIMATE	54971	57732
	90% CONFIDENCE INTERVAL	(53713,56273)	(56419,58995)

Table 4: Projected elderly dependency ratio

YEAR	without migration	With migration
2050	0.6339	
2065	0.6229	0.5857

Total Projected Population: with migration (green), without migration (blue)