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Towards a Generalized Subpopulation Support for Stochastic Population Projections

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ABSTRACT

Demographic heterogeneity, i. e. differing mortality and fertility among subpopulations, is an important issue in stochastic demographic forecasting. Common approaches typically use the variables age and sex to construct subpopulations, but this might be insufficient and induce projection error. Many studies show significant differences in mortality and fertility among people with and without migration background, but also among people with different level of education or country of origin. So far, our model projects the autochthonous population, immigrants, emigrants, and their descendant generations with separate mortality and fertility. Hence, the subpopulations are build with the variables age, sex, and migration status. In this paper, we extend the model so that a forecaster can project an unlimited number of subpopulations. Next to age, sex, and migration background, a forecaster can use other characteristics like reason of migration or employment to construct subpopulations, and thus to increase projection accuracy.

1 DEMOGRAPHIC MOTIVATION

Population forecasts have a great societal relevance. For instance, the future population size can play a fundamental role in political decisions regarding the social security system. In the past, demographic population forecasts did not become more accurate in Europe (Keilman 2008) — a reason why they should be enhanced further. We address an important issue in stochastic demographic forecasting, i. e., the adequate modeling of demographic heterogeneity. Common approaches (Lutz et al. 1996, Lutz et al. 2001, Alho and Spencer 2005) typically disaggregate a total population in subpopulations by single age and sex, to forecast them with separate mortality and fertility. This might be insufficient, as many studies (e.g., Blue and Fenelon 2011) show that mortality and fertility do not only differ by age and sex, but also by migration status. This is why the probabilistic population projection model (PPPM) forecasts autochthonous population, immigrants, emigrants, and their descendant generations (by single age and sex) with separate assumptions in mortality and fertility (Bohk et al. 2009, Bohk 2012). In contrast to common approaches, the PPPM allows us, for instance, to simulate that immigrants' lower mortality approaches the higher mortality level of the autochthonous population over successive descendant generations —as it actually has been observed in Germany (Kohls 2012). The single projection of the autochthonous population, immigrants, emigrants, and their descendant generations in the PPPM considers demographic heterogeneity far more than common approaches, but even the immigrants can still differ substantially in mortality and fertility (Scott and Stanfors 2011, Andersson 2004, Milewski 2010). Basically, demographic behavior, i. e. the level of mortality and fertility, depends on many factors, like the country of origin, the reason of migration, and participation in the labor market. For instance, the fertility is likely to be higher for young people if the reason to migrate is family reunion, and not getting a better job. Therefore, we propose a general extension of the PPPM, so that a forecaster can project as many subpopulations with separate assumptions in mortality and fertility as needed, in order to increase projection accuracy. Next to migration status, a forecaster can now use

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other characteristics like reason of migration, education, and participation in the labor market to construct subpopulations, and to forecast them with separate assumptions regarding mortality and fertility.

2 IMPLEMENTATION

PPPM projections are generated by stochastic simulation, in which possible assumption matrices are randomly drawn for each sub-population and then used to project future population development. After a certain number of replications, the results are aggregated to yield a probabilistic projection, e.g., in the form of upper and lower quartiles (per sex, age, and subpopulation) for each year within the projection horizon. While the general principles of the PPPM are not affected by a generalization of the subpopulation structure, both the deterministic core of the PPPM projections (i.e., the functions to compute the population development, given the randomly drawn assumption matrices) as well as the user interface have to be adjusted. As the user interface is already relatively complex, this poses several challenges. Besides being able to freely define arbitrary subpopulation structures, result reporting and assumption editing have to be adapted, in order to keep user interaction as simple as possible. Moreover, subpopulation structures have to be managed in the PPPM database, as they are now an essential part of a projection. This poster illustrates how we addressed the above issues and shows some preliminary results. The PPPM implementation is based on the open-source modeling and simulation framework JAMES II (Himmelspach and Uhrmacher 2007); it is open source and freely available at https://bitbucket.org/Christina_Bohk/p3j.

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