Sub National Population Projection: How to Deal with Heterogeneity?

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Introduction

This paper describes our approach to establish a method to downscale population data, from higher spatial units to smaller administrative units or grid level to conduct sub national population projections.

Population projections are often done by national statistical offices with the aim to provide, to planners, the size and the distribution of population at various geographic level of administration. In the short run, these numbers are used in allocating budgets to implement government plans for e.g. in education, health and other services. Projections are also done to simulate the evolution of population structure in the medium and long run and these are done mostly at the national or larger sub-national level. These long run projections shows development of phenomenon which will take years to evolve and could reveal the impact of policies in the past on the population in the future for e.g. effect certain fertility policy on the labor force.

Beyond social science, population projections at various spatial levels are frequently requested in several research fields (for e.g. systems analysis, climate change, ecology, disaster and vulnerability, water, land use, energy etc.). Researchers from different disciplines tried to develop approaches to downscale population data, from higher spatial units to smaller administrative units or grid levels.

One of the challenges in the conduction of sub-national population projections are the increasing discrepancies of the projection outcome from the real population size in the future from bigger spatial aggregations to smaller spatial units. In other words, larger population when projected tends to have smaller discrepancies. Similarly, the national projections will have smaller discrepancies compared to the projections at the sub-national level. The reason is that a smaller population is likely to fluctuate

(due to random or non-random error) more than a larger one and in case of geographic aggregation, the errors are to some extent averaged out. However, there are some approaches to cope with this and other issues, that we want to present and refine in this study to enhance the accuracy in capturing the small-scaled demographic patterns in the present and future.

Methodological Approach

A common approach for instance is a simple linear downscaling method (Smith, Tayman, and Swanson 2002; Gaffin et al. 2004) which assigns the mathematically equivalent fractional share of each small scale spatial unit (e.g. census district) constant to the superior spatial unit (e.g. country). That is insofar problematic as it uses uniform growth rates as downscaling algorithm. Others use a scenario specific mathematical technique of decomposition and optimization combined with gravity-based models. (Grübler et al. 2007; Guo, Li, and Li 2012)

Both, and other not here noted approaches, show a lack of consideration of the interaction of demographic variables, like age composition, sex ratio, mortality, fertility, migration, etc., which shape the domestic heterogeneous patterns of each nation. Approaches that take in to account the demographic heterogeneity are also used, for e.g., the NUT2 level projection done by EUROSTAT (Lanzieri, G. 2007). At the same time some projections done by national statistical agencies are to some extent based on the demographic heterogeneity.

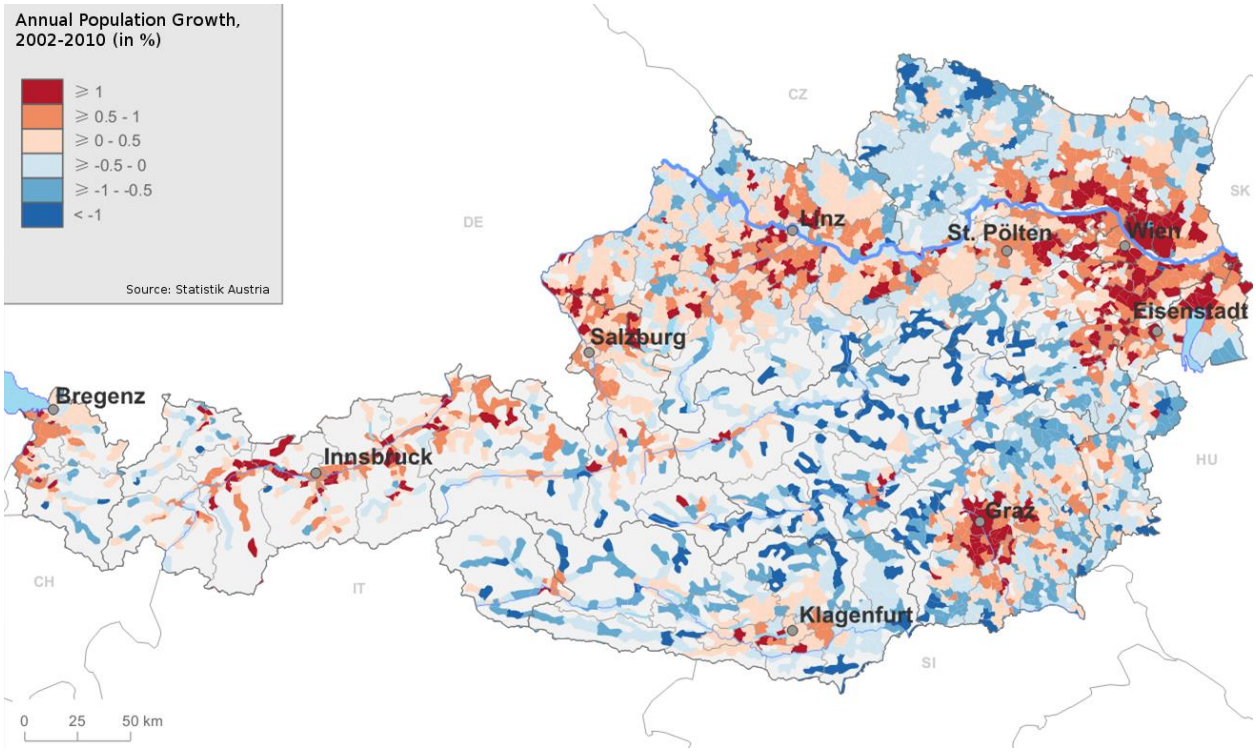
We will further explore these practices and develop a sub-national population projection model that will take the demographic heterogeneity into account. In this paper, we will propose a methodology which is primarily based on past and current demographic trends and heterogeneity within a country. In addition, we will consider various driving forces of demographic changes like the educational composition within a region.

Thereby we use different micro data sets from censuses (e.g. IPUMS) or survey data (e.g. Demographic and Health Survey), as well as data from national statistical offices or regional agencies (e.g. Eurostat). We apply our sub-national population projection model to downscale the national projections done by United Nations (United Nations Population Division 2013), whereby we will focus in this paper on four selected countries: Austria, Nepal, Mexico or Turkey. These countries got chosen as first sample countries due to the availability of data as well as representing diverse regions of the World.

In the case of Austria the population of the whole country grew between 2002 and 2010 about 0.43% from 8.08 million inhabitants in 2002 to about 8.36 million in 2010. But this steady growth was not (see Figure 1) homogenously allocated to the whole Austrian national territory. After the exclusion of uninhabitable areas like mountain, forest or water areas the map shows the remaining potential settlement areas on municipality level. Here we have a quite heterogeneous picture, with high positive

annual population growth rates of over 1% in the urban areas, especially in and around the Austrian capital, Vienna, while the remote rural areas show a decline in population.

Figure 1 – Annual Population Growth in Austria, 2002-2010 (in %)



This diverse development is not limited to the change of the population size, but pervades other demographic aspects of every population, like age and sex composition, fertility and mortality rates or even the educational composition in every spatial unit. One of these trends behind this picture, is the domestic migration from the younger population, aged 20 to 40 years, from rural into urban areas to study, work and other aspects that make living in a city more attractive, like the accessibility to services of general interests or a bigger variety of leisure activities. (Bauer and Speringer 2013)

We can observe this sub national heterogeneity in almost all countries in the world, but with the difference that for a wide range of countries we simple don't have so detailed and valid empirical data to show this differences. But in fact it are those sub national differences in which policy makers, researchers and the public audience are interested in. That is major motivation to produce a method that makes it possible to model these heterogeneity when there is no sufficient small scaled data to refer to.

In case of Austria and our other sample countries, depending upon the availability of data (demographics and human capital), we will use our model to downscale the national population and to

validate it with the empirical data. However, each country, region and local area is in one socio-demographic facet different from another so that we have to investigate the evolution of the demographic heterogeneity at the sub-national level and use the knowledge gain to predict the future.

1. What are the reasons behind certain trends?
2. Can we predict what will happen in the future?
3. What are the main determinants?
4. What will happen in the future?

Summary

This is an ambitious plan can be summed up in the following project tasks: 1) collect available demographic data for these four countries, 2) review the methods of sub-national projections and develop one that takes into account demographic heterogeneity, and 3) project the population at the sub-national level using several models and compare with the model that we will develop.

The significance of this work will be its effect on the increasing quality of our population projections in general, but also the inclusion of demographic methods into a process of population downscaling to gain small scaled population data.

References:

Bauer, Ramon, and Markus Speringer. 2013. "Religious and Ethnic Neighbourhood Profiles in Vienna (1971): A Comparison of Two Dimensions of Urban Diversity. VID Working Paper. Vienna Institute of Demography (Austrian Academy of Sciences)."

Gaffin, Stuart R., Cynthia Rosenzweig, Xiaoshi Xing, and Greg Yetman. 2004. "Downscaling and Geo-spatial Gridding of Socio-economic Projections from the IPCC Special Report on Emission Scenarios (SRES)." *Global Environmental Change* 14 (2). Global Environmental Change: p.105–123. doi:10.1016/j.gloenvcha.2004.02.004.

Grübler, Arnulf, Brian O'Neill, Keywan Riahi, Vadim Chirkov, Anne Goujon, Peter Kolp, Isolde Prommer, Sergei Scherbov, and Erika Slentoe. 2007. "Regional, National, and Spatially Explicit Scenarios of Demographic and Economic Change Based on SRES." *Technological Forecasting & Social Change* 74 (7). Technological Forecasting & Social Change: p.980–1029. doi:10.1016/j.techfore.2006.05.023.

Guo, Yan, Jianping Li, and Yun Li. 2012. "A Time-Scale Decomposition Approach to Statistically Downscale Summer Rainfall over North China." *Journal of Climate* 25. Journal of Climate: p.572–591. doi:10.1175/JCLI-D-11-00014.1.

Smith, Stanley K., Jeff Tayman, and David A. Swanson. 2002. *State and Local Population Projections. Methodology and Analysis*. The Springer Series on Demographic Methods and Population Analysis XVI. New York: Kluwer Academic Publishers and Springer.

United Nations Population Division (2013). *World Population Prospects, the 2012 Revision*. United Nations, New York.