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Spatial association of population pyramids across Europe: The application of symbolic data, cluster analysis and join-count tests

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ABSTRACT

Demographic processes across European regions show great diversity, but because of this diversity, it is hard to gain an overview of similarities and differences. This paper aims to examine the application of a new combination of existing approaches to the analysis of regional population pyramids to offer such an overview. Symbolic data analysis and cluster analysis are used to identify typical shapes of population pyramids, before applying join-count tests to examine the spatial distribution of these pyramid shapes. The data used are for 1397 NUTS regional units in 37 European countries in 2015.

We find that Irish regions, Cyprus and some of the capital cities of Western Europe present the youngest population across Europe, while the population of Eastern Germany is the oldest and shrinking in size. Countries of East-central Europe are the most homogeneous in their demographic processes for the chosen period, while the large demographic discrepancies occur within Spain, France, the UK, Finland, and Sweden between NUTS regions. A spatial study indicated positive spatial autocorrelation, and the transnational character of demographic processes across Europe. For a detailed examination of East-central Europe, we applied local statistics, and revealed three transnational spatial clusters resulting from historical and socio-economic processes.

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1. Introduction

One of the processes accompanying socio-economic trends within Europe is demographic transition. Demographic processes affect regional economies and their sustainable development (e.g. labour markets, goods and services demands, etc.). Understanding the demographic situation of European regions and making accurate predictions requires the examination not just of the total size of the population and its fluctuations in time but of the population structure.

This paper considers population structure across Europe. It examines regional disproportions of population distribution and identifies a typology of population pyramids across Europe. The results of this study then serve to study spatial dependence among different types of population pyramids.

This paper answers the following questions: What population pyramids are typical of European regions? At which stage are the particular areas of Europe in demographic transition? Which areas of Europe present the largest deviations from the European average? Which European countries or areas are the most homogeneous in their demographic processes? And an associated question, following from the above questions, is how important are geographical location and spatial relations for demographic transition of Europe? Is the population structure of Europe regular in space? Is there any spatial dependence between European regions in terms of population structure? Are there any transnational clusters? What spatial trends occur across Europe? This paper also gives recommendations on how to compare a set of population pyramids using statistical methods and reveal some classes of population pyramids and how to measure the spatial dependence of classes.

This paper is arranged in the following way. The first part introduces the population pyramid as a tool to identify demographic processes across European regions. The main body of our paper concerns the methodological problems, dilemmas and challenges within the comparative study of population pyramids, and proposes how to deal with these using symbolic data analysis and spatial statistics methods. The next two sections explain how we cluster a set of population pyramids and examine their spatial relations. The empirical part of this paper diagnoses the population structure across Europe at the beginning of 2015, and identifies demographic regularities and anomalies. The paper concludes with a discussion of our research results.

2. Population pyramids as a tool for studying population structure across Europe

2.1. Population pyramids

The population pyramid defines the demographic composition of a population. It may indicate past events, the current situation, and future demographic trends, e.g. the gender and age disproportions, reproductive capabilities, the demographic age, and the other demographic trends (Preston et al., 2001).

The population pyramid is a graphical illustration of the age distribution in the male and female populations. The width of its base indicates the birth rate. A wide base implies a high birth rate, while a narrow base – a low birth rate. The shapes of its sides denote the death rate. A concave side is identified with a high death rate, while a convex side – a low death rate. An examination of population proportions between pre-reproductive (0, 14), reproductive (15, 44), and post-reproductive age (45 and over) will indicate demographic burdens and the dependency ratio.

Bumps or refractions in the sides identify demographic anomalies such as rapid increase or decrease of a population (e.g. baby boom, mass migration, war, epidemics, and social policy). An asymmetry between the sides denotes disproportions between male and female populations in some age cohorts (e.g. as a result of different life expectancies, or mass male work migration) which can be also determined by the femininity ratio. According to their individual features, Sündbarg (1900) distinguished three models of population pyramid (see Fig. 1).

The expansive model takes a pyramidal form and is typical of young and growing populations, usually for developing economies, and preindustrial societies, e.g. the Third World countries. The stationary model with its bell shape identifies a stable demographic situation in which no increases or decreases of population occur. It is typical for most Scandinavian countries, industrial societies, and developed economies. The constrictive model looks like a spindle. It is typical for elderly and shrinking populations like for example the population of Japan.