DEMOGRAPHIC ANALYSES

MOMENTUM AND CHANGES IN SIZE AND AGE STRUCTURE OF THE POPULATION IN BULGARIA OVER THE PERIOD 1947-2009

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Summary. Population momentum in Bulgaria during 1947-2009 has been studied in relation to changes in the population size and age structure. The population momentum of Bulgaria has been decreasing continuously for more than 70 years – from high positive to high negative values. So in the middle of the last century the age structure ensured potential for 30% future population increase, and today it has potential for 20% population reduction. Momentum decomposition into stable and nonstable components showed that the age composition was highly destabilized in the 1990s, due to sharp changes of the birth rate. Calculation of age-specific momentum showed the presence of peculiar trends in the age groups. Trend analysis of the total and age-specific momentum statistics in the context of the demographic transition threw additional light on the mechanism of population ageing in Bulgaria.

Keywords: population age structure, population age composition, population momentum, population inertia, population growth potential, demographic ageing, reproduction

DEFINING AND MEASURING THE MOMENTUM

“Momentum of population growth” or “population momentum” is “the tendency for changes in population growth rates to lag behind changes in childbearing behaviour and mortality conditions”. “Momentum operates through the population age distribution” that reflects past fertility and mortality schedules and therefore reacts with a “delay” to each change in these processes (Demeny & McNeil, 2003: 646-647).

The population momentum as a measure of growth power, embedded in the age structure, was first studied by Paul Vincent (1945) who called it “growth potential”.

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2 Childbearing behaviour and mortality conditions determine the so-called “reproduction schedule” which comprises the age-specific fertility rates (fertility schedule) and the age-specific mortality rates (mortality schedule).
Later on, the French demographer Bourgeois-Pichat elaborated the concept of “inertia of a population”, referring to the law of inertia in physics (Bourgeois-Pichat, 1971: 240-244). Central for this concept is the stable equivalent population. Population inertia was measured by “the coefficient of inertia” which was calculated as a ratio between the stable equivalent population size and the initial population size. The Canadian demographer Nathan Keyfitz studied the inertia of a stable population in the case of transition to stationary state after an immediate fertility change to replacement level (Keyfitz, 1971). In order to measure it, he introduced the term “momentum” that is used today when it comes to studying the inertia properties of populations in different conditions of transition to stationarity.

Numerous researchers have contributed for the theoretical and empirical studies of momentum (for stable and non-stable populations): Keyfitz (1971, 1985); Potter, Wolowyna & Kulkami (1977); Cerone & Keane (1978); Mode, Busby, Jacobson & Pickens (1985); Preston (1986); Preston & Guilot (1997); Kim, Schoen & Sarma (1991); Kim & Schoen (1997); Schoen & Kim (1991, 1998); Schoen & Jonsson (2003); Goldstein (2002); Li & Tuljapurkar (1999); Knodel (1999); Espenshade, Olgiati & Levin (2011); etc. Young Kim and Robert Shoen demonstrated the existence of a linear relationship between momentum and some basic indicators of population ageing. So they concluded that: “population momentum expresses population aging, and vice versa”; momentum and ageing are “separate aspects of the same demographic phenomenon – that is, the long-term changes in size and age structure that accompany a change in vital rates to replacement level” (Kim & Schoen, 1997: 427). Momentum could be calculated for the entire population or for the individual age groups – usually only for females (Rowland, 1996; Kim, Schoen & Sarma, 1991; etc.).

Momentum is calculated by comparing the size of population in its initial state to that in its final state, reachable when applying the following transitional model: 1) age-specific fertility rates change suddenly and proportionately to replacement level; 2) age-specific mortality rates remain without changes; 3) the new reproduction schedule is maintained for a long time until the age structure becomes stationary. Using this model, we could measure the population potential for future changes as a result of cohort movement towards higher ages (cohort ageing).

This model provides the most precise way for population momentum measurement. If it includes an assumption of a gradual change in fertility to replacement level, this would result in higher momentum values, due to the joint effect of advancing cohorts and age-specific fertility rates (above/below replacement level) on the population size. We have similar effect when comparing the size of the current population to that of the stable population that would be obtained if the current reproduction schedule is kept constant (Rowland, 1996: 42).

Momentum is assessed by calculating the “momentum rate” in one of the following forms: 1) “absolute change” – the difference between the sizes of the final stationary population and the initial population; 2) “ratio” – the ratio between the sizes of the final stationary population and the actual population; 3) “relative change”

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1 The “replacement fertility schedule” includes age-specific fertility rates for which the net reproduction rate equals one.
– relative increase (or decrease) of the population number during its transition to the final stationary condition. Momentum is positive when the momentum coefficient is higher than one (the ratio form) or positive (the absolute or relative forms). It is negative in the opposite case, when the coefficient is lower than one or negative.

The positive momentum shows that when fertility drops immediately to the replacement level and remains at this level long enough, the population will continue to grow before reaching its stationary state. The final stationary population, that results from this fertility schedule, will be larger than the observed (initial) population. This is the classical momentum case. Positive momentum and ageing are typical for the transition of increasing populations towards stationarity. The increase in the share of elderly population is due, on the one hand, to decrease of the share of young people as a result of decreasing fertility and giving birth to fewer cohorts, and on the other hand – to movement of more numerous cohorts (born at higher fertility before the transition beginning) to higher ages. The increase in the size of the elderly is due to movement of the last-mentioned cohorts.

The negative momentum means that after the fertility change to replacement, the population will keep decreasing before becoming stationary and the final population will be lower than the initial population. The negative momentum is typical for the fifth stage of the demographic transition which is characterized by low age-specific mortality rates (increasing crude death rate) and age-specific fertility rates below the replacement level. This stage is also defined as the “second demographic transition” (van de Kaa, 1987). The negative momentum is typical for some European countries with “hyper-ageing” populations, to which Bulgaria belongs⁴.

We usually use the following formula for total momentum calculation:

\[ \Omega = \frac{S}{N} \]  

(1)

where \( \Omega \) is the momentum ratio, \( S \) is the size of the long-run (final) stationary population resulting after prolonged action of the simple reproduction schedule, \( N \) is the size of the observed population before the reproduction schedule change.

Preston & Guillot (1997) reconsidered Keyfitz’s formula for the births in the final stationary population and Kim, Schoen & Sarma’s formulae (Keyfitz, 1985; Kim, Schoen & Sarma, 1991) and arrived to the following momentum expression for female population (\( \Omega^F \)):

\[ \Omega^F = \frac{S^F}{N^F} = \beta \int_0^\beta \frac{c(a)}{c_s(a)} w_s(a) da \]  

(2)

where

⁴ Hyper-ageing is typical for the fifth phase of the demographic transition. It is about the excessive increase of the elderly people share (usually aged 65 or more) to a level that could be maintained only in the case of population decrease (Rowland, 1996: 56). Italy and Germany have hyper-ageing populations, too.