Age Dynamics of Learned Societies and Other Fixed-Sized Populations

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Abstract: In this paper the dynamics of age-structured populations with fixed size is studied. In a hierarchical organization whose total membership size remains constant the annual trade-off is strictly determined by the number of deaths, births and a statutory retirement age. There is a fundamental dilemma of two conflicting goals, of a constant-sized age-structured population, e.g., an Academy of Science to keep a young age-structure while to guarantee a high recruitment rate.

In this paper we first present a reconstruction of the population of the Austrian Academy of Sciences from 1847 to 2005. Based on alternative scenarios of the age distribution of incoming members we project the population of the Austrian Academy forward in time and study the sensitivity of the total number of members, their age distribution and the number of recruits for these alternative scenarios. Then, we introduce an age-structured optimal control model to determine the optimal trade-off between the rate of replacements and the mean age of a constant-sized population whose dynamics is modeled by the McKendrick partial differential equation. A variant of Pestovsky’s maximum principle is derived and used to determine the optimal recruitment distribution in the stationary case. It turns out that due to a bounded age-specific death rate of a member it is optimal to select rather young or old new members. We discuss some interesting policy implications of the obtained optimal recruitment policy (scientific excellence and life-long achievements).

Furthermore, we study two important issues, namely personnel management and migration. In the last area, a two-level age- and duration-specific optimal control model is an appropriate methodological framework. In particular, we aim to study the dynamics of corresponding members since they constitute the pool from which the predominant number of full members is elected. Questions on the promotion of members can be dealt with in a two-stage model framework. An overly long waiting period is either small chance for corresponding members to ever become elected as full members may entail frustration and a base reputation of the academy. Although, the optimization problem for the academy may be decomposed into a cascade of two problems, it is hard to study. Using a multi-compartment model approach we pose the question how to optimally recruit corresponding members and how to promote them to full member status in an efficient way.

Regarding the 2nd topic, we explore the relationships between the age distribution of arriving immigrants and the shorter- and long-run age distribution of national populations. The relevant methodological framework...