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Approximating the survival probability in finite life-span population models

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Abstract

We consider the numerical approximation of the survival probability in the case of an unbounded mortality rate related to a finite life-span in age-structured population models. Our numerical approach is based on the approximation of the integral that characterizes this probability function by means of an appropriate quadrature rule. We demonstrate the convergence of this approximation assuming suitable conditions in relation with the unbounded mortality rate that will be reasonable in the real applications of this model. The numerical experiments carried out with typical mortality rates corroborate the interest of this method.

Keywords: Age-structured population models; finite life-span; survival probability; numerical methods; quadrature rules; convergence analysis
2000 MSC: 65D32, 92D25

1. Introduction

Many different numerical methods have been proposed in the literature for the numerical solution of deterministic age-structured population models (see, for example, [1] and the references therein as a general overview). Lately it has been considered a more realistic situation in which all individuals of the population have a finite life-span. In order to assume a vanishing probability of survival at a finite age, an unbounded mortality rate must be considered. However, this situation leads to additional problems in the convergence analysis of these methods.

In this way, some authors consider numerical methods applied to the age-structured model assuming the exact knowledge of the survival probability (see [17, 16, 8, 2, 3, 4]). Other authors (we remark the numerical methods proposed for the nonlinear case with a separable mortality rate) assume that the intrinsic mortality part (depending only on age) possesses a specific expression near the maximum age [13, 6, 12, 14, 5, 9, 15]. These specific mortality rates were previously considered in the paper of Iannelli and Milner [11]. In their

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