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Modeling Regional Employment. An Application in High Technology Sectors in Greece

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Abstract

Mathematical models of competing species defined by ordinary differential equations are considered to construct a model for analysing the spatial dimension of employment. Analysis of the points of equilibrium is given in an application of the model using data on employment in High Technology Sectors (HTS), for the period 1999-2008, for Greece. The findings suggest that there is tendency of movement in employees in HTS in Greece from the Attica region to the Rest of Greece. In the long-run equilibrium it was found that the employment in Attica will be between the levels of 2007 and 2008 while it will increase in the periphery of Greece.

Key words: mathematical models; differential equations; regional employment; Greece.

1. Introduction

In the last two decades a lot of work has been done in an effort to explain the mechanisms that generate patterns in spatial domains in economics and especially in the field of economic geography and

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environmental economics (e.g. Fujita et.al. 1999, Krugman 1996, Xepapadeas 2010). In the present work an attempt has been made to develop a model to examine the spatial dimension of employment. More specifically, data on employment in Greece has been used in order to explain regional employment in High Technology Sectors (HTS), for the period 1999-2008. The model that was developed was based on a mathematical model from biology, of the growth of two species sharing a common environment. The original model focuses on biological phenomena and the object is to find out the long-run qualitative behaviour of the trajectories. In this paper we present a mathematical model with two regions i.e. the Region of Attica and the Rest of Greece and investigate the possible equilibrium points as well as their characterisation in terms of stability of employment in HTS. In Section 2, the mathematical model is developed for *n* regions and the application for the two-region case is also presented, in Section 3 the data used are described and the estimation of the model is presented and finally, Section 4 concludes.

2. The mathematical model

The mathematical model with n regions with employment $x_1, x_2, \ldots, x_n$ is defined by the following system of ordinary differential (ODEs):

$$\begin{aligned} x_1' &= F_1(x_1, x_2, \ldots x_n) \\ x_2' &= F_2(x_1, x_2, \ldots x_n) \\ \vdots &\quad \vdots \\ x_n' &= F_n(x_1, x_2, \ldots x_n) \end{aligned}$$

where $x_i(t)$ are functions of time.

The rate of change x_i' of employment x_i over the actual level of employment (x_i'/x_i) is considered to depend linearly on employment in each region $x_1, x_2, \ldots, x_n$:

$$\begin{aligned} x_1' &= (b_1 + a_{11}x_1 + a_{12}x_2 + \cdots a_{1n}x_n)x_1 \\ x_2' &= (b_2 + a_{21}x_1 + a_{22}x_2 + \cdots a_{2n}x_n)x_2 \\ \vdots &\quad \vdots \\ x_n' &= (b_n + a_{n1}x_1 + a_{n2}x_2 + \cdots a_{nn}x_n)x_n \end{aligned}$$

An equilibrium point is characterized by the condition $x_1'(t) = 0, x_2'(t) = 0, \ldots, x_n'(t) = 0$ In order to find the equilibrium points the system of equations is solved:

$$\begin{aligned} F_1(x_1, x_2, \ldots x_n) &= 0 \\ F_2(x_1, x_2, \ldots x_n) &= 0 \\ \vdots &\quad \vdots \\ F_n(x_1, x_2, \ldots x_n) &= 0 \end{aligned}$$

The equilibrium points are characterized as stable on unstable by the behavior of the eigenvalues of the Jacobian matrix