



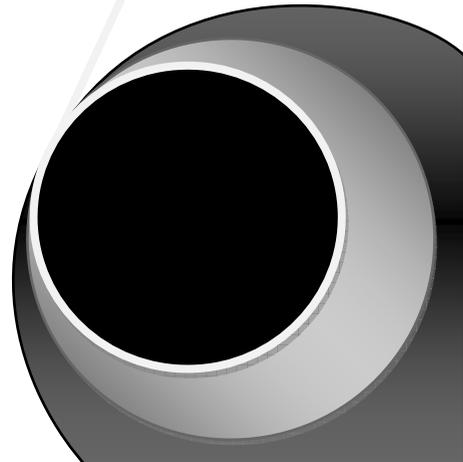
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AIMS AND SCOPE

The *HELLENIC OPEN BUSINESS ADMINISTRATION Journal* is published two times a year and focuses on applied and theoretical research in business Administration and economics.

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The *HELLENIC OPEN BUSINESS ADMINISTRATION Journal* also publishes special issues. A special issue focuses on a specific topic of wider interest and significance, which is announced through relevant call for papers.

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The *HELLENIC OPEN BUSINESS ADMINISTRATION Journal* (The HOBA Journal) is published two times a year, in January and July. These two issues constitute one volume. One or more issues may focus on a specific topic of wider interest and significance, which is announced through relevant call for papers.

The editorial process at The HOBA Journal is a cooperative enterprise. Articles received are distributed to the Editor for a decision with respect to publication. All articles are first reviewed to be judged suitable for this journal. The Editor arranges for refereeing and accepts and rejects papers or, alternatively, forwards the papers to a member of the Board of Editors. The member of the Board of Editors, then, arranges for refereeing and accepts or rejects papers in an entirely decentralized process. In any case, each submission is sent to two referees for blind peer review and the final decision is based on the recommendations of the referees. The referees are academic specialists in the article's field of coverage; members of the Board of Editors and/or members of the Editorial Advisory Board may act as referees in this process. Only when a paper is accepted for publication it is sent again to the Editor. Subsequently, the Editor sends the finally accepted paper to The HOBA Journal office for final editing and typesetting.

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The above outlined co-editing process has major advantages. First, it is helpful in the assignment of referees and in the decision whether to publish a submission. Second, it avoids the apparent conflict of interest that results when an Editor handles a colleague's article. As a general rule the Editor and the members of the Board of Editors never assign papers written by authors at the same institution.

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INSTITUTIONAL REFORMS IN A REGION: ON THE COMPLEXITY OF THEIR EVOLUTION

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Abstract

The paper considers the evolution of institutional reforms in a region during the implementation of a reform, on regional development. For this purpose we use a difference equation. The existence and stability of equilibria are studied. We show that the slope of the tax function may change the stability of equilibrium and cause a structure to behave chaotically. For some values of this parameter there is a locally stable equilibrium which is the value that maximizes the profit function of the local government. Decreasing these values, the equilibrium becomes unstable, through period-doubling bifurcation. The complex dynamics, bifurcations and chaos are displayed by computing numerically Lyapunov numbers and sensitive dependence on initial conditions.

Keywords: Regional Development, Institutional Reforms of Local Governments, Difference Equation, Equilibrium, Stability, Chaotic Behavior.

JEL Classification: C61, C62, C72, R11

Introduction

The reforms that take place in local government have main mission to improve the conditions of operation of local government. The enhanced role of local government can act as a catalyst for local development. As local governments have a monopoly on the production of public services reforms upgrade their role in the design and execution of regional policy. The most important element in the adoption and implementation of a reform at the local level is the additional responsibilities for local and regional administrations (Sarafopoulos & Ioannidis, 2013). Strengthening the powers of local and regional government, through powers delegated by the central government is crucial to the local community. This evolution is directly linked to a number of fields of local economic activity.

In previous work (Sarafopoulos and Ioannidis, 2014) we examined a sufficient condition for attracting investment in an area in which they apply various administrative reforms. In this article we study the evolution of the reforms on a region through a difference equation. Various empirical works have shown that difference equations have been extensively used to simulate an economic behavior (Abraham et al., 1997; Elaydi, 2005; Sedaghat, 2003). Recent research has attempted to explore the views of two successive reforms implemented in Greece (Ioannidis, 2013; Sarafopoulos & Ioannidis, 2014). However, there is a significant gap in the broader definition of the relationship between the exercise of local government reforms and sequential growth.

The structure of the paper is the following: In section 2, we emphasize the interesting study of the temporal evolution of reforms in an area. In section 3, we study the evolution through a discrete difference equation based on the marginal profit of the local government. The equilibrium points and local stability are investigated. We prove that evolution can be complex. As a parameter of the model is varied, the stability of the equilibrium is lost and the complex (periodic or chaotic) behavior occurs. Numerical simulations are presented to show the chaotic behavior.

Literature review

Institutional reforms aimed at rearranging the terms of regional policy have particular importance for regional development. As significantly based to reinforce the role of regional and local administrations, act decisively for local economies. Their effectiveness is shaped by the terms of implementation by local actors. The study of successive applications of institutional reform can reveal additional aspects of operating conditions for the local economy (Citroni

et al, 2013). Exploring the interaction of local actors in a dynamic context can shed strong light in the specific characteristics of each community. Therefore, policy makers can improve conditions for local development.

In the case of local governments reforms the interest lies in the context of widening their choices through the adoption of new powers (Wollman, 2004). The strengthening of their competences makes them calculable players of the local economic system. Therefore conditions improved their interventions to local and regional policy and therefore to the constitution of terms for local welfare. Reforms of local government are determined by multiple dimensions, reshaping key local area. Increasing the powers of a municipality expands the action and incorporates the local administration more effectively in the local financial system (Davey & Pteri, 2006). In parallel are generated important conditions for effective functioning of the state and the exercise of regional policy (Kuhlmann et al, 2006). Apart from the transfer of powers reforms of local governments are associated to the financing conditions of municipalities, the terms of local elections and the bureaucratic connections with the central government. The research on the abovementioned pillars reveals primarily the relationship among the acceptance of reforms by local agents and the particular elements of the local economic space (Teles, 2012). It is notable that the reception of reforms is directly linked to the cooperative actions of local actors, such as through enhanced scope of completion (Bel et al, 2013).

Specifically the research about the association between the reform of local governments and their evolution in time, can disclose the individual fields of acceptance and rejection by society (Ioannidis, 2013). As the effective implementation of reforms requires a substantial period of time, it is obvious that their investigation in time may reveal the additional deterministic variables of their effectiveness. The information requested is to find a suitable methodology for the analysis of the development of local government reform.

A dynamic approach

The local government in a region is the primary local administrative body. Its basic task is the effective execution of local government institutional reform. In this section, we will study the temporal course of the degree of adaptation to reforms implemented in an area. For this purpose we will use a difference equation based on the marginal profit of the local government. If x is the degree of adaptation to reforms, we assume that the tax per unit reform is linear and decreasing:

$$T = a - bx \quad (1)$$

and the cost function is linear:

$$C(x) = cx \quad (2)$$

where $a, b, c > 0$.

With these assumptions the profit of the local government is given by

$$\Pi(x) = x(a - bx) - cx \quad (3)$$

Then the marginal profit is given by

$$\frac{d\Pi}{dx} = a - c - 2bx \quad (4)$$

The local government decides to increase its institutional reforms if it has a positive marginal profit, or decreases its institutional reforms if the marginal profit is negative (boundedly rational player). We assume that the rate of growth of the degree of adaptation is given by the marginal profit. Then the dynamical equation has the form

$$x(t+1) = x(t) + x(t) \frac{d\Pi}{dx}, \quad t=0,1,2,\dots \quad (5)$$

or equivalently

$$x(t+1) = x(t) + x(t)[a - c - 2bx(t)] \quad (6)$$

Equilibria and stability

If

$$f(x) = x + x(a - c - 2bx) \quad (7)$$

The fixed points of Eq. (6) are the solutions of the equation $f(x) = x$, and then the fixed points are

$$x_1 = 0, \quad x_2 = \frac{a - c}{2b} \quad (8)$$

Since

$$\begin{aligned} \frac{df}{dx}(0) &= 1 + (a - c) > 1 \\ \frac{df}{dx}\left(\frac{a - c}{2b}\right) &= 1 - (a - c) \end{aligned} \quad (9)$$

The equilibrium $x_1 = 0$ is instable and the equilibrium $x_1 = \frac{a - c}{2b}$ is locally stable if

$$|1 - (a - c)| < 1 \quad (10)$$

Or, equivalently,

$$0 < a - c < 2 \quad (11)$$

We assume that the profit is maximized for $x = 1$. Therefore $a - c = 2b$. It follows that:

Proposition. If we suppose that $a - c = 2b$, map (6) has an equilibrium at $x = 1$ which is the value that maximizes the profit of the local government. It is locally stable if the slope $s = -b$ of the demand function satisfies the condition $-1 < s < 0$. Moreover there is a period doubling bifurcation if $s = -1$.

Numerical simulations

To provide some numerical evidence for the chaotic behavior of Eq. (6), we present various numerical results here to show the chaoticity, including its bifurcations diagrams, Lyapunov numbers¹ and sensitive dependence on initial conditions. If the Lyapunov number is greater of 1, one has evidence for chaos (Fig.3). In Fig.1 we use 550 iterations of the map Eq.(7) and the bifurcation scenario is occurred. As one can see the equilibrium point is locally stable for $-1 < s < 0$. As s decreases, the equilibrium becomes unstable, infinitely many period doubling bifurcations and the behavior becomes chaotic, as s

¹ Let f be a smooth map on \mathbb{R} and let x_0 be a given point. The Lyapunov number $L(x_0)$ is defined as $L(x_0) = e^{\lambda(x_0)}$, where $\lambda(x_0) = \lim_{k \rightarrow \infty} \frac{1}{k} (\ln |f'(x_0)| + \dots + \ln |f'(x_{k-1})|)$

is the Lyapunov exponent (if the limit exists), (Kulenonic, M., Merino, O., 2002).

decreased. It means for small values of s the system converge always to complex dynamics. Also, one can see that the period doubling bifurcation occur at $s = -1$.

To demonstrate the sensitivity to initial conditions of Eq.(6), we compute two orbits (60 iterations of the map) with initial points $x_0 = 0.1$ and $x_0 + 0.001$, respectively. The results are shown in Fig.2. At the beginning the time series are indistinguishable; but after a number of iterations, the difference between them builds up rapidly.

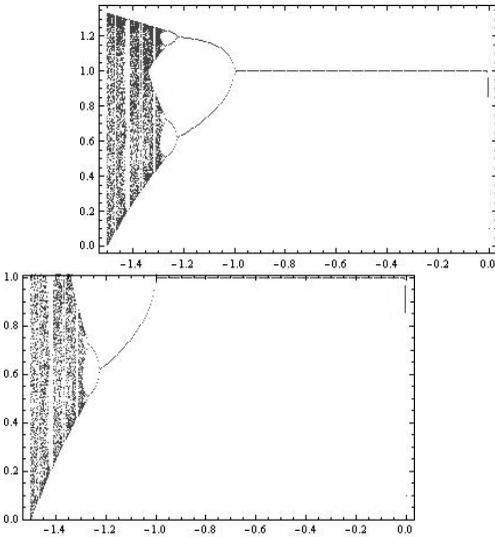


Fig.1. Bifurcation diagram with respect to the parameter s against variable x (left) and x with $0 < x < 1$ (right), for $x_0 = 0.1$ and 550 iterations of the map (7).

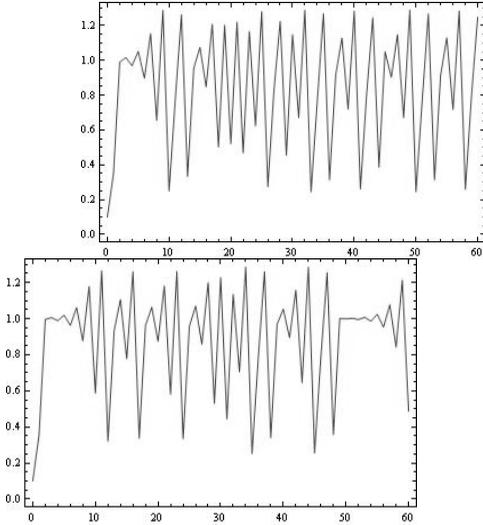


Fig.2 (a) For sensitive dependence on initials conditions: x plotted against the time, parameter value $s = -1.4$ and initial condition $x_0 = 0.1$ (left), $x_0 = 0.101$ (right).

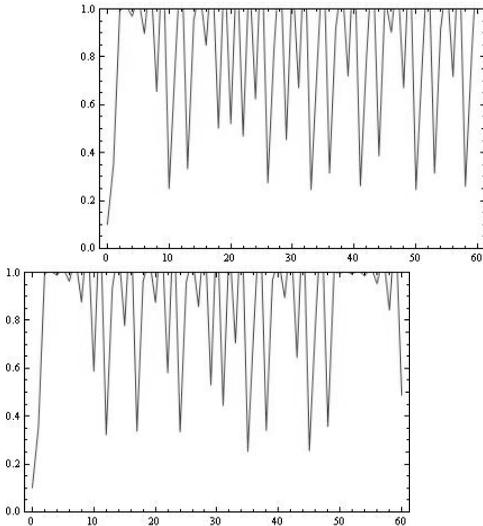


Fig.2 (b) Sensitive dependence on initials conditions for equation (6), parameter value $s = -1.4$ and initial condition $x_0 = 0.1$ (left), $x_0 = 0.101$ (right) with $0 < x < 1$.

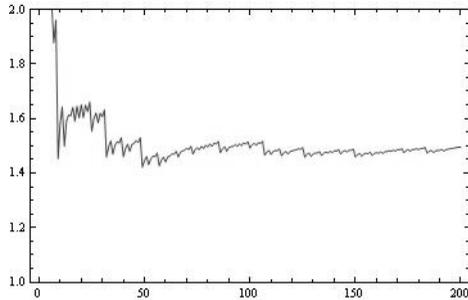


Fig.3. Lyapunov numbers of the orbit of 0.1, for $s = -1.4$, versus the number of iterations of the map (7).

Conclusions

In this paper, we analyzed through a discrete dynamical equation based on marginal profit of the local government, the evolution of institutional reforms in a region during the implementation of an administrative reform for attracting investment. The stability of equilibria, bifurcation and chaotic behavior are investigated. We show that the slope of the tax function may change the stability of equilibrium and cause a structure to behave chaotically. For some values of this parameter there is a stable equilibrium which is the value that maximizes the profit function. Decreasing these values, the equilibrium becomes unstable, through period-doubling bifurcation.

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