The HELLENIC OPEN BUSSINES ADMINISTRATION *Journal*

Volume 2 - 2016, No 2

Edited by: ***Dimitrios A. Giannias****, Professor*
HELLENIC OPEN UNIVERSITY

ISSN: 2407-9332

Athens
Publisher: D. Giannias

Volume 2 - 2016, No 2

ON THE EVOLUTION OF INSTITUTIONAL REFORMS IN A REGION: A BOUNDED RATIONAL APPROACH

Georges Sarafopoulos
Democritus University of Thrace, Greece

Abtract

The paper considers the evolution of institutional reforms in a region during the implementation of a reform, on regional development. In previous work (Sarafopoulos and Ioannidis, 2014) we examined the evolution of the reforms on a region through a difference equation and we demonstrated that the slope of the tax function may change the stability of equilibrium and cause a structure to behave chaotically. In this article we show that by introducing a new parameter we can control the previous instability. For values of the slope which in the previous case created instability resulting a stable equilibrium. But also we prove that the new parameter generates instability and chaos. 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. Increasing 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, D42

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 evolvement is directly linked to a number of fields of local economic activity.

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. 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.

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.

In previous work (Sarafopoulos and Ioannidis, 2014) we examined the evolution of the reforms on a region through a difference equation and we demonstrated that the change in the slope of the tax function can generate chaotic dynamics. In this article we show that by introducing a parameter we can control the previous instability. For values of the slope which in the previous case created instability resulting a stable equilibrium. But also we prove that the new parameter generates instability and chaos.

The structure of the paper is the following: In section 2, we study the evolution through a discrete difference equation based on boundedly rationality. 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 lost and the complex (periodic or chaotic) behavior occurs. In section 3, numerical simulations are presented to show the chaotic behavior.

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:

$$T = a - bx \tag{14}$$

and the cost function is linear:

$$C(x) = cx \tag{15}$$

where $a,b,c > 0$.

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

$$\mathrm{P}(x) = x(a - bx) - cx \tag{16}$$

Then the marginal profit is given by

$$\frac{d\mathrm{P}}{dx} = a - c - 2bx \tag{17}$$

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 proportional to the marginal profit. Then the dynamical equation has the form

$$x(t + 1) = x(t) + kx(t)\frac{d\mathrm{P}}{dx},\ \mathrm{k} > 0,\ \mathrm{t} = 0,1,2,... \tag{18}$$

or equivalently

$$x(t + 1) = x(t) + kx(t)[a - c - 2bx(t)] \tag{19}$$

If

$$f(x) = x + kx(a - c - 2bx) \tag{20}$$

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

$$x_1 = 0,\ x_2 = \frac{a - c}{2b} \tag{21}$$

Since

$$\begin{aligned} \frac{df}{dx}(0) &= 1 + k(a - c) > 1 \\ \frac{df}{dx}\left(\frac{a - c}{2b}\right) &= 1 - k(a - c) \end{aligned} \tag{22}$$

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

locally stable if

$$\left|1 - k(a - c)\right| < 1 \tag{23}$$

Or, equivalently,

$$0 < k(a - c) < 2 \tag{24}$$

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 Eq.(6) has an equilibrium at $x = 1$ which is the value that maximizes the profit of the local government. It is locally stable if $0 < k < \frac{1}{b}$. Moreover there is a period doubling bifurcation if $k = \frac{1}{b}$.

Remark: For values of the parameter b which in the previous paper Sarafopoulos, Ioannidis, 2014 created instability, it suffices to choose k less than 1 / b.

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 numbers[7] 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 $0 < k < 0.5$. As s decreases, the equilibrium becomes unstable, infinitely many period doubling bifurcations and the behavior becomes chaotic, as s 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 $k = 0.5$.

[7] Let f be a smooth map on 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

$$\lambda(x_0) = \lim_{k\to\infty} \frac{1}{k}\left(ln\left|f'(x_0)\right| + \ldots + ln\left|f'(x_{k-1})\right|\right)$$

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

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 $x_0 = 0.101$, 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.

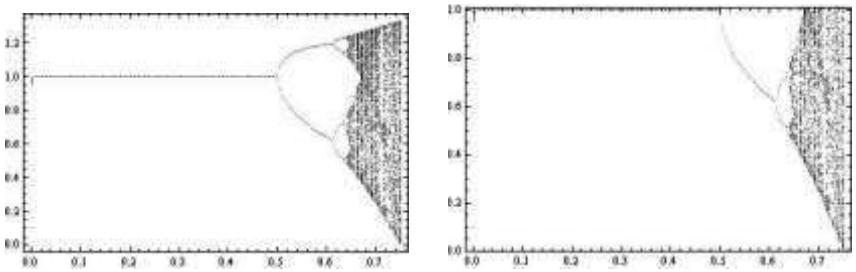

Fig.1. Bifurcation diagram with respect to the parameter k against variable x (left) and x with 0<x<1 (right), for x_0=0.1, with 550 iterations of the map (7) and b = 2.

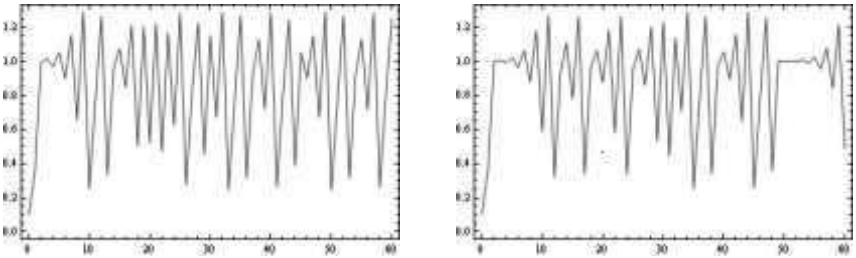

Fig.2 (a) Sensitive dependence on initials conditions with b = 2: x plotted against the time, parameter value k = 0.7 and initial condition x_0 = 0.1 (left), x_0 = 0.101 (right).

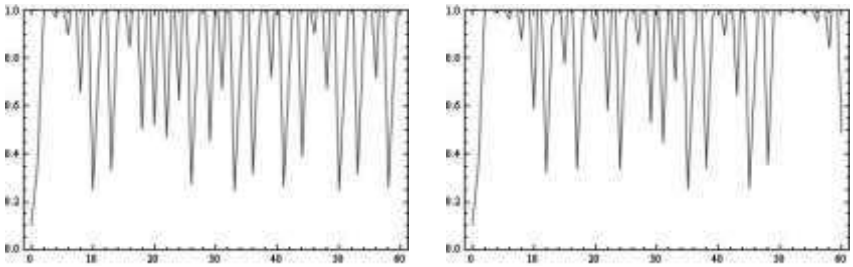

Fig.2 (b) Sensitive dependence on initials conditions for equation (6), with b=2, parameter value k = 0.7 and initial condition x_0 = 0.1 (left), x_0 = 0.101 (right) with 0<x<1.

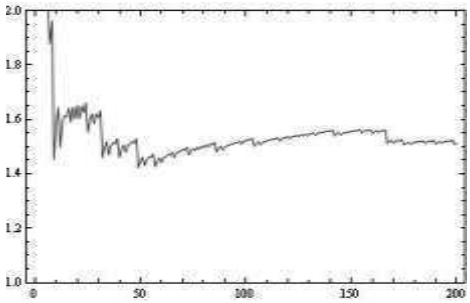

Fig.3. Lyapunov numbers of the orbit of 0.1, for b=2, k = 0.7, versus the number of iterations of the map (7).

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. In previous work (Sarafopoulos, Ioannidis, 2014) we examined the evolution of the reforms on a region through a difference equation and we demonstrated that the change in the slope of the tax function can generate chaotic dynamics. In this article we show that by introducing a new parameter we can control the previous instability. For values of the slope which in the previous case created instability resulting a stable equilibrium. But also we prove that the new parameter generates instability and chaos. For some values of this parameter there is a stable equilibrium which is the value that

maximizes the profit function. Increasing 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.

References

Abraham, R., Gardini, L., Mira, C., (1997), *Chaos in Discrete Dynamical Systems: A Visual Introduction in Two Dimensions.* Springer, Berlin.

Bel G., Fageda X., Mur M., (2013), Why Do Municipalities Cooperate to Provide Local Public Services? An
Empirical Analysis, *Local Government Studies*, 39, (3): 435-454.

Citroni, G., Lippi, A. and Profeti, S., (2013), 'Remapping the State: Inter-Municipal Cooperation through Corporatization and Public-Private Governance Structures', *Local Government Studies,* 39,2: 208-234.

Davey,K., Pteri G., (2006) Taxes, transfers and transition – adjusting local finances to new structures and institutions: The experience of the Czech Republic, Hungary and Slovakia*, Local Government Studies*, 32 (5): 585-598.

Elaydi, S., (2005), *An Introduction to Difference Equations.* Springer-Verlag, New York.

Ioannidis, P.G., (2013), Local Government Institutional Reforms and Cooperation among Local Actors: The Case of Eastern Macedonia and Thrace ', Paper presented at the 6th Biennial Hellenic Observatory PhD Symposium on Contemporary Greece and Cyprus 6-7 June 2013, Hellenic Observatory, London School of Economics.

Kulenovic, M., Merino, O., (2002), *Discrete Dynamical Systems and Difference Equations with Mathematica.* Chapman & Hall/Crc.

Kuhlmann S., Bogumil J., Grohs, S., (2006), Evaluating Administrative Modernization in German Local Governments: Success or Failure of the "New Steering Model"? *Public Administration Review*, 68, (5): 851-863

Sarafopoulos, G., Ioannides, P.G., (2014), Institutional Reforms in a Region: On the complexity of their evolution. Paper Presented at the First International Conference Hoba, Mars, 2014

Sarafopoulos G., Ioannidis P.G., (2014), Local Agents' Cooperation as a Signal Game: Firms, Local Governments and Investment Strategies, Paper Presented at the 5th International Conference The Economies of Balkan and Eastern Europe Countries in the changed world (EBEEC 2013) Istanbul, Turkey, May 9-12 2013 (accepted for publication at Procedia Economics and Finance-Elsevier).

Sarafopoulos, G., Ioannides, P.G., (2013), Institutional Reforms and Interaction of Local Governments: A Dynamic Approach, Paper Presented at the 2nd International Conderence on Econophysics, 13-14 September, 2013, Kavala, Greece

Sedaghat, H., (2003), *Nonlinear Difference Equations: Theory with Applications to Social Science Models.* Kluwer Academic Publishers.

Teles F.,(2012) Beyond Paternalism Towards Social Capital: Local Governance Reform in Portugal, *International Journal of Public Administration*, 35,(13): 864-872,

Woollman, H. (2004), Local Government Reforms in Great Britain, Sweden, Germany and France: Between Multi-Function and Single-Purpose Organisations, *Local Government Studies,* 30, (4), 639 – 665.