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AIMS AND SCOPE

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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.

The journal was established in 2014 following the completion of the HELLENIC OPEN BUSINESS ADMINISTRATION International Conference.

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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While the Journal seeks to publish papers, which are academically robust, hence the rigorous review process (double blind peer review), it also seeks to publish papers that communicate effectively. It is interesting, well written and, therefore, readable papers that really contribute to the area of interest. Articles submitted should, therefore, keep technical jargon and statistical formulae within papers to a minimum and always aim to present material, however complex, simply and clearly.

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INTERACTION OF LOCAL GOVERNMENTS: A DYNAMIC APPROACH WITH HOMOGENEOUS PLAYERS

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Abstract

In this paper we point to the difficulty of applying concepts of microeconomic theory (competition between products and firms) at the political level (competition between regions). To emphasize this difficulty we present a model of competition between two local governments in order to show complexity and non-predictability. We consider the interaction between local governments during the implementation of a reform on regional development through a discrete – time duopoly game where the players have homogeneous expectations. The existence and stability of equilibria of this system are studied. We show that a parameter of the system may change the stability of equilibrium and cause a structure to behave chaotically. For the low values of this parameter the game has a stable Nash equilibrium. Increasing these values, the Nash 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, Game Theory, Nash Equilibrium, Discrete Dynamical System; Chaotic Behavior.

JEL Classification: C61, C62, C72, R11

Introduction

Intraregional competition among regional unities is an important variable of local economic activity. Neighboring regional unities function in order to attract investments and to promote local comparative advantages. The exploitation of local comparative advantages may result by the affiliation of local actors to commonly accepted strategies that upgrade local prosperity. Local governments can adopt crucial role in this process as they hold the monopoly of public service delivery (Citroni et al, 2013; Ioannidis, 2013). Cognitive cooperation strategies generate strong conditions for local development by diminishing transaction cost and by increasing the efficiency of local resources. One of the most important dimensions of regional development stands in the field of local governments institutional reforms. Institutional reforms of local government produce changes in local communities as new condition of public policy are created. Under this perspective the ability of a local community to implement efficiently reforms can be associated by the prospect of local development (Sarafopoulos & Ioannidis, 2014).

Ardinat, 2011, Krugman, 1994 and Krugman, 2011 point to the difficulty of applying concepts of microeconomic theory (competition between products and firms) at the political level (competition between regions). To emphasize this difficulty we present a model of competition between two local governments in order to show complexity and non-predictability. In previous work (Sarafopoulos & Ioannidis, 2013), it was emphasized in the impact of interaction among local governments on reforms' implementation. In this paper we focus on the competition among local governments. Game Theory has been used as a methodological tool that study diverse options of interaction among local actors (Fontitni, 2003; Steinacker, 2004; Feiock & Park, 2005). Complicate options of interaction can be represented either by static or dynamic forms. Dynamic forms have the potential to reveal in a more multidimensional way the multiple outcomes of equilibrium.

The structure of the paper is the following: Section 2 emphasizes on the interaction among local governments and local actors. In Section 3, we study

the interaction between local governments through a discrete dynamical system based on the marginal profits of the players. The equilibrium points and local stability of the game are investigated. As a parameter of the model is varied, the stability of the Nash equilibrium point is lost and the complex (periodic or chaotic) behavior occurs. Numerical simulations are presented to show that the game behave chaotically.

Literature review

Regional economic activity is a complicate process as integrates apart from economic, societal, cultural and institutional elements. Interregional differences in these characteristics create diversified local government outcomes. Recent studies of relational geography shed strong light in the notion of spatial heterogeneity so to comprehend the terms of interregional divergences (Ettliger, 2001; Deas & Lord, 2003; Harrison, 2013). Effective use of local comparative advantages is one of the explanatory variables, when local cooperative culture and path dependence in compliance to formal and informal institutions have significant impact as well (Knoben & Oerlemans, 2012). On the other hand, the advancement of local governments by new powers alternates the terms that local actors operate.

Especially during the implementation of institutional reform new prospects of cooperation and conflict arise into a region. The role of local governments into local milieu is upgraded as they have the potential to schedule and to implement local public policy. Therefore, the ability of local governments to execute effectively the reforms is a crucial variable of local comparative advantages (Kuhlmann & Wollmann, 2011). It should be notified also, that institutional reforms of local governments are directly associated with the broadest tend of local communities to adopt evolvments. Especially, regions with levels at cooperative actions in investment strategies and joint exploitation of comparative advantages have significantly more chances to interact efficiently with local governments. As a sequence, reform's implementation is determined by a twofold framework: in one pillar stands local government's action and in the other social cohesion of local community (Sarafopoulos & Ioannidis, 2014). The competition of local communities is shaped by the strategies of local entrepreneurship, the efficiency of local governments and the activities of societal organizations. Interaction among the abovementioned actors can determine the options of regional development. So it can be stated

that the more effective this interaction is, the biggest is the possibility for a region to compete efficiently neighboring regions.

The game

In this section, a dynamic game between two local governments is presented. The game is taking place just after the implementation of a local government institutional reform. The local government is the primary local administrative body. Its basic task is the effective execution of local government institutional reforms.

We consider a simple Cournot-type duopoly game where the players are the local governments. Let x (resp. y) the variable that measures the degree of adaptation of the reform in the region 1 (resp. in the region 2), $0 \leq x \leq 1$, $0 \leq y \leq 1$. We assume that the tax per unit reform is linear and decreasing:

$$T = a - b(x + y) \quad (1)$$

where $a, b > 0$ and that the cost functions are:

$$C_1(x) = c_1x, \quad C_2(y) = c_2y \quad (2)$$

With these assumptions the tax profits of the local governments are given by

$$\begin{aligned} \Pi_1(x, y) &= x[a - b(x + y)] - c_1x \\ \Pi_2(x, y) &= y[a - b(x + y)] - c_2y \end{aligned} \quad (3)$$

Then the marginal profit of the local government at the point (x, y) of the strategy space is given by

$$\begin{aligned}\frac{\partial \Pi_1}{\partial x} &= a - c_1 - 2bx - by \\ \frac{\partial \Pi_2}{\partial y} &= a - c_2 - 2by - bx\end{aligned}\tag{4}$$

The local government decides to increase its level of adaptation if it has a positive marginal profit, or decreases its level if the marginal profit is negative (boundedly rational player). Then the dynamical equations of the players are:

$$\begin{aligned}\frac{x(t+1) - x(t)}{x(t)} &= u_1 \frac{\partial \Pi_1}{\partial x}, \\ \frac{y(t+1) - y(t)}{y(t)} &= u_2 \frac{\partial \Pi_2}{\partial y}\end{aligned}\tag{5}$$

where $u_i > 0, i = 1, 2$ is the speed of adjustment of the players. Then the dynamical system of the players is described by

$$\begin{cases} x(t+1) = x(t) + u_1 x(t) (a - 2bx(t) - by(t) - c_1) \\ y(t+1) = y(t) + u_2 y(t) (a - 2by(t) - bx(t) - c_2) \end{cases}\tag{6}$$

We will focus on the dynamics of the system (6) to the parameters $u_i, i = 1, 2$.

The equilibria of the game

The equilibria of the dynamical system (6) are obtained as nonnegative solutions of the algebraic system

$$\begin{cases} x(t) (a - 2bx(t) - by(t) - c_1) = 0 \\ y(t) (a - 2y(t) - bx(t) - c_2) = 0 \end{cases}\tag{7}$$

which obtained by setting $x(t+1) = x(t)$, $y(t+1) = y(t)$ in Eq. (6) and we can have four equilibriums $E_0 = (0, 0)$, $E_1 = ((a - c_1) / 2b, 0)$, $E_2 = (0, (a - c_2) / 2b)$ if $a > c_i, i = 1, 2$ and $E^* = (x^*, y^*)$, where

$$x^* = \frac{a + c_2 - 2c_1}{3b}, y^* = \frac{a + c_1 - 2c_2}{3b} \tag{8}$$

The fixed points E_0, E_1, E_2 are called boundary equilibria. The equilibrium E^* is called Nash equilibrium, provided that

$$\begin{cases} 2c_1 - c_2 < a \\ 2c_2 - c_1 < a \end{cases} \tag{9}$$

The study of the local stability of equilibrium solutions is based on the localization on the complex plane of the eigenvalues of the Jacobian matrix of the two dimensional map (Eq. (6)). In order study the local stability of equilibrium points of the model (6), we consider the Jacobian matrix along the variable strategy (x, y) . According to Bischi, Naimzada, (1999), E_0, E_1, E_2 are instable points of the system (6) and the Nash equilibrium E^* is locally stable if the following conditions are hold

$$\begin{cases} (i) 1 - T + D > 0 \\ (ii) 1 + T + D > 0 \\ (iii) 1 - D > 0 \end{cases} \tag{10}$$

where T is the trace and D is the determinant of the Jacobian matrix

$$J(E^*) = \begin{bmatrix} 1 - 2u_1bq_1^* & -u_1bq_1^* \\ -u_2bq_2^* & 1 - 2u_2bq_2^* \end{bmatrix} \tag{11}$$

The two conditions (i) and (iii) are always satisfied, whereas the second condition define a bounded region of stability in the parameters space

(u_1, u_2) . Then the second condition is the condition for the local stability of Nash equilibrium which becomes:

$$3b^2x^*y^*u_1u_2 - 4bx^*u_1 - 4by^*u_2 + 4 > 0 \quad (12)$$

Numerical simulations

To provide some numerical evidence for the chaotic behavior of the system Eq. (6), as a consequence of change in the parameters u_1, u_2 of the local governments, we present various numerical results here to show the chaoticity, including its bifurcations diagrams, strange attractor, Lyapunov numbers and sensitive dependence on initial conditions (Kulenovic, M., Merino, O., 2002). In order to study the local stability properties of the equilibrium points, it is convenient to take the parameters values as follows $a = 10, b = 6, c_1 = 3, c_2 = 2$. Numerical experiments are computed to show the bifurcation diagram with respect to u_1, u_2 , strange attractor of the system (6) in the phase plane (x, y) , and the Lyapunov numbers. Fig. 1 shows the bifurcation diagrams with respect to the parameter u_1 for $u_2 = 0.3$ Fig. 2 shows the bifurcation diagrams with respect to the parameter u_2 for $u_1 = 0.2$ In these figures one observes complex dynamic behavior such as cycles of higher order and chaos. Fig. 3 show the graph of strange attractor and Lyapunov numbers of the orbit of $(0.1, 0.1)$ for $u_1 = 0.3, u_2 = 0.4$.

From these results when all parameters are fixed and only u_i is varied the structure of the game becomes complicated through period doubling bifurcations, more complex bounded attractors are created which are aperiodic cycles of higher order or chaotic attractors.

To demonstrate the sensitivity to initial conditions of the system (6), we compute two orbits with initial points $(0.1, 0.1)$ and $(0.101, 0.1)$, respectively. Fig. 4 shows sensitive dependence on initial conditions for y-coordinate of the two orbits, for the system (6), plotted against the time with the parameters values $u_1 = 0.3, u_2 = 0.4, c_1 = 3, c_2 = 2$. At the beginning the time series are indistinguishable; but after a number of iterations, the difference between them builds up rapidly. From Fig. 4 we show that the time series of the system Eq.

(6) is sensitive dependence to initial conditions, i.e. complex dynamics behaviors occur in this model.

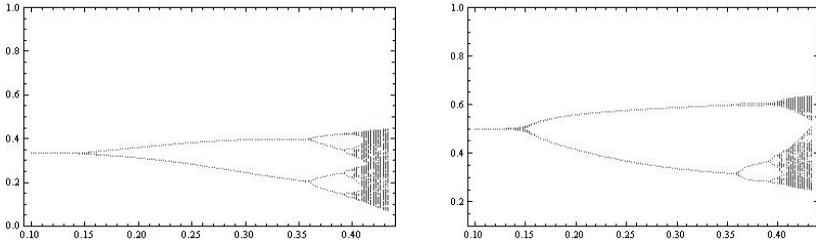


Fig.1. Bifurcation diagrams with respect to the parameter u_1 against variable x (left) and against y (right) for $u_2 = 0.3$, with 550 iterations of the map Eq.(6).

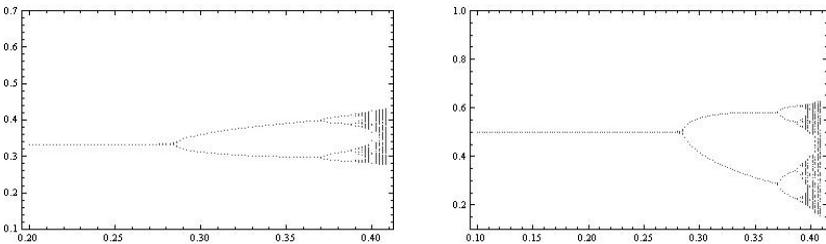


Fig.2. Bifurcation diagrams with respect to the parameter u_2 against variable x (left) and against y (right) for $u_1 = 0.2$, with 550 iterations of the map Eq. (6).

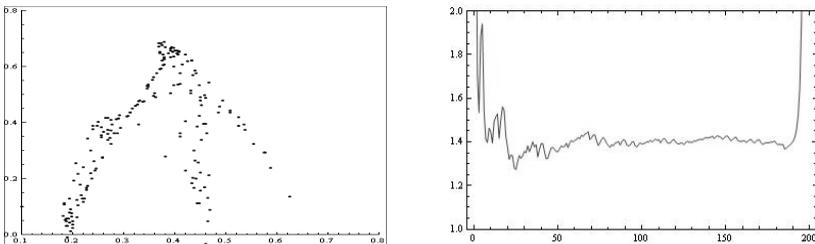


Fig.3. Strange attractor with 6000 iterations (left) and Lyapunov numbers versus the number of iterations (right), of the orbit orb. $(0.1, 0.1)$, for $u_1 = 0.3$, $u_2 = 0.4$, $c_1 = 3$, $c_2 = 2$.

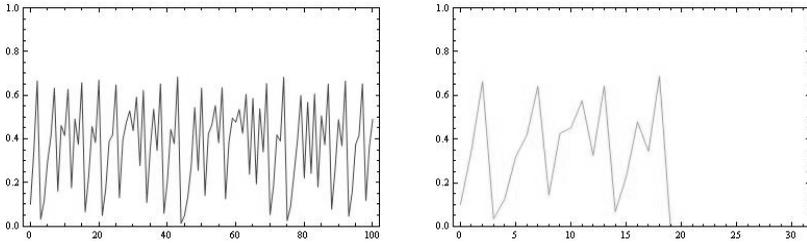


Fig.4. Sensitive dependence on initial conditions, for y -coordinate plotted against the time: The two orbits orb.(0.1, 0.1) (left) and orb.(0.101, 0.1) (right), for the system (6), with the parameters values $u_1=0.3$, $u_2=0.4$, $c_1=3$, $c_2=2$.

Conclusions

In this paper, we analyzed through a discrete dynamical system based on the marginal profits of the players, the intraregional competition during the implementation of local government institutional reforms. The stability of equilibria, bifurcation and chaotic behavior are investigated. We show that a parameter (speed of adjustment) may change the stability of equilibrium and cause a structure to behave chaotically. For low values of this parameter there is a stable Nash equilibrium. Increasing these values, the equilibrium becomes unstable, through period-doubling bifurcation.

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