http://ansinet.com/itj

ITJ

ISSN 1812-5638

INFORMATION TECHNOLOGY JOURNAL

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Information Technology Journal 12 (19): 5080-5084, 2013
ISSN 1812-5638 / DOI: 10.3923/itj.2013.5080.5084

Analysis of Different Competitive Strategy's Impact on the Pricing of Food Supply Chain

Ting Li
School of Economics and Management, Dezhou University, 253023, Dezhou

Abstract: This study uses the theory of nonlinear dynamical systems, considering pricing competition model for food supply chain. Based on the analysis of this situation, we established the corresponding game models. Then we performed a numerical simulation on system complexity with different conditions. We analyzed the profits of different oligarchs when the system is in different states. The result shows that when the food market is in disordered, the oligarchs profit fluctuation is obviously greater than that when the system is in a stable state, that is why does the chaos not be wished to be appear in the real market. So the government set out a policy to avoid disordered competition in some situations.

Key words: Competitive strategy, supply chain, dynamic price

INTRODUCTION

Oligopoly theory is one of the most intensively studied areas of mathematical economics. On the basis of the pioneering works of Cournot (1938), many researchers have developed and extensively examined the different variants of oligopoly models. Initially, the existence and uniqueness of the equilibrium of the different types of oligopolies was the main concern and later the dynamic extensions of these models became the focus. Puu (1996), Bischi and Lamantia (2002, 2008), Agiza and Elsadany (2003) Agiza *et al*. (2009) Fanti and Gori (2012), Xin and Chen (2011) and Li and Ma (2013), their research have shown that a duopoly model can lead to both simple and complex dynamics through the well-known period doubling route to chaos.

Some food market are followed the Oligopoly competitive model. In our study, we considered two retailers and in the market. As we know, profits maximization is not the only business objective for managers in reality. All the retailers could only get part of the whole market information and they are bounded rationality. Based on the analysis of this situation, we established the corresponding dynamic price game model for the price competition of food supply chain. So, the rest of this study is as follows: In section 2, we describe the Game model of food supply chain with bounded rationality. In section 3, we do simulation for the system. Finally, some conclusions are drawn in section 4.

MODEL CONSTRUCTION

We consider two oligopoly retailers in the food supply chain. The retailers sell similar products on the basis of price competition. They have the same cost. One retailer will consider not only profits maximization, but also market share under the price strategy and the other will consider not only profits maximization, but also online direct retailers profits for the price strategy. Where $Q_i(t)$ denotes the demand of the two retailers and given by:

$$Q_1 = a - bP_1 + kP_2,\quad Q_2 = a - bP_2 + kP_1 \tag{1}$$

where, a represents the possible largest demand, b is the price elastic coefficient, k is the substitution of price and a, b, k>0. The two retailers have no fix cost and their variable cost of unit goods is C. So, the profits function is:

$$\pi_1 = (P_1 - C)Q_1,\quad \pi_2 = (P_2 - C)Q_2$$

As in the previous assumptions, the retailer takes weight average of maximizing his own profits and reducing the opponents profits, so the utility function of retailer is:

$$U_1 = \pi_1 - \omega\pi_2$$

where, $\omega\in(0,1)$ denotes the retailer's attitude to the other retailers profits. ω = 0 shows that on price by considering his own profits only. With the increase of ω, the retailer will be more sensitive to the profits of the other retailer.

In the same way, the other retailer takes weight average of maximizing his own profits and expanding market share, so the utility function of the retailer is:

$$U_2 = \theta\pi_2 + (1-\theta)l_2 \tag{4}$$

where $\theta\in(0,1)$ denotes the retailer's attitude to how to balance the profits and market share. In the denotes the market share of retailer, it can use sale revenue for the proportion of total sales.

It can be typed by:

$$l_i = \frac{P_iQ_i}{\sum_{i=1}^{n} P_iQ_i} \tag{5}$$

Substitute Eq. 1 and 2 into Eq. 3, we get the marginal utility of retailer:

$$\frac{\partial U_1}{\partial P_1} = a + b(C - 2P_1) + k(P_2 + \omega(C - P_2)) \tag{6}$$

Similarly, we calculate the marginal utility of the other retailer:

$$\frac{\partial U_2}{\partial p_2} = a + kP_1 + b(2C\theta - 2P_2)$$

In fact, when making price decision, each retailer could only get part of the whole market information and its input decision is not completely rational. For instance, if retailers do not know the competitor's price decision in advance, they are not able to compute to get max profits. Supposing retailers are bounded rational, so their next-period decision on the basis of the local estimate to their marginal profit in current period. That is:

$$\begin{cases} P_1(t+1) = P_1(t) + \alpha_1 P_1(t)(a + b(C - 2P_1) \\ +k(P_2 + \omega(C - P_2)))) \\ P_2(t+1) = P_2(t) + \alpha_2 P_2(t)(a + kP_1 \\ +b(2C\theta - 2P_2)) \end{cases} \tag{7}$$

where, α_i>0 represents the relative speed of price adjustment speed.

NUMERICAL SIMULATIONS FOR SYSTEM

To provide some qualitative behavior of system 7, we use numerical simulation to describe the dynamic behaviors and characteristics such as bifurcation or sensitive dependence on the initial value and so on. Let:

$$a = 4, b = 1, C = 1, k = 0.5, \omega = 0.5, \theta = 0.5$$

Figure 1 gives a stable region, also provides that Nash equilibrium point is stable through the necessary and sufficient conditions. In the region, whatever the initial price of retailers 1, 2 is, the final price decision of

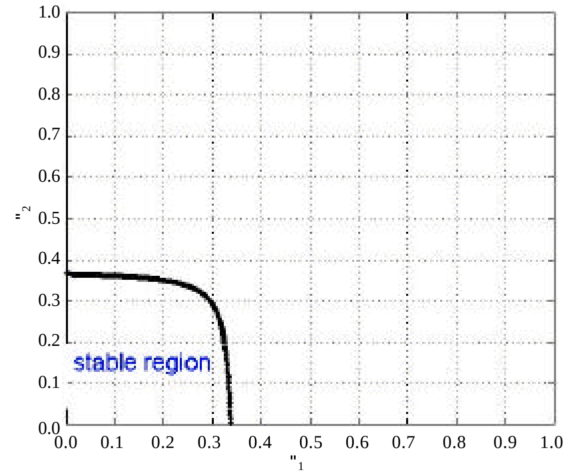

Fig. 1: Stable region of Nash equilibrium in the phase plane of (α_1, α_2)

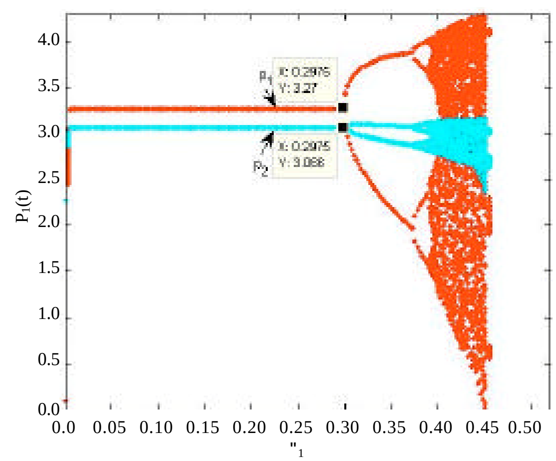

Fig. 2: Price decision bifurcation with change of α_1 when $\omega = 1$, $\theta = 0$

retailers will keep stable at Nash equilibrium point after a limited number of games. What is noticeable is that the retailers may accelerate adjustment speed of price decision in order to increase their market competitiveness. However, once one of the retailer makes its price adjustment speed out of stable region for whatever purpose, the stable state of system 7 at point Nash equilibrium point will be broken and the bifurcations, even chaos phenomena, will appear.

Figure 2 shows price bifurcation and Fig. 3 shows the corresponding chaos attractors of system 7 which is another characteristic of system 7 in chaotic period. With the increasing of α_1, Nash equilibrium became unstable, the price decisions of retailers are changed from Nash equilibrium to the first double period bifurcation at

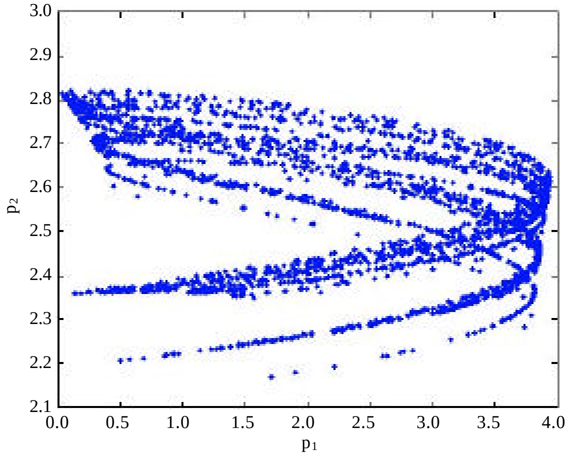

Fig. 3: Chaos attractor of system when the system in chaotic period

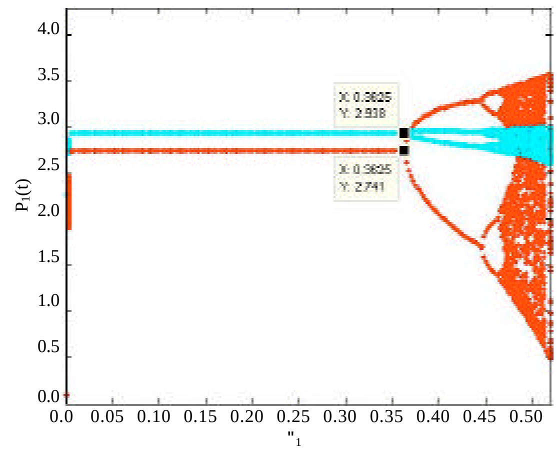

Fig. 6: Price decision bifurcation with change of α_1 when $\omega = 0$, $\theta = 0$

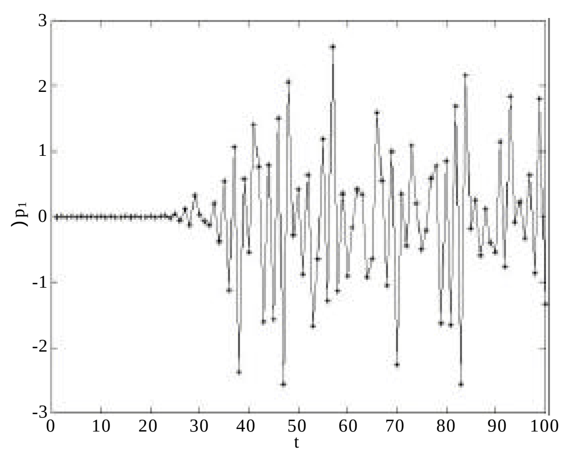

Fig. 4: Sensitive of price decision dependence on the initial conditions of system

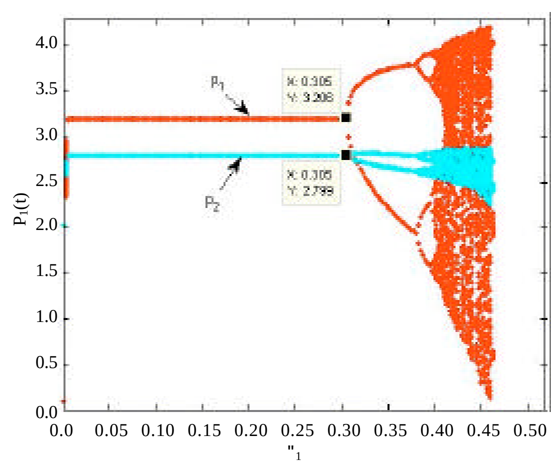

Fig. 7: Price decision bifurcation with change of α_1 when $\omega = 1$, $\theta = 0.5$

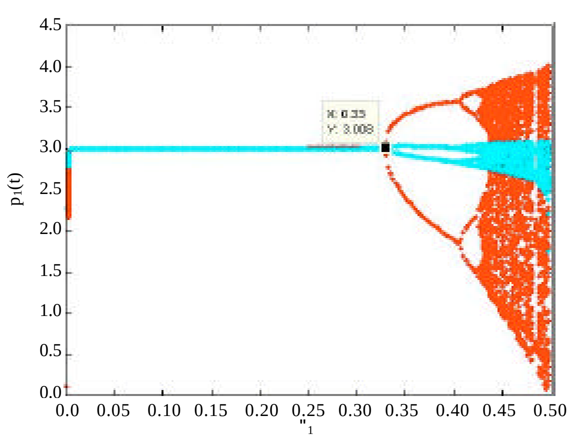

Fig. 5: Price decision bifurcation with change of α_1 when $\omega = 1$, $\theta = 0.5$

$\alpha_1 = 0.332$, then bifurcation again and again and the system fall into chaos eventually. From Fig. 4 we can see that when P_1 change a little and P_2 keep changeless, the price decision will have distinct changes when the system in chaotic period. It manifests fully the sensitive dependence with initial conditions of system 9.

Figure 5-6 show when fix ω the stable region will become bigger with θ increasing. Similarly, from Fig. 7-8, the stable region will also become bigger with ω decreasing when fix θ. This means that the fiercer competition tends to stabilize the Nash equilibrium. From the figures above, we know that the price decision will become uncertain when retailers accelerate their price decision adjustment speed (Ma and Ji, 2009).

Figure 9 shows the profit of retailers in fifty games when the system is in stationary period, two

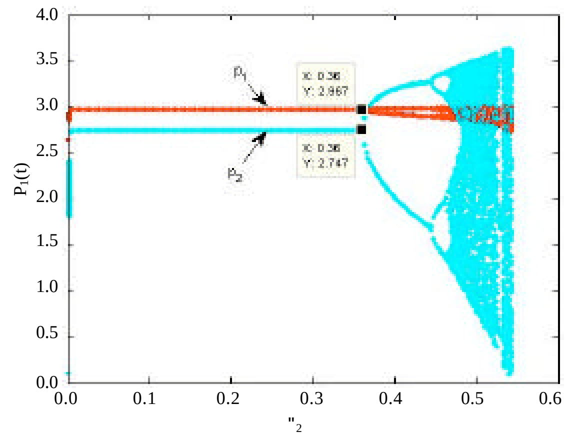

Fig. 8: Price decision bifurcation with change of α_1 when ω = 0.5, θ = 0.5

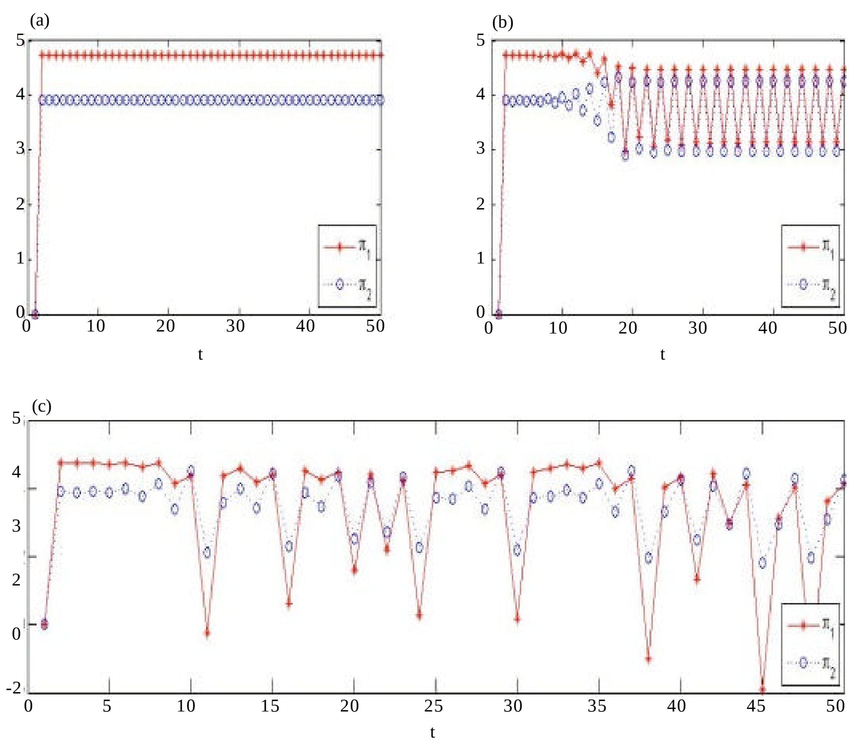

Fig. 9: Profit changes of retailers when system in (a) stable period; (b) two period-doubling bifurcation; (c) chaotic period

period-doubling bifurcation and chaotic period. We can see that profit fluctuation is grate when the system in chaotic period, that is why does the chaos not be wished to be appear in the real market. So the government set out a policy to avoid disordered competition in some situations.

CONCLUSION

This study studies dynamical behaviors of price competition model. We find that bifurcation, chaos and other complex phenomena occur when adjustment speed of price decision changes. When chaos occurs, it breaks the whole system and the market will become abnormal, irregular and unpredictable.

The research of complexity of this nonlinear dynamical system has theoretical significance and more importantly has practical significance as well. We can see that profit fluctuation is grate when the system in chaotic period. It is a realistic guide for the retailers to formulate price decision strategies to avoid the loss of total profit of the system. It is also a realistic reference for the government to formulate relevant policies on macro-control ecology.

ACKNOWLEDGMENT

This work was supported by the Social Science Fund of Dezhou (No. 311326)

REFERENCES

Agiza, H.N. and A.A. Elsadany, 2003. Nonlinear dynamics in the Cournot duopoly game with heterogeneous players. Phys.: Stat. Mech. Appl., 320: 512-524.

Agiza, H.N., E.M. Elabbasy, H. El-Metwally and A.A. Elsadany, 2009. Chaotic dynamics of a discrete prey Cpredator model with Holling type II. Nonlinear Anal.: Real World Appl., 10: 116-129.

Bischi, G.I. and F. Lamantia, 2002. Nonlinear duopoly games with positive cost externalities due to spillover effects. Chaos Solutions Fractals, 13: 701-721.

Bischi, G.I., L. Sbragia and F. Szidarovszky, 2008. learning the demand function in a repeated cournot oligopoly game. Int. J. Syst. Sci., 39: 403-419.

Cournot, A.A., 1938. Research into the Mathematical Principles of the Theory of Wealth. 1st Edn., L. Hachette, New York.

Fanti, L. and L. Gori, 2012. The dynamics of a differentiated duopoly with quantity competition. Econ. Modell., 29: 421-427.

Li, T. and J. Ma, 2013. The complex dynamics of R and D competition models of three oligarchs with heterogeneous players. Nonlinear Dynamics, 74: 45-54.

Ma, J.H. and W.Z. Ji, 2009. Complexity of repeated game model in electric power triopoly. Chaos, Solitons Fractals, 40: 1735-1740.

Puu, T., 1996. Complex dynamics with three oligopolists. Chaos Solitons Fractals, 7: 2075-2081.

Xin, B. and T. Chen, 2011. On a master slave Bertrand game model. Econ. Modell., 28: 1864-1870.