Effect of chaos theory on Tehran stock exchange index

Nasrollah Amouzesh[*1], Mohsen Ahmadi[2], Jafar Nekounam[3]
[1.] Department of Accounting, Gachsaran branch, Islamic Azad University, Gachsaran, Iran
[2.] Department of Accounting, Gachsaran branch, Islamic Azad University, Gachsaran, Iran
[3.] Department of Accounting, Payame Noor University, I.R. of IRAN.
[*]E-mail: e_amouzesh2011@yahoo.com

Abstract: Accuracy and adequacy of economical prediction models in the world of business, is strategic and vital. Many economists believe that the linear models are not suitable enough for prediction of price and shares index. Therefore many of the researches are concentrating on the economical time series and their suitable dynamic models. In the present research the whole share price in a 5 years duration from 2008 to 2012 have been chosen as the statistical sample to find out the effect of chaos theory on Tehran stock exchange index. A main hypothesis which has been considered is: the chaos theory has effect on the whole share price index and also 3 secondary hypotheses have been mentioned which are whole shares prices index have non-random structure. Whole share price index have non-linear structure. Whole share price index has chaos structure. For data processing Herest view test has been used and then Liaponof view and coordination is used. Results of the research show that the whole share price index has non-random, non-linear and chaos structure and therefore chaos point of view theory has effect on the whole share price index in Tehran stock exchange.
[Nasrollah Amouzesh, Mohsen Ahmadi, Jafar Nekounam. **Effect of chaos theory on Tehran stock exchange index**. *Life Sci J* 2013;10(7s):79-83] (ISSN:1097-8135). http://www.lifesciencesite.com. 13

Keywords: economical prediction models, chaos theory, non-random structure, non-linear structure.

Introduction:

Access to long term and continuous economy needs optimized resources in the national economic level and this work will not be possible without the help of financial markets especially extensive and efficient capital market. In a healthy economy existence of efficient financial system in suitable capital distribution and financial resources play a basic role.
Price of the share for financing and economical decisions are important and share prices indexes from the whole share prices movements of all companies or a special class of existing companies in the stock exchange have been ibtained and therefore analysis and size of the price movements in the stock market possible. In fact extension of financial theories and innovations in the recent decades according to their central role and considering the market movement with continuous tendency in methods of calculation and analysis have been accompanied with such indexes.

Discussion and analysis:

Statement of the problem:
Accuracy and output of the economical prediction models in the world of business, is strategic and vital. For choosing the most suitable financing in the stock market, there are different financial theories which are placed in 3 models of linear, non linear and random. Many financial analysts believe that the linear models are more efficient for choosing the most optimized stocks (16).
In present research chaos theory which is one of the non-linear behavior models has been used for prediction of shares prices and for proving it 3 tests have been conducted. In this research we are looking for:
Does chaos theory have effect on whole share price index?
Does the whole share price index have a non-linear structure?
Does whole share price index have chaos structure?

Research background and theoretical frame work:

Chaos is obtained from the Greek root of "χαος" and it means non prediction. In Iran different terms have been used in different subjects such as chaos, order after disorder, final order, irregularity Etc.
In supernatural sciences, chaos is the opposite of law and order. In mathematics, chaos means certain periodical behavior which is very sensitive in relation to initial situations. In holy books chaos has been used for explanation of world's primary situation, non-limited place and shapeless matter which existed before the world's creation and has been used then (16). Chaos has been defined as a specific and non-linear process with a behavior like random but not random[1]. The main and key idea of chaos theory is

that in any chaos there is an order hidden, therefore order should not be looked for in a scale [3].
After Izak Newton some other scientists could determine a new science. Frank said that " give me a ruler and a watch, I want to measure the whole world" and Laplas mentioned " give me a current movement of the smallest matter in the world because I want to predict future of humanity". They thought world is like a mechanical machine complicated to be able to predict it with Newton mechanical theory. To show its accuracy many years was needed. At the end of 19th century King Scar from Sweden announced that a prize will be given to the first person who can determine and solve the problem of sky, moon, earth and sun and prove the moon's stability. Among 2000 participants non could prove these, but Henry Povankar (1890) won the prize by solving the problem and discovering that the celestial bodies of 3 or more have a stable and non-predictable behavior. Povankere found a chaos behavior for the first time in science but to name it he did not take any effort. For the first time he could mention his ideas in the world. In the next coming years many other people use different mathematical equations to explain this natural trait. But none could get acceptable result from the findings regarding chaos behavior. Around the year 1960, Edward Lorenz who was a meteorologist developed suitable models for solving the atmospheric problems with computer. His models consisted of many different equations and the results obtained in different times in a complex behavior with weather condition differences were almost similar. In the year 1961, Lorenz tries to continue his research, but instead of starting from the first point, he used the previous data which he used in the previous years and used up to 3 decimeters. For some times the results were following each other but after that the results became far away from each other and at the end they had no connection with each other. Lorenz could discover sensitivity in relation to primitive condition which may be the most known trait of chaos and nowadays have been explained as the butterfly effect. He started to simplify the equations to determine the least necessary conditions for chaos behavior. The results obtained are now called as "Lorenz equations" which show the initial samples of appearance of complex absorbent of different equations. Lorenz published the results of his work in journal of meteorology in the year 1963 with the title of " determined non-periodic current" but unfortunately his article was not considered in the next decade. Nowadays the effect of determined non- periodic current is called chaos. After Lorenz, the others conducted the same kinds of examinations at the scientific level such as modeling of many electrical currents with chaos behavior or Henonn mapping in astronomy. Henonn mapping is one of the models with most of the studies have been conducted on dynamic systems with chaos behavior. Any way this successes helps in smoothing the way on chaos behavior. But the first person to make this method famous was the young mathematician James York by publishing Lorenz article 9 years later in the year 1972. He understood the importance of this article and therefore took some copies of the article and with his address on them, he send the copies to Berclay university for their opinion. York understood the present chaos and commotion in the in the nature soul. But mathematicians and physicists tried only to discover discipline and did not care about chaos. York spoke to Roberts May about his ideas. Robert May cared about its logistic equation and behavior under determined conditions. He compared the logistic model with animal populations and found two ramification in this kind of systems. Results obtained helped the chaos theory . he finally published his own article in the year 1976 in a nature scientific magazine and for the first he mentioned the application of chaos in politics and economics. York understood that eastern scientists are also working on the similar incident during that time on the Kolmograph works (1950). In the year 1970 many groups in the east and west started working on the theory of chaos and York introduced his article in the year 1975. The title of this article was "chaos in three period" James York also introduced the control of chaos theory in the year 1990.
The matter of chaos became one of the important matters during the 1980s decade and many engineers and scientists started working on it. researchers such as Ping Chan (1996) Kertso (2002), Atin Das and PeridaDas (2006) Sadat Modarshahi (2006) and in Iran people such as Khalozadeh (1377) started work on different courses and analyzed chaos theory.

Research hypothesis:

In this research to analyze existence and effect of chaos theory on the exchange stock, there is a main and 3 auxiliary theory which are as follows:
Main theory: Chaos theory has effect on the whole sale price index.
First auxiliary hypothesis: the whole sale price index has none-random structure.
Second auxiliary hypothesis: whole share price index has a none-linear structure.
Third auxiliary hypothesis: whole sale price index has a chaos structure.

Research methods:

Statistical society and samples:

Statistical society of whole share price index in Tehran stock exchange and whole share price index (Tipex) in a 5 years plan from 2008 to 2012 which consisted of 1154 working days have been chosen as the statistical sample which has been analyzed.
Statistical test: in this research below statistical tests have been collected for analysis.

Calculation of daily output:

Time series used in the present research is the daily output of Tehran stock exchange market whole share price index which is defined as follows:

$$Rt = \frac{It - It-1}{It-1}$$

in this relation It is index amount in a day t, It-1 index amount in the day before t which is also daily index output.
By defining time series of whole index as above the output of time is processed and goes towards a static series. There is even possibility that with replacing the random amount of whole index a random time series be produced and each stage the main series results be compared for the results to be absolutely correct.
Herest test:
According to Herest analysis (R/S), recognition of a random time series from a none-random without thinking of its distribution (Gosi or None-Gosi) is possible. In Herest analysis, change of base area causes changes as follows:
RN = Max [rt,N]- Min [rt,N]
Where t= 1,2,…….N

$$Rt,N = \sum_t^N (rt - r_{-})$$

As can be noticed in Herest analysis, R shows the differences between the most and the least deviations from the assumed time series average ® and a function from the numbers noticed (N). S is also equal to time series deviation criterion which is obtained as follows:

$$S = \frac{\sqrt{\sum_{t-1}^{N}(rt-r)}}{N-1}$$

But according to an experimental law it has been proved that

$$\frac{R}{N} = N^{H}$$

H is Herest power which is with the output of [0,1] and according to different N will be:

$$H = \frac{\log(\frac{R}{S})}{\log(N)}$$

if the Herest power is equal to 0/5 therefore it shows random structure of time series of index output. If Herest power is an amount except 0/5, this shows that the none random structure is a time series. If the Herest power is between 0/5 to 1 then the amount shows the long term memory effect. In the other words the mentioned time series remains with the previous indexes with daily output of whole index and remains for some times. It also means that increasing method is due to increasing method in future and decreasing method in the past is due to decreasing method in future. If N become with H power, long term memory average will be obtained . in return if Herest power is between 0 to /5, in this case method is non-static and therefore an increasing method in the past is due to a decreasing method in future and a decreasing method in the future is because of an increasing method in the past is due to increasing method in the future.

Test of coordination dimension:

Cooperative dimension, is a criterion of the amount of complexion in an event. Dimension of a point is equal to zero and dimension of a line is one and a white disorder or a stochastic process is infinity. Chaos process has a positive dimension but it is limited. To calculate cooperative dimension Grassberger Prokaksia's method should be used. In this method, at first memory matrix should be prepared and therefore a time series output index must be arranged such as {Xt-1,…..,N} and M dimensional vectors with the name of –M memory should be made as follows:
XMt = (Xt, Xt+1,……..XN)
In fact N is time series output index number for the share N-M+1 vector with entries which overlap each other. In practice with creation of –M memory we try to give new life and dynamic structure rebuilding and process of data production. In the other words some new data produced should be placed between –M vectors. In estimation method cooperative dimension, relation and cooperation between –M memory points should be measured. To do this the cooperative integral CM(ε) estimation is one possible of two vector of time series with the length of M, less space from ε with each other. In fact CM (ε) can be calculated as follows:

CM (ε) = limit /N-$^{\infty}$ N …
Where Nm = N-(M-1)
And M is memory dimension and I ε (X,Y) is a function of characteristic of X, and Y and defined as follows:

$$I_{\varepsilon}(X,Y) \cong \{0; \|X-Y\| > \varepsilon$$

$$\{1; \|X-Y\| \leq \varepsilon$$

Process of cooperative dimension for M inscribed dimension is as follows:

$$Dm = \lim m \to \infty, \quad \varepsilon \to 0 \ \frac{logCm(\varepsilon,N)}{\log(\varepsilon)}$$

Cooperative of system D dimension is equal to

$D= \lim M^{\rightarrow} \infty D_M$

If the system is chaos, DM as the big amount of M will be bigger than one convergent.

The greatest view of Lioponof test:

Lioponof view analysis is a criterion for measuring the amount of convergence or divergence of near to each other route in the space phase which is shown by –M vector. In this method first the matrix of –M memory vector will be produced for renewal of process structure of index production and among this matrix all pairs of vectors which can be placed in the following relation will be specified.

$Ro(M;I;J)= \| X_I^m - X^{X_J^M} \| \leq \varepsilon$

ε is a small positive number. In this equation the close points in the M dimensional space will be chosen. By going forward close by points in the main series will be calculated as follows in "n" stage:

$Rn(M;I;j;)= \| X_{i+n-}^M X_{j+n}^M \|$

$Dn(M;I,j)= \frac{r_{n(M;i,j)}}{r_{o(M;i,j)}} = \frac{\| X_{i+n-}^M X_{j+n}^M \|}{\| X_{i-}^M X_j^M \|}$

If the close by points of "n" is bigger than zero being separated from each other, then dn is bigger than one. And finally statistical elements L will be calculated as follows:

$L(m;n)= \sum_{I \neq J} \frac{LOG dn(M;i,j)}{N-n}$

The positive amount of "L" shows non-cooperative between close by conditions in corresponding non-linear or share index process. "L" positive shows the chaos behavior and therefore long term evaluation of initial conditions is predictable. With choosing the biggest Lioponof view we have:

$T= \frac{1}{LLE}$

And T shows the time when the data effect has been disappeared and use of past information in the improvement of forecasting process will not be effective.

Research findings

Research hypothesis has been produced with tests and analyzed with Exel software in 2007 and following results obtained:

First auxiliary hypothesis:

In this hypothesis to prove that the whole share price index structure is non-random, Herest test has been used. For the main series the Herest view is equal to 0/9950 which being between 0/5 and 1 shows the amount of non-random structure and static index of whole share price. To the random series made from the main series the Herest view is equal to 0/3805 which since it is less than the main series, therefore it shows the accuracy of the results and in the whole proves the hypothesis which means the whole share price index has a non-random structure which conforms the researches of Khalozadehb and Sadat Madarshahi in the years 1377 and 2006 respectively.

Second auxiliary hypothesis:

In this hypothesis to prove that the whole share price index structure is non-linear the cooperative dimension test has been used. The main series of cooperative dimension obtained is equal to 1/25 which is bigger than 1 and being smaller, shows the whole non-linear index structure. For random amount series cooperative dimension is equal to 3/5 which this amount being bigger in comparison to main series shows accuracy of the results and in the whole proves the hypothesis which means the whole share price index has a non-linear structure which is the result of Ping Chen (1996) and Keristo (2002) research.

Third auxiliary hypothesis:

This hypothesis is used for proving the chaos of whole share price index structure from the Lioponof view test. The biggest Lioponof view for different inscribed dimensions the main series amount is positive which shows the biggest Loiponof view of chaos structureof the whole index. The biggest Lioponof view for different inscribed dimensions of random series is negative which shows the accuracy of results and in the whole proves the hypothesis which means whole share price index has a chaos structure and this finding is the result of Atin Das and Prida Das (2006), Sadat Madarshahi (2006) researches.

Main hypothesis:

To analyze the main hypothesis in the present research the auxiliary hypothesis are considered and since they are conducted according to the tests therefore all the auxiliary hypothesis are being accepted. Therefore the main hypothesis is also accepted which means the chaos theory are effective in Tehran stock exchange whole share price on the index. From this findying we get the result that the researches conducted by Khalozadeh (1377), Ping Chen (1996), Kerteso (2002), Atin and Priada Das (2006) and Madarshahi (2006) are accepted.

Result:

Accuracy and efficiency in the economical prediction models in the world of business, is strategic and vital. For choosing the most suitable financing in the stock exchange, different financial theories have been presented which are in the 3 models of linear, non-linear and random. Many of financial analysts believe that linear models are not efficient for choosing the optimized shares. In the present research chaos theory which is one of non-linear behavior model for the share price prediction have been studied and for proving these 3 tests Herest view, Lioponof cooperative and view have been used. Results of these tests show that Tehran stock exchange market for the whole share price index there is non-random, non-linear and chaos structure and therefore the result show that chaos theory has effect on Tehran stock exchange market's whole price index.

Suggestions about the research matter:

Considering the results of the research shows that chaos theory has effect on the stock exchange index, therefore it is suggested to the financers and work makers of the stock exchange to use non-linear methods of stock exchange such as nervous networks and expert systems to be used and the long term memory data be calculated in Lioponof view test. Also it should be remembered that considering the chaos theory effect on the stock index and sensitivity about the initial conditions, to financers and together with other financial elements, other elements such as political and social and cultural elements are considered.

Suggestions about the future researches:

In this research the effects of chaos theory on the whole share price index has been analyzed. In this research for analyzing the chaos theory the Herest tests, Lioponof cooperative and view in a 5 years course have been used. It is suggested that the effect of longer time theories on the other available tests be evaluated. And also try for development of these tests and creation of new tests. In the research only "predictability" of index and share prices with the use of non-linear methods have been suggested. The "prediction" is more suitable with the use of nervous network and other models.

Corresponding Author:
Nasrollah Amouzesh
Department of Accounting, Gachsaran branch,
Islamic Azad University, Gachsaran, Iran
E-mail: e_amouzesh2011@yahoo.com

References

1. Khalo zadeh Hamid (1997), non-linear modeling and prebehaviour of share price in Tehran stock exchange market. Tarbiat Modares University, P.hd thesis of electricity engineering, guide: Dr. Ali Khaki Sadigh.
2. Raeei, Reza. Telengi, Ahmad (2003), advanced financing management, Tehran. Samat publication. First addition
3. Reyahi, Behrooz. Sultan Mohammedi, Narjes (2006): "an introduction to view of chaos in management quality" Tadbeer Monthly publication, No. 183, Tehran page 20, 21
4. Sha Sadeghi, Mokhtar (2000). Analysis of prediction and estimation of chaos systems with the help of nervation system. Tarbiat Modares university, thesis for completion of master in electricity engineering. Guide Dr. Vahid Johari Majd.
5. Safaeei, Hamideh (1998). Organizations in the twentieth century. Tadbeer monthly publication. No. 94, Tehran, Page 20to 23
6. Forotan, Faezeg (2002). Nonlinear test of chaos in the oil future market and prediction with an artificial Nervation network model. Tarbiat Modares university. Thesis for the master in economy energy. Guide Dr. Saeed Mosheeri
7. Mohazab, Behzad (1992). Chaos in a free non-linear dynamic system . Tehran university, master thesis in physics, guide Dr. Mehdi Barezi.
8. Baillic,R.T.,(1986),Econometric Tests of Rationality and Market Efficiency.Michigan State University,Department of Economics Working Paper.
9. Benettin,G.,Galgani,L.,Giorgilli,A.and Strelcyn,J.M.,(1980),Lyapunov Characteristic Exponent for Smooth Dynamical Systems and forHamiltonian Systems:A Method for Computing All of Them.Meccanica 15.
10. Brock,W.,Sayers,C.,(1988),Is The Business Cycle Characterized by Deterministic Chaos?Journal of Monetary Economics 22.
11. Brockman,P.,Chowdhury,M.,(1997),Deterministi c Versus Stochastic Volatility: Implications for Option Pricing Model.Applied Financial Economiccs 7.
12. Casdagli,M.,(1991),Nonlinear Forecasting,Chaos and Statistics.In:Modeling Complex Phenomena.Springer-Verlag,Berlin.
13. Frank,M.Z.,Gencay,R.,Stengos,T.,(1988),Interna tional Chaos?European Economic Review 32

4/18/2013