APPLICATIONS OF THEORIES OF COMPLEXITY AND CHAOS TO GOLD PRICES

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ABSTRACT | Chaos theory is considered as a new subject in understanding non linear system's dynamic behaviours. Chaos theorem is used in several fields such as mathematics, physics, chemistry as well as in finance and economics sector. Although, there is a enourmous demand for gold, gold prices are volatile because of different reasons. This volatility chould be reduced by chaos theory. Also, the aim is to show whether gold prices data shows any chaotic behavior or not.

Keywords: Chaos Theory, Gold Prices, Complexity, Forecasting, Non-Linear Dynamic Systems

JEL codes **:** A11,C32,C53
Scope **:** Statistics
Type : Research

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KAOS VE KARMAŞIKLIK TEORİSİNİN ALTIN FİYATLARINA UYGULANMASI

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ÖZ| *Kaos teorisi, doğrusal olmayan sistemlerin dinamik davranışlarını anlamada yeni bir konu olarak kabul edilir. Kaos teori, matematik, fizik, kimya gibi finans ve ekonomi sektörlerinde de kullanılmaktadır. Altın için büyük bir talep olmasına rağmen, altın fiyatları farklı sebeplerden dolayı değişkenlik gösteriyor. Bu dalgalanma kaos teorisi ile azaltılabilir. Amacımız, altın fiyatlarının herhangi bir kaotik davranışı gösterip göstermediğini bulmaktır.*

Anahtar Kelimeler: Kaos Teorisi, Tahmin, Doğrusal Olmayan Dinamik Sistemler

JEL Kodu*:* A11,C32,C53
Alanı: İstatistik
Türü: Araştırma

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1. INTRODUCTION

Chaos theory is utilized in science researches at the beginning of nine. In 1961, leading the researches of Einstein, Bohr, Poincare and other, actually Lorenz used it at first. Lorenz was using the computer program to be able to predict the weather. Lorenz arranged the computer to predict the weather by generating twelve equations. Lorenz's program did not predict the weather exactly but it predicted the possible weathers for the next days. In science studies like mathematics and physics, the behavior of certain nonlinear dynamical systems which are under exact circumstances is described by chaos theory.

These exact circumstances indicate dynamics which easily affected starting conditions. In chaos theory initial conditions that easily affected refers to "butterfly effect". That is to say, changes in conditions of a nonlinear dynamic system could be caused by large changes in the long term (Frear, 2011: 2).

Chaos could be defined as opposite of "order". Surprisingly, in chaos symmetric items could be included (Sorin, 2010: 11). Moreover, everything continues so quickly. The vision of predict the future is restricted, because of having so many variables. Even well organized institutions could fail to predict truly their institutions' future. In that kind of world chaos and non-linear dynamic systems could be a solution (Sloan, 2011: 10).

Furthermore, Chaos theory is not only used in physics, chemistry, meteorology, biology but also in economics and management disciplines and the problems from each area is easy to solve with computers. Thus, chaos theory is refer to science computer era (Karaçalı & Demirci, 2009: 7). During the last forty seven years chaos theory is discussed in myriad of fields. Chaos theory also could be used in small medium enterprises(SME's). In Previous researches, some models are built for SME's for overcoming crisis (Nguyen, 2011: 9).

Chaos theory is also prominent in finance sector. In finance, most of the time the expected and the real data do not fit with each other. Because most of the time supervisors ignore the external noise effect (Jinguang, 2008: 6). Chaos theory is used in economics for 20 years. In that field chaos theory is not widely used. Moreover there are just few studies which research the effect of chaos theory in the commodity like gold (Chatrath et al. 2001: 2).

Gold is a precious mine which is used as a good and monetary entity.

Once upon a time, gold had been in the base of money system and then, it was fixed to USA dollar as reserve via Bretton Woods. After 1973, some of the European currencies had been allowed float,dollars convertibility to gold was terminated.

Because of that circumstances, gold has lost the attribute of exchange medium and it has used a part of the reserves of Central Banks and a medium of individual savings. However in last decade demand of gold has been increased despite of improving technology, using gold in industrial products and jewel industry is being flourished. One has found that gold price is influenced most buy USA dollar exchange rate and oil prices (Toroman et al. 2011: 13).

After the Collapse of Bretton Woods system in 1971, most of the countries concur their currencies to float. Thus after 1971 the demand of gold has increased (Vatti, 2008: 14).

The demand of gold and its restricted supply provide the gold to be an attractive instrument. Gold is not only demanded by jewelry sector but also finance sector. In jewelry sector gold is used as a raw material, processed and made ready to buy. Gold prices are seen as the main indicator in myriad of fields. Also macroeconomic indicators should be considered to analyze the changes of gold prices (Alptekin et al. 2010: 1).Investors keep their money into gold, due to gold being a crucial in stabilizing affect for portfolios (İsmail et al. 2009: 5).

Gold prices has declined after 1995. For instance, while the price of gold $393 (per ounce) in 1990, it was $286 in the early 2000s. Although the gold prices are being declined, the demand to derivative instruments like forwards, options, futures etc. is increased promptly (Kearney &Lombra, 2008: 8). Gold is still indisputable valuable instrument, in spite of the loss of the gold standard in international markets (Vatti, 1973: 15).

In this paper, we investigate whether the time series of gold price data chotic or not (see fig.1). The use of regression model to find out corporate financial distress (see fig. 2, fig. 3).

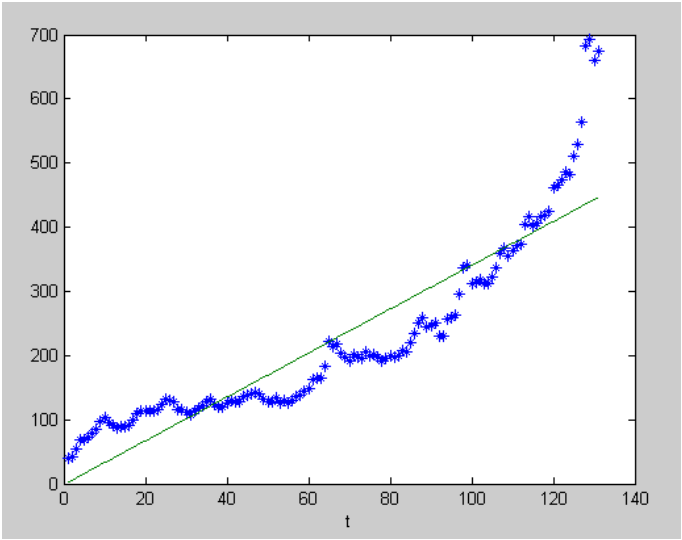

Figure 1: Gold Prices Data Series

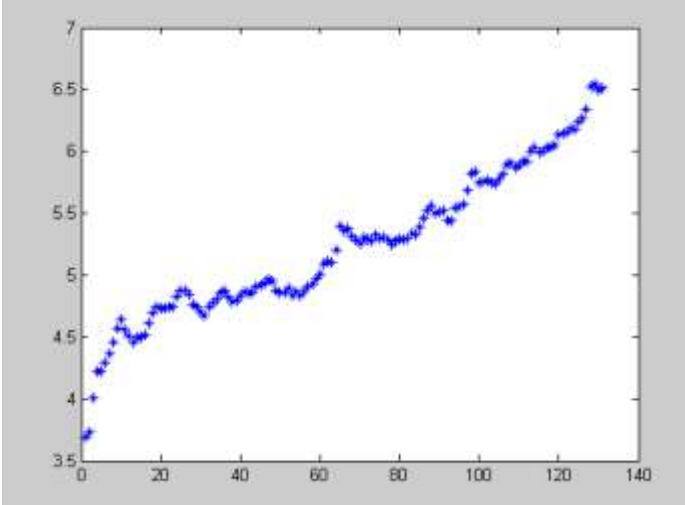

Figure 2: Transformed Data

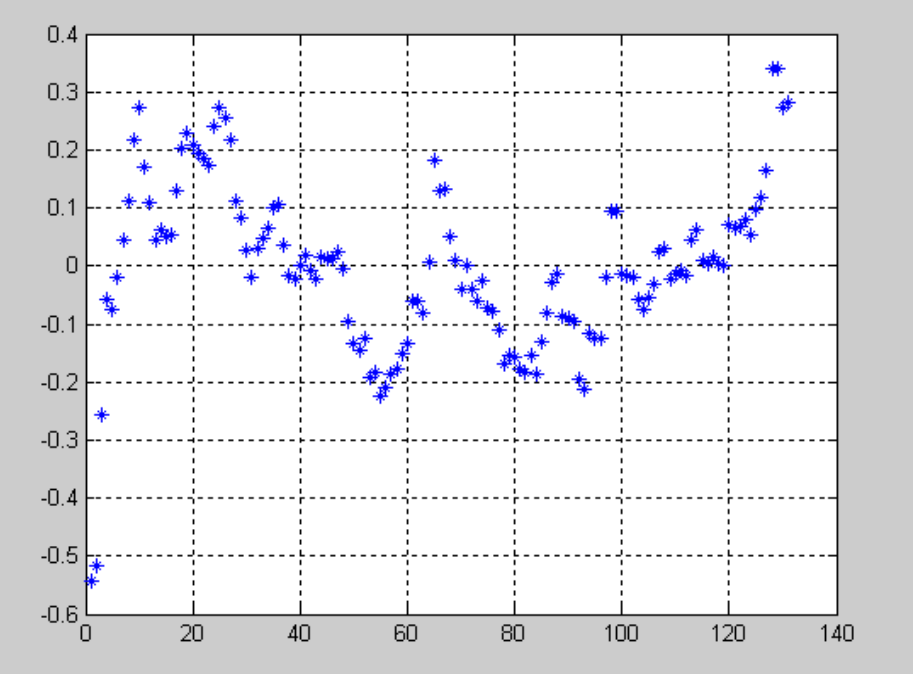

Figure 3: Residual Plot For Time Series Data

2. METHOD

Embedding method (Takens F:1981) is used for chotic behavier. The N-dimensional state vectors Y(t) are defined following

$$Y(t) = [\, y(t), y(t+\tau), \ldots , y(t+(N-1)\,\tau)] \qquad (2.1)$$

y(t): a value of the time series at time t, τ is a suitable time delay and N: embedding dimension. This vector fully represents the non-linear dynamics when N is a large enough. The m dimension phase point connection line ,while te system state evolves over time (see Fig. 4).

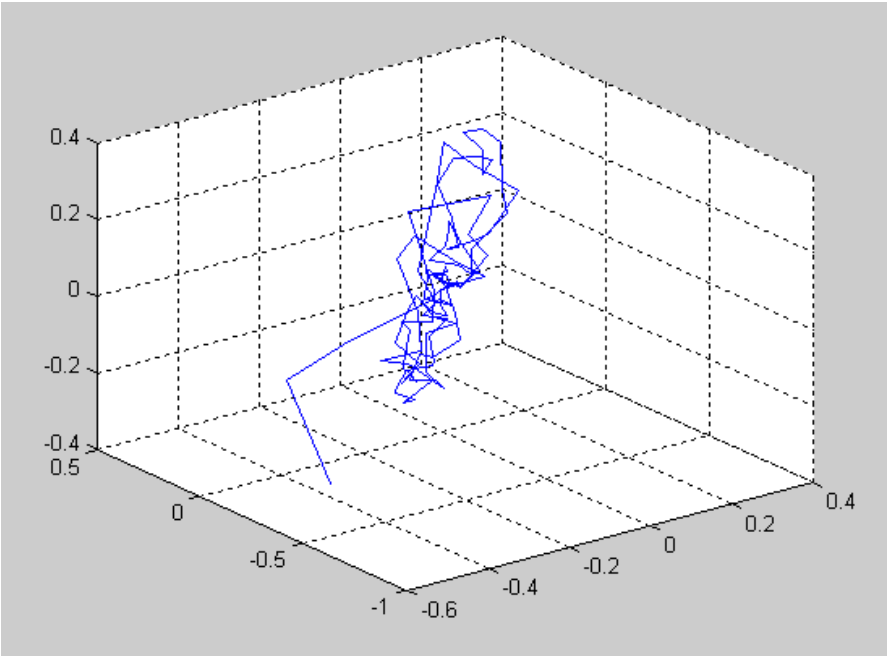

Figure 4: 3-D Phase Space For Gold Prices

3. CORRELATION DIMENSION TEST

The correlation dimension test is used to reveal chaotic behavior The algorithm proposed by Grassberger and Procaccia (Grassberger P & Procaccia I,1983) .For m Dimensions phase space ,the correlation integral is given following;

$$C(r,m) = \frac{1}{N(N-1)} \sum_{i,j=1(i\neq j)}^{N} \theta\left(r - \left\| X_i - X_j \right\|\right) \qquad (3.1)$$

θ: Heaviside function, r: critical distance. The correlation dimension is defined D_2 as follow

$$D_2 = \left| \frac{\lg(C_2(r,m))}{\lg(r)} \right| = \left| \frac{\ln(C_2(r,m))}{\ln(r)} \right| \qquad (3.2)$$

Embedding dimension m is is not increased until m is up to m_c (m_c is saturation embedding dimension) , D_2 is determined which sysytem is chaotic or non chaotic.

4. THE GOLD PRICES CHAOTIC ANALYSIS

We researched for the behaviors of the gold price data (see Figure 1). Figur 4 shows that the time series complex structure. In additon, the phase point has an irregular motion (see Fig.2). we obtain a C value based on eq (3.1). Figure 5 shows that slope When m >25, straight lines almost paralled, and partially straight lines are overlap. We compute the slope of each straight line based on eq (3.2) by using linear regression method (see Fig.6). Its shows that the gold price data has strange attractor, and non-linear chaotic system with complex structure.

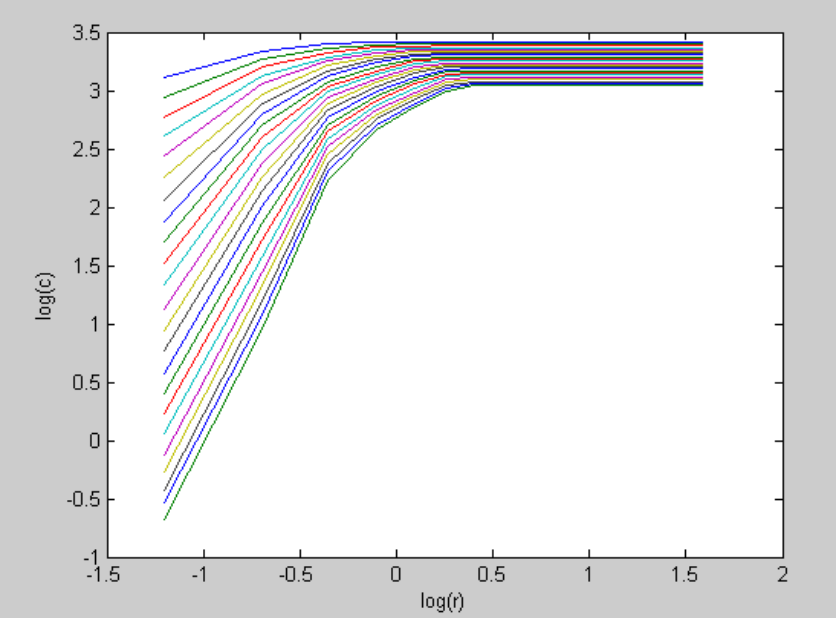

Figure 5: The Correlation Dimension For Gold Prices Data

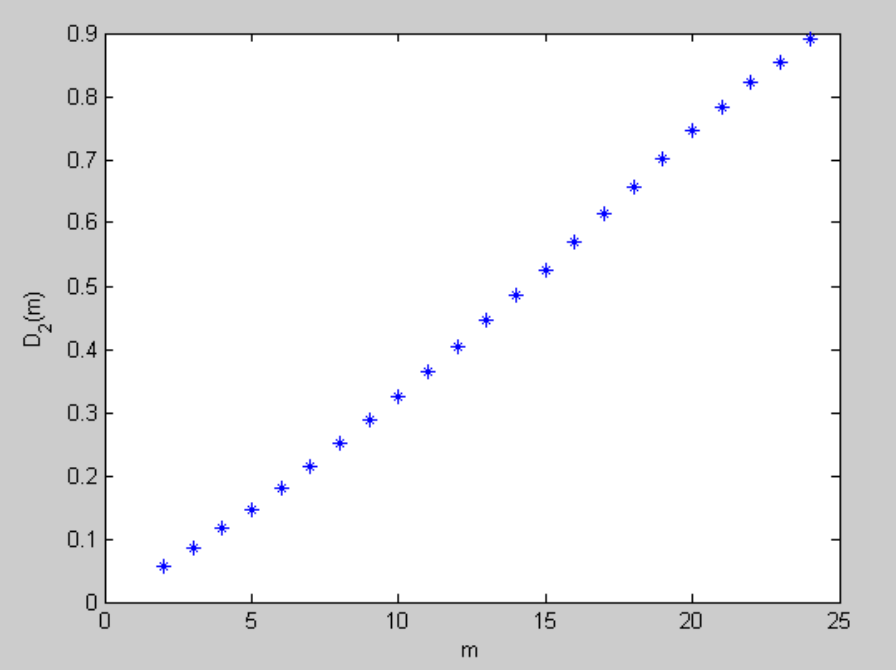

Figure 6: The Embedding Dimension For Gold Prices Data Series

5. CONCLUSIONS

This study show that the saturation embedding dimension of gold prices data series is very high (>25) , and attractor dimension is 0.9. This is the resault of the fact that the embedding dimension is very too high and the gold prices system has chaotic facts. So that the problem on chaotic phenomena and predictable time scale is very complex. So, gold price data are unpredictable .

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