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A Research on Chaos Forecast with the Capital Market Structure Model

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ABSTRACT

To study the process of pricing in capital market and look for a new way for decision support in financial market, according to the mechanism of artificial neural network, Capital Market Structure Model is developed in this case due to the influence between bargainer and price of asset in market. During proof-test, result of chaos forecast under the capital market structure model shows that chaos forecast capability of the Capital Market Structure Model is good for decision support.

Key words: chaos; forecast; capital market structure model.

In financial market, the bargainer always concentrated in same place and the information spread quickly, meanwhile, bargainer and price are affected by each other. This means that the bargainer will influence the asset price in financial market when they trading. As we know, the decision of trading always after the changing of asset price in market. The new price also will influence the new decision of trading. So we can conclude that the bargainer and the price of asset in financial market are also influenced by each other continually. It is very important to study the principle of the influence before predict the tendency of asset price in financial market, because we need to know the process of price changing to support our decision.

According to related papers in recent years, most of the researches about the asset forecast make use of the Artificial Neural Network (ANN). In the cases of positive research about forecast by using of the Artificial Neural Network, theories of chaos and fuzzy are apply to improve the data processing. In addition, wavelet theory is applies in forecast.

According to the fundamental concepts of dynamical reconstruction theory and multi resolution analysis, YangYiwen, LiuGuizhong and ZhangZongping^[1] take the reconstructed state vectors as multiple inputs to neural network to predict stock index trend of Shanghai Stock Exchange (SSE) in future multiple trading days.

We can get high accuracy in imitating nonlinear curve through ANN, but we don't know the relationship among input variables in ANN. So when ANN is applies to forecast in capital market, we can't explain the process of pricing, which means we get the result without reason.

The way of price forecast can't explain the process of pricing and will not be variable in economics, and also will not make people know much more about the market. This is the key problem people faced in price forecast when ANN is applies to it. People can't explain the meaning of weights and biases of ANN in real market.

Until now, except researches of forecast by using ANN or wavelet theory directly, no research of forecast due to the principle of the influence among bargainers and prices in financial market has been reported.

The purpose of this study is to fund a structure model of capital market due to principle of influence among bargainers and prices in capital market according to the idea by which ANN is founded. This structure model applies to forecast the future price in capital market. To insure the validity of forecast, chaos theory is applied to account the available length of non-periodic cycle of stock price.

1 ABOUT THE CAPITAL MARKET STRUCTURE MODEL

The main purpose of founding the CMSM is to analysis the process of pricing and forecast future price. Here the capital market means the security market in which information spread quickly, bargainer concentrated in same place. The model condition Hypothesis as follow:

- 1.1 Bargainer with the same averseness to risk will has the same game in bargaining.
- 1.2 The sensitivity of every bargainer to losing is higher than which to earning^[2].
- 1.3 The decision of bargaining is made due to the changing of price.
- 1.4 The rate of price fluctuating is less than 100% every time.
- 1.5 There is no influence outside economy.
- 1.6 there is a relationship which can be described as S curve between the influence of bargainer's asset portfolio changing to asset price and real surplus^[2].(figure 2)

The model is applies to analysis the process when bargainer and prices influencing each other.

Time t		Time t+1
asset(k=1~n)	bargainer (j=1 ~m)	asset (k=1~n)

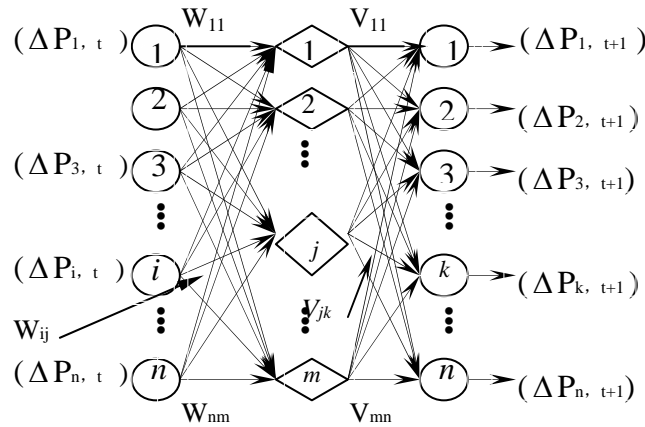


Figure1: Capital Market Structure Model

In this model, there are n assets and m kinds of bargainer. Bargainer is partitioned into m kinds due to the degree of averseness to risk. The degree of averseness to risk of bargainer j is θ_j . In time t, the price of asset k is $P_{k,t}$, $k=1\sim n$, and its price fluctuating rate is shown in equation (1):

$$\Delta P_{k,t} = (P_{k,t} - P_{k,t-1}) / P_{k,t-1} \quad (1)$$

The weight of influence from price fluctuating rate $\Delta P_{k,t}$ to bargainer j is w_{kj} , the whole influence come from the price fluctuating rate of n asset of bargainer j is $\sum_{k=1}^n w_{kj} \Delta p_{k,t}$. deducting from θ_j , the real influence to the decision of bargainer j is $\sum_{k=1}^n w_{kj} \Delta p_{k,t} - \theta_j$. If

$\sum_{k=1}^n w_{kj} \Delta p_{k,t} - \theta_j \neq 0$, bargainer will changing his portfolio of assets. The influence of this changing to whole market will be $f(\sum_{k=1}^n w_{kj} \Delta p_{k,t} - \theta_j)$.

The function $f(x)$ means the transformation from this influence to the changing of market. The weight of influence from bargainer j to asset k is v_{jk} , so the influence from the portfolio changing of bargainer j to the price fluctuating rate of asset k is $v_{jk} f(\sum_{k=1}^n w_{kj} \Delta p_{k,t} - \theta_j)$. All the influence from portfolio changing of m kind of bargainer to the price fluctuating rate of asset k is

$$\sum_{j=1}^m v_{jk} f(\sum_{k=1}^n w_{kj} \Delta p_{k,t} - \theta_j), \text{ which is shown in}$$

equation(2):

$$\Delta P_{k,t+1} = \sum_{j=1}^m v_{jk} f(\sum_{k=1}^n w_{kj} \Delta p_{k,t} - \theta_j) \quad (2)$$

The price of asset k in time t+1 is shown in equation(3):

$$P_{k,t+1} = P_{k,t} (1 + \Delta P_{k,t+1}) \quad (3)$$

In this model, the function $f(x)$ is the key factor in describing the process of price fluctuating of asset k deduced from $\Delta P_{k,t}$ to $\Delta P_{k,t+1}$.

According to the Prospect theory of Kahneman and Tversky^[2], the relationship between the subjective value and real surplus can be described by S curve. Because the behavior of bargainer is decided by his subjective value in bargaining, here we assume that there is a relationship which can be described as S curve between the influence of bargainer's asset portfolio changing to asset price and real surplus. It is showed as follow:

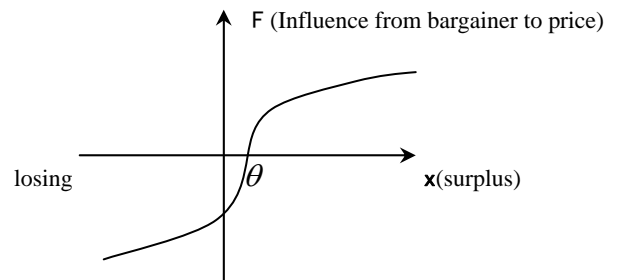


Figure 2: Relationship between Influence from Bargainer to Price and Surplus

Because the sensitivity of every bargainer to losing is higher than which to earning, so here the slope of curve above axis X is less than which under axis X in figure 2.

Due to the Hypothesis, value of $f(x)$ is inside the zone (-1, 1):

$$f(x) = \begin{cases} a \cdot b \cdot \tan \text{sig}(x), & x > \theta, 0 < a < 1, 0 < b < 1 \\ 0, & x = \theta \\ b \cdot \tan \text{sig}(x), & x < \theta, 0 < b < 1 \end{cases} \quad (4)$$

In Chinese stock market, if daily price is applies, the constant b should be 10%.

To proof-test capability of the model, here the method of chaos forecast jointed to forecast price of stock in Shanghai Stock Market through the model.

To forecast under chaos theory, the historic time series data of a stock must be rebuilt- in special phase space, so the model must predigested. In the new model, the historic time series data is rebuilt- in a phase space with n dimensions.

data of dimension $K(k=1 \sim n-1)$ bargainer $j(j=1 \sim m)$ data of dimension n

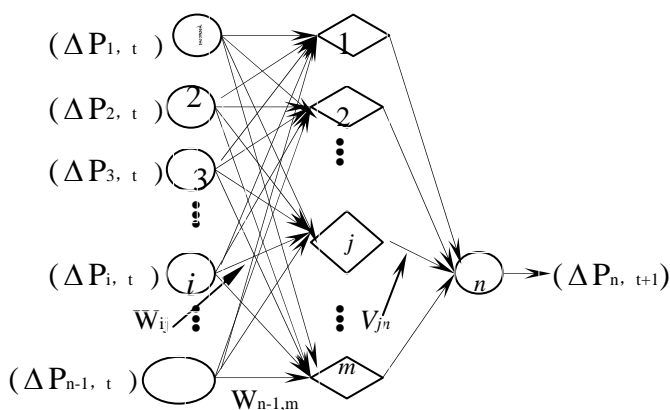


Figure 3 : Predigested CMSM

Here it is assumed that bargainer change their portfolios according data $\Delta P_k, t, k=1 \sim n-1$, influence of this changing to the price will be $\Delta P_n, t$

$$\Delta P_{n,t} = \sum_{j=1}^m v_{jn} f\left(\sum_{k=1}^{n-1} w_{kj} \Delta P_{k,t} - \theta_j\right) \quad (5)$$

there is no changing with function $f(x)$.

Weights w_{kj} 、 v_{jk} and averseness to risk θ_j can be accounted by error propagation.

2. A RESEARCH OF STOCK PRICE FORECAST

Some researches show that Shanghai Stock Market is a chaos economy^{[3][4]}, and those papers also show that it is available^[5] in short-term forecast. Here the historic daily price fluctuating of stock 600622 from May17,1993 to

Oct.10,2003 are apply to this research , software MATLAB 6.01 is also applies in data computing.



Figure 4: Process of Chaos Forecast through CMSM

First of all, the length of non-periodic cycle of stock price fluctuating should be accounted by V-Stat. developed by Hurst:

$$V_n = (R/S)_n / \sqrt{n} \quad (6)$$

$(R/S)_n$ can be accounted as follows:

$$x_m = (x_1 + \dots + x_n) / n, \quad x_r (r = 1 \sim n) \quad (7)$$

$$\Delta x_i = (x_i - x_m); \quad i = 1 \sim n \quad (8)$$

$$y_r = \sum_{i=1}^r \Delta x_i; \quad r = 1 \sim n \quad (9)$$

$$R_n = \max(y_r) - \min(y_r); \quad r = 1 \sim n \quad (10)$$

$$s_n = \sqrt{\frac{1}{n} \sum_{r=1}^n (x_r - x_m)^2} \quad (11)$$

$$(R/S)_n = \frac{\max(y_r) - \min(y_r)}{\sqrt{\frac{1}{n} \sum_{r=1}^n (x_r - x_m)^2}} \quad (12)$$

If $(R/S)_n$ is independence and stochastic, and changing with the square root of time, we will get a horizontal line in a figure which with the X axis of $\text{Log}(n)$ and the Y axis of $(R/S)_n$. If the changing rate of $(R/S)_n$ is faster than which of time square root, we will get a decline curve in the figure. Otherwise, we will get an upswept curve.

When the curve changing its trend, it means the end of non-periodic cycle, so the length of non-periodic cycle is gotten.

When analyzing the historic price fluctuating of stock 600622, we find that the non-periodic cycle is 30 days. It means that the available length in forecasting is 30 days.

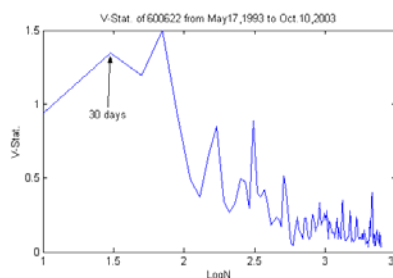


Figure 5: V-Stat. of 600622

According to Wolf.,^[6] the product of the number of phase space dimension and arrearage equal to the length of non-periodic cycle. There are 5 working days every week, so the number of dimension is 5, Accordingly, the arrearage should be 6 days.

After the process of rebuilt in phase space, the one dimension historic time series is convert into 5 dimension time series. 4 of 5 dimension time series is taken as the input data, and the 5th dimension of time series is taken as the output data. When forecasting, we can use the data of 1st and 7th and 13th and 19th to predict the value of 25th. According to the principle of pricing, it can be explained that bargainer change their stock portfolios due to price fluctuating occurred at 1st and 7th and 13th and 19th those 4 Days, all influences of portfolio changing will decide the pricing at the day of 25th. Most of historic data are apply to train CMSM, less of them are apply to proof-test the accuracy of the CMSM. The constant of a is 0.816, and the number of kinds of bargainer is 9. Percentage of daily price fluctuating forecasted and its error list as follows:

Table 1: Percent of daily price fluctuating forecasted and pricing error

NO.	Real value (%)	Accounted value(%)	Error(%) of pricing
1	0.13	0.84	0.71
2	-0.41	2.68	3.09
3	-0.88	2.02	2.90
4	1.74	-0.94	-2.68
5	-0.32	1.42	1.75
6	-1.06	0.33	1.38
7	-0.96	0.85	1.80
8	-3.04	3.24	6.28
9	-1.01	-3.10	-2.09

3. CONCLUSION

Through the work of test-proof about the CMSM in forecasting the daily price fluctuating, we can find that the CMSM is applies to price forecasting in chaos economy because of the accuracy which shows that 8 of the 9 cases in price forecasting with its error less than 3.5% and there is only one case of price forecasting with its error more than 5%. So CMSM is apply to consult in decision-making.

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