

NON-LINEAR MODE AND FORECASTING THE PRICE OF THE STOCK OF THE BANKS LISTED ON TSE

Hassan Falahnezhad Nowdehi^{1*}, Seyed Ali Nabavi Chashmi², Nouroollah Asadi³, Meisam Naghavi Mermeti¹

¹Young researchers and elite club, Sari Branch, Islamic Azad University, Sari, Iran.

²Management Department, Babol Branch, Islamic Azad University, Babol, Iran.

³Young researchers and elite club, Babol Branch, Islamic Azad University, Babol, Iran.

*Corresponding Author

ABSTRACT

After the entrance of Banks in TSE, the importance of this industry is increased in Iran trading system as these banks absorb many investors for investment. This paper investigates stock price behavior of six banks including EghtesadNovin, Parsian, Karafarin, Tejarat, Saderat and Sina by chaos and correlation dimension estimate theories. Their price time series was investigated during their listing in TSE to September 21, 2011. Finally, various banks were ranked in terms of complexity of forecast process and chaotic stock behavior and by some changes in four non-linear chaos attractor including Henon, Rosler Cheos, Lorenz Attractor and Rossler Hyper Chaos; they were turned into the models with forecast ability. The designed models were used to predict stock price of the studied banks during 20 days and the difference of the predicted and actual values was computed by each model in banks. The results showed that in Eghtesad Novin bank, the designed model by Rossler Hyper Chaos and in other studied banks the designed model by Lorenz were the best models with the lowest difference between the forecast values and actual values.

KEYWORDS: Forecast, Time series forecast, Chaos theory, Correlation Dimension Estimate, Non-linear mode

INTRODUCTION

Today, investment in stock market is the most important part of Iran economy and the major capital is traded via stock markets in all over the world and national economy is mostly influenced by stock market performance. In addition, stock market both for macro investment and for all people is an available investment tool. It is obvious in such market, those who can achieve good return of investment can have correct perception of market future. Future forecast is always a necessity in routine life and it is also as common field in all sciences and this issue is specifically in financial issues and stock market. Stock markets are not only influence by macro parameters, but also they are influenced by thousands of other factors. Unknown nature of the effective factors on stock price changes is a reason to use forecasting stock price changes of companies. It is obvious that uncertainty is not a suitable factor in investment and it is an unavoidable feature for the investors selecting stock market as investment place. Thus, all attempts of investors are dedicated to reduction of uncertainty and this goal is true about those investing in banking industry. Recently, by privatization of governmental banks and listing of these banks in stock market and establishing private banks, many investors try to invest in the stock of these economic enterprises. As stock market forecast is one of the tools of uncertainty reduction, investors of bank sector of stock market try to find the methods predicting stock market of banks better to achieve the highest return of their investment (Arabi, 2005). Based on the unavailability of exact information regarding the effective factors on fluctuations of stock market, forecasting these changes is not possible easily. Here, efficient market theory is used. It means that stock price fluctuations are not predicted by public available information. In other words, the mentioned process follows astochastic trend. Indeed, this hypothesis is based on random steps and null hypothesis means the forecasting capability of prices. The researches conducted in this regard and the results showed that based on fractal dimension of productive process of price of time series is different from a stochastic process (Manafi, 2006, Khaluzade, 2010). Thus, price behavior forecast based on time series of the variables in price and by behavioral models, forecast efficiency is defined. The inability of linear methods in forecast and determining the existing models in non-linear times series and the instability of linear methods to existing disturbances in the real world data caused that using non-linear dynamic models is considered as one of the methods in time series forecast (Van Altrok, 1997). The recent progresses in chaotic time series showed that linear methods have no required adequacy to receive and extract non-linear models in times series of price or stock return (Fisher, Ronald and Jordan, 1991). For example, quasi-stochastic variable of price may not be stochastic but if it is investigated by linear test methods, it is possible its stochastic nature is obtained. In this case, non-stochastic variable is non-linear chaos variable with valuable information and models of prediction but linear models are not efficient to extract the information. There are various

methods of non-linear and chaos variables in economy and many researches should be conducted in this regard. In this study, at first by chaos test (correlation dimension), the type of structure and time series complexities are investigated and finally chaos static model consistent with each of time series is introduced and the results of forecast are much reliable. Thus, the main question of the study is how is the type of stock price of the banks listed on TSE? How can we present chaos model to predict stock price of the banks listed on TSE?

MATERIALS AND METHODS

Methodology

This study is time series evaluation investigating the chaos and feasibility of stock price behavior forecast of the banks listed in stock market. Also, the type of time series structure is also considered.

Study population and sample

The study population is all the companies listed on TSE. The banks listed in TSE until the start of this study with suitable series are selected as study population. These banks include Parsian, Karafarin, EghtesadNovin, Tejarat, Sina and Saderat.

Data analysis and study questions test

At first, by correlation dimension estimate, we determined the dimension of each of the studied banks, then the banks were sorted based on chaos and finally by changes in chaos attractor, some models are created predicting the price. Finally, we introduced the best model for each bank with forecast capability with less error percentage. Chaos attractors of the study are as followings:

- Henon Chaos
- Rossler Chaos
- Lorenz Attractor
- Rossler Hyper chaos

The calculation and estimation of correlation dimension

Correlation dimension is a criterion to determine the complexity of a phenomenon. Dimension of a zero point, the line with dimension 1 and white noise and a stochastic process with infinite dimension. Chaos process has positive and finite dimension (Khaluzade, 1998).

To do correlation dimension estimate calculations by MATLAB software, at first we should design a matrix with a row and column as the number of studied data by stock price data of the required bank. For example, if the number of price data of a bank is 1000 data, we should create a matrix with a row and 1000 columns.

$b = [3752 \ 3755 \ 3942 \ 4139 \ 4345 \ \dots \ 3865 \ 3872 \ 3905];$

stock division and converting a stock to some stocks in some banks cause strong price reduction and this price reduction is not due to the demand and supply. Thus, reduction of the price of dividing the stock to some stocks makes disturbance in correlation dimension calculation. Thus, when stock division is obtained and price reduction is occurred, to the end of working day, the reduced value is added to the entire price data in order than the calculations are done carefully. For example, in EghtesadNovin bank, stock division was occurred in 278th day and it led into the reduction of value as 5266 on 278th day to the previous day (277th day) and this value is added to all working days from day 278 to the last day. Thus, if stock division is not occurred in a bank, this process (reduction of price of stock division) is not occurred.

The days in which stock division is occurred, the added values and the banks in which stock division is not occurred are shown in Table 1.

Table 1-The values added to stock price of banks for easy calculations

Value increase	The working day in which stock division is occurred	Bank
5266	278	EghtesadNovin
-	-	Tejarat
-	-	Sina
6247	57	Karafarin
3926	134	Prasian
-	-	Saderat

In addition, correlation dimension estimate is done on stationary data. To do this, before estimate calculations of correlation dimension, the time series should be stationary. This is done by once differentiating.

RESULTS

The results of calculated DM (correlation dimension), banks and order of banks based on the complexity of productive system of time series are presented in Table 2, 3.

Table 2- The calculated DM results (correlation dimension), banks

DM relevant dimension	Selected dimension	Studied dimension	Bank
1.78	70	$2 \rightarrow 70$	EghtesadNovin
1.11	30	$2 \rightarrow 30$	Parsian
1.61	22	$2 \rightarrow 22$	Sina
1.51	20	$2 \rightarrow 20$	Karafarin
1.61	32	$2 \rightarrow 35$	Saderat
1.57	35	$2 \rightarrow 35$	Tejarat

Table 3- The order of banks based on complexity of productive time series system

DM	Bank	Rank in terms of complexity
1.78	EghtesadNovin	1
1.61	Saderat and Sina	2
1.57	Tejarat	3
1.51	Parsian	4
1.11	Karafarin	5

The results of modeling by Henon attractor and forecast by designed model in the studied banks after doing the calculations in studied banks, the results are shown in Table 4.

Table 4- The final results of designed model by Henon attractor, about the studied banks

Bank	Model coefficient		The designed model by Henon attractor
EghtesadNovin	A	364.15	$x_{n+1} = 364.15 + 0.0000142x_n^2 + 0.828x_{n-1}$
	B	0.0000342	
	C	0.828	
Karafarin	A	136.59	$x_{n+1} = 136.59 + 0.0000350x_n^2 + 0.85x_{n-1}$
	B	0.0000350	
	C	0.85	
Parsian	A	250.58	$x_{n+1} = 250.582 + 0.0000193x_n^2 + 0.835x_{n-1}$
	B	0.0000193	
	C	0.835	
Saderat	A	461.440	$x_{n+1} = 461.440 + 0.000265x_n^2 + 0.288x_{n-1}$
	B	0.000265	
	C	0.288	
Sina	A	175.94	$x_{n+1} = 175.94 + 0.0000407x_n^2 + 0.82x_{n-1}$
	B	0.0000407	
	C	0.82	
Tejarat	A	473.287	$x_{n+1} = 473.288 + 0.00020x_n^2 + 0.370x_{n-1}$
	B	0.00020	
	C	0.370	

Quadratic model of the studied banks is shown in the above model.

Now we can extract actual data x_{n-1}, x_n is extracted from the banks and is put in the model and it is predicted as 20 working days and is compared with the actual information of 20 working days in market. The predicted values are as followings.

Table 5- The 20-day forecast results by designed model extracted from Henon attractor for Eghtesad Novin bank

Working day	Actual values	Forecast values
1	3940	3788.87
2	4096	3803.45
3	4259	3708.84
4	4429	3710.77
5	4481	3632.61
6	4628	3626.01
7	4801	3560.60
8	4918	3548.42
9	4748	3493.00
10	4664	3477.35
11	4544	3429.89
12	4398	3412.24
13	4401	3371.21
14	4404	3352.62
15	4406	3316.85
16	4383	3298.05
17	4372	3266.65
18	4362	3248.13
19	4376	3220.40
20	4375	3202.51

Table 6- The 20-day forecast results by designed model extracted from Henon attractor for Karafarin bank

Working day	Actual values	Forecast values
1	3207	2896.82
2	3206	2879.10
3	3206	2883.00
4	3205	2868.76
5	3196	2869.20
6	3211	2857.22
7	3212	2855.19
8	3238	2844.62
9	3342	2840.79
10	3380	2831.07
11	3383	2825.89
12	3380	2816.62
13	3382	2810.39
14	3380	2801.31
15	3359	2794.25
16	3352	2785.16
17	3340	2777.40
18	3319	2768.19
19	3322	2759.81
20	3318	2750.38

Table 7- The 20-day forecast results by designed model extracted from Henon attractor for Parsian bank

Working day	Actual values	Forecast values
1	3460	3324.77
2	3441	3354.59
3	3438	3245.51
4	3440	3256.46
5	3383	3166.74
6	3369	3164.71
7	3349	3089.53
8	3333	3078.72
9	3328	3014.64
10	3336	2998.05
11	3346	2942.59
12	3373	2922.35
13	3381	2873.73
14	3381	2851.36
15	3362	2808.27
16	3304	2784.86
17	3296	2746.34
18	3300	2722.66
19	3300	2687.97
20	3283	2664.56

Table 8- The 20-day forecast results by designed model extracted from Henon attractor for Saderat bank

Working day	Actual values	Forecast values
1	1495	1483.35
2	1494	1478.1
3	1494	1470.89
4	1490	1463.71
5	1489	1456.03
6	1486	1448
7	1469	1439.57
8	1461	1430.79
9	1456	1421.65
10	1496	1412.18
11	1507	1402.4
12	1510	1392.35
13	1511	1382.05
14	1508	1371.55
15	1503	1360.89
16	1483	1350.12
17	1458	1339.27
18	1456	1328.4
19	1455	1317.55
20	1452	1306.78

Table 9- The 20-day forecast results by designed model extracted from Henon attractor for Sina bank

Working day	Actual values	Forecast values
1	3207	3379.91
2	3206	3385.65
3	3206	3404.32
4	3205	3414.17
5	3196	3432.16
6	3211	3445.21
7	3212	3463.57
8	3238	3479.40
9	3342	3498.87
10	3380	3517.34
11	3383	3538.52
12	3380	3559.70
13	3382	3583.12
14	3380	3607.24
15	3359	3633.44
16	3359	3660.86
17	3340	3690.41
18	3319	3721.66
19	3322	3755.24
20	3318	3790.99

Table 10- The 20-day forecast results by designed model extracted from Henon attractor for Tejarat bank

Working day	Actual values	Forecast values
1	1877	1874.57
2	1880	1873.48
3	1877	1871.77
4	1875	1870.07
5	1873	1868.17
6	1869	1866.11
7	1867	1863.86
8	1854	1861.42
9	1851	1858.76
10	1842	1855.86
11	1838	1852.72
12	1833	1849.31
13	1831	1845.62
14	1816	1841.62
15	1812	1837.29
16	1808	1832.61
17	1798	1827.56
18	1787	1822.12
19	1782	1816.26
20	1782	1809.97

Modeling results by Rossler Chaos attractor and forecast by designed model in studied banks

Table 11- The designed model by Rossler attractor

Bank	Model coefficients		The designed model by Rossler attractor
EghtesadNovin	A	1.055	$X_{i+3} = 1.055X_{i+2} + 0.0000048X_{i+2}X_i + 0.000012X_i^2 - 0.0028X_i - 0.0000450X_{i+1}X_i - 0.0389X_{i+1} - 23.64$
	B	0.0000048	
	C	0.000012	
	D	-0.0028	
	E	0.000026	
	F	-0.0000450	
	G	-0.0389	
	H	-23.64	
Karafarin	A	1.239	$X_{i+3} = 1.239X_{i+2} - 0.000058X_{i+2}X_i - 0.000119X_i^2 - 0.0178X_i - 0.00017X_{i+1}^2 + 0.00033X_{i+1}X_i - 0.159X_{i+1} - 49.91$
	B	-0.000058	
	C	-0.000119	
	D	-0.0178	
	E	-0.00017	
	F	0.00033	
	G	-0.159	
	H	-49.91	
Parsian	A	0.40552	$X_{i+3} = 0.40552X_{i+2} + 0.00009X_{i+2}X_i - 0.0000065X_i^2 + 0.2130X_i + 0.000053X_{i+1}^2 - 0.00014X_{i+1}X_i + 0.3821X_{i+1} + 5.415297$
	B	0.00009	
	C	-0.0000065	
	D	0.2130	
	E	0.000053	
	F	-0.00014	
	G	0.3821	
	H	5.415297	
Saderat	A	0.0176	$X_{i+3} = 0.0176X_{i+2} - 0.0000034X_{i+2}X_i - 0.000002CX_i^2 + 0.0076X_i + 0.000003X_{i+1}^2 + 0.0000017X_{i+1}X_i - 0.0136X_{i+1} - 1.023$
	B	-0.0000034	
	C	-0.000002	
	D	0.0076	
	E	0.000003	
	F	0.0000017	
	G	-0.0136	
	H	-1.023	
Sina	A	1.224	$X_{i+3} = 1.224X_{i+2} - 0.000053X_{i+2}X_i - 0.00012X_i^2 - 0.002X_i - 0.00017X_{i+1}^2 + 0.00033X_{i+1}X_i - 0.157X_{i+1} - 52.49$
	B	-0.0000053	
	C	-0.00012	
	D	-0.002	
	E	-0.00017	
	F	0.00033	
	G	-0.157	
	H	-52.49	

Tejarat	A	0.0161	$X_{i+3} = 0.0161X_{i+2} - 0.000002X_{i+2}X_i - 0.0000025X_i^2 + 0.0018X_i - 0.0000021X_{i+1}^2 + 0.0000069X_{i+1}X_i - 0.0062X_{i+1} - 1.270$
	B	-0.000002	
	C	-0.0000025	
	D	0.0018	
	E	-0.0000021	
	F	0.0000069	
	G	-0.0062	
	H	-1.270	

Table 12- The 20-day forecast results by designed model extracted from Rossler chaos attractor for EghtesadNovin bank

Working day	Actual values	Forecast values
1	3940	3914.8
2	4096	3919.28
3	4259	3928.07
4	4429	3936.54
5	4481	3936.54
6	4628	3935.29
7	4801	3943.83
8	4918	3943.7
9	4748	3953.15
10	4664	3950.99
11	4544	3962.39
12	4398	3958.01
13	4401	3972.48
14	4404	3962.56
15	4406	3983.54
16	4383	3965.73
17	4372	3996.89
18	4362	3966.21
19	4376	4013.57
20	4375	3962.44

Table 13- The 20-day forecast results by designed model extracted from Rossler chaos attractor for Karafarin bank

Working day	Actual values	Forecast values
1	3207	3200.76
2	3206	3201.09
3	3206	3199.95
4	3205	3199.04
5	3196	3199.04
6	3211	3197.66
7	3212	3197.02
8	3238	3196.48
9	3342	3194.53
10	3380	3194.76
11	3383	3192.85
12	3380	3191.86
13	3382	3192.01
14	3380	3188.97
15	3359	3190.13
16	3352	3188.07
17	3340	3186.35
18	3319	3188.3
19	3322	3183.42
20	3318	3184.13

Table 14- The 20-day forecast results by designed model extracted from Rossler chaos attractor for parsian bank

Working day	Actual values	Forecast values
1	3460	3438.39
2	3441	3416.8
3	3438	3416.39
4	3440	3418.43
5	3383	3418.43
6	3369	3410.45
7	3349	3411.56
8	3333	3406.52
9	3328	3408.17
10	3336	3401.43
11	3346	3403.57
12	3373	3396.63
13	3381	3399.5
14	3381	3391.74
15	3362	3395.33
16	3304	3386.84
17	3296	3391.3
18	3300	3381.91
19	3300	3387.34
20	3283	3376.94

Table 15- The 20-day forecast results by designed model extracted from Rossler chaos attractor for Saderat bank

Working day	Actual values	Forecast values
1	1495	1485.83
2	1494	1475.51
3	1494	1473.85
4	1490	1483.18
5	1489	1483.18
6	1486	1476.58
7	1469	1476.68
8	1461	1475.96
9	1456	1483.4
10	1496	1476.98
11	1507	1487.28
12	1510	1470.32
13	1511	1496.51
14	1508	1458.44
15	1503	1518.67
16	1483	1427.68
17	1458	1567.17
18	1456	1354.18
19	1455	1679.52
20	1452	1180.22

Table 16- The 20-day forecast results by designed model extracted from Rossler chaos attractor for Sina bank

Working day	Actual values	Forecast values
1	3207	3200.84
2	3206	3201.17
3	3206	3200.04
4	3205	3199.16
5	3196	3199.16
6	3211	3197.81
7	3212	3197.19
8	3238	3196.65
9	3342	3194.78
10	3380	3194.99
11	3383	3193.13
12	3380	3192.19
13	3382	3192.3
14	3380	3189.41
15	3359	3190.51
16	3359	3188.49
17	3340	3186.93
18	3319	3188.67
19	3322	3184.11
20	3318	3186.52

Table 17- The 20-day forecast results by designed model extracted from Rossler chaos attractor for Tejarat bank

Working day	Actual values	Forecast values
1	1877	1873.05
2	1880	1877.00
3	1877	1877.54
4	1875	1886.00
5	1873	1886.00
6	1869	1878.71
7	1867	1903.64
8	1854	1877.77
9	1851	1890.11
10	1842	1927.90
11	1838	1835.81
12	1833	1956.82
13	1831	1908.05
14	1816	1772.15
15	1812	2161.32
16	1808	1656.11
17	1798	1914.66
18	1787	2472.12
19	1782	866.73
20	1782	3080.61

Modeling results by Lorenz attractor and forecast by designed model in studied banks

Table 18- The designed model by Lorenz attractor

Bank	Model coefficients		The designed model by Lorenz attractor
Eghtesad Novin	A	-0.02740	$x_{i+3} = -0.02740x_{i+1} - 0.0633x_i + 0.000000029x_{i+1}^2x_i + 0.00000002x_i^3 - 0.00000005x_{i+1}x_i^2 + 1.09300x_{i+2}$
	B	-0.0633	
	C	0.000000029	
	D	0.00000002	
	E	-0.000000005	
	F	1.09300	
Karafarin	A	-0.0109	$x_{i+3} = -0.0109x_{i+1} - 0.055x_i - 0.000000054x_{i+1}^2x_i - 0.000000036x_i^3 + 0.00000009x_{i+1}x_i^2 + 1.0717x_{i+2}$
	B	-0.055	
	C	-0.000000054	
	D	-0.000000036	
	E	0.00000009	
	F	1.0717	
Parsian	A	0.07198	$x_{i+3} = 0.07198x_{i+1} + 0.071269x_i + 0.000000012x_{i+1}^2x_i - 0.000000010x_i^3 - 0.0000000042x_{i+1}x_i^2 + 0.8581x_{i+2}$
	B	0.071269	
	C	0.000000012	
	D	-0.000000010	
	E	-0.0000000042	
	F	0.8581	
Saderat	A	-0.5197	$x_{i+3} = -0.5197x_{i+1} + 0.26399x_i + 0.00000019x_{i+1}^2x_i + 0.000000046x_i^3 - 0.00000024x_{i+1}x_i^2 + 1.261488x_{i+2}$
	B	0.26399	
	C	0.00000019	
	D	0.000000046	
	E	-0.00000024	
	F	1.261488	
Sina	A	-0.0257474	$x_{i+3} = -0.0257474x_{i+1} - 0.03297x_i - 0.000000054x_{i+1}^2x_i - 0.0000000376x_i^3 + 0.00000009x_{i+1}x_i^2 + 1.066446x_{i+2}$
	B	-0.03297	
	C	-0.000000054	
	D	-0.0000000376	
	E	0.00000009	
	F	1.066446	
Tejarat	A	-0.09878	$x_{i+3} = -0.09878x_{i+1} - 0.01267x_i - 0.000000112x_{i+1}^2x_i - 0.000000102x_i^3 + 0.00000021x_{i+1}x_i^2 + 1.11707x_{i+2}$
	B	-0.01267	
	C	-0.000000112	
	D	-0.000000102	
	E	0.00000021	
	F	1.11707	

Table 19- The 20-day forecast results by designed model extracted from Lorenz Attractor for EghtesadNovin bank

Working day	Actual values	Forecast values
1	3940	3914.37
2	4096	3921.23
3	4259	3919.94
4	4429	3919.62
5	4481	3919.62
6	4628	3919.59
7	4801	3919.63
8	4918	3919.64
9	4748	3919.64
10	4664	3919.63
11	4544	3919.63
12	4398	3919.63
13	4401	3919.63
14	4404	3919.63
15	4406	3919.63
16	4383	3919.63
17	4372	3919.63
18	4362	3919.63
19	4376	3919.63
20	4375	3919.63

Table 20- The 20-day forecast results by designed model extracted from Lorenz Attractor for Karafarin bank

Working day	Actual values	Forecast values
1	3207	3206.74
2	3206	3205.34
3	3206	3205.73
4	3205	3206.07
5	3196	3206.07
6	3211	3205.73
7	3212	3205.71
8	3238	3205.77
9	3342	3205.86
10	3380	3205.52
11	3383	3205.78
12	3380	3205.77
13	3382	3205.87
14	3380	3205.74
15	3359	3205.79
16	3352	3205.77
17	3340	3205.82
18	3319	3205.78
19	3322	3205.80
20	3318	3205.78

Table 21- The 20-day forecast results by designed model extracted from Lorenz Attractor for Parsian bank

Working day	Actual values	Forecast values
1	3460	3448.85
2	3441	3448.03
3	3438	3445.48
4	3440	3445.21
5	3383	3445.21
6	3369	3445.00
7	3349	3445.03
8	3333	3445.03
9	3328	3445.01
10	3336	3445.01
11	3346	3445.01
12	3373	3445.01
13	3381	3445.01
14	3381	3445.01
15	3362	3445.01
16	3304	3445.01
17	3296	3445.01
18	3300	3445.01
19	3300	3445.01
20	3283	3445.01

Table 22- The 20-day forecast results by designed model extracted from Lorenz Attractor for Saderat bank

Working day	Actual values	Forecast values
1	1495	1497.38
2	1494	1499.54
3	1494	1495.45
4	1490	1498.85
5	1489	1498.85
6	1486	1495.68
7	1469	1497.35
8	1461	1497.82
9	1456	1495.07
10	1496	1496.11
11	1507	1498.04
12	1510	1495.71
13	1511	1496.28
14	1508	1498.28
15	1503	1495.92
16	1483	1496.03
17	1458	1498.25
18	1456	1496.09
19	1455	1495.83
20	1452	1498.22

Table 23- The 20-day forecast results by designed model extracted from Lorenz Attractor for Sina bank

Working day	Actual values	Forecast values
1	3207	3206.62
2	3206	3205.15
3	3206	3205.52
4	3205	3205.82
5	3196	3205.82
6	3211	3205.52
7	3212	3205.50
8	3238	3205.55
9	3342	3205.62
10	3380	3205.32
11	3383	3205.56
12	3380	3205.56
13	3382	3205.63
14	3380	3205.53
15	3359	3205.57
16	3359	3205.55
17	3340	3205.58
18	3319	3205.56
19	3322	3205.57
20	3318	3205.56

Table 24- The 20-day forecast results by designed model extracted from Lorenz Attractor for Tejarat bank

Working day	Actual values	Forecast values
1	1877	1876.72
2	1880	1876.12
3	1877	1876.23
4	1875	1876.25
5	1873	1876.25
6	1869	1876.23
7	1867	1876.23
8	1854	1876.24
9	1851	1876.24
10	1842	1876.22
11	1838	1876.24
12	1833	1876.24
13	1831	1876.24
14	1816	1876.24
15	1812	1876.24
16	1808	1876.24
17	1798	1876.24
18	1787	1876.24
19	1782	1876.24
20	1782	1876.24

Modeling results by Rossler Hyper Chaosattractor and forecast by designed model in studied banks

Table 25- The designed model by Rossler Hyper Chaosattractor

Bank	Model coefficients		The designed model by Rossler Hyper Chaos attractor
EghtesadNovin	A	-0.4685	$x_{i+3} = -0.4685x_{i+1} + 1.084545x_{i+2} + 0.37877x_i + 0.0000424x_{i+1}^2 + 0.000125x_{i+1}x_i - 0.000163x_i^2 - 0.00000016x_i^2x_{i+1} + 0.00000015x_i^3 - 0.009102$
	B	1.084545	
	C	0.37877	
	D	0.0000424	
	E	0.000125	
	F	-0.000163	
	G	-0.00000016	
	H	0.00000015	
	I	-0.009102	
Karafarin	A	-0.50836	$x_{i+3} = -0.50836x_{i+1} + 1.05575x_{i+2} + 0.4278x_i - 0.0002382x_{i+1}^2 + 0.000902x_{i+1}x_i - 0.00063x_i^2 - 0.000000102x_i^2x_{i+1} + 0.000000096x_i^3 + 0.016196$
	B	1.05575	
	C	0.4278	
	D	-0.0002382	
	E	0.000902	
	F	-0.00063	
	G	-0.000000102	
	H	0.000000096	
	I	0.016196	
Parsian	A	0.13566	$x_{i+3} = 0.13566x_{i+1} + 0.84892x_{i+2} + 0.01375x_i + 0.0000109x_{i+1}^2 - 0.0000817x_{i+1}x_i + 0.0000692x_i^2 + 0.0000000105x_i^2x_{i+1} - 0.00000001039x_i^3 + 0.014860$
	B	0.84892	
	C	0.01375	
	D	0.0000109	
	E	-0.0000817	
	F	0.0000692	
	G	0.0000000105	
	H	-0.00000001039	
	I	0.014860	
Saderat	A	6.320818	$x_{i+3} = 6.320818x_{i+1} + 1.21674x_{i+2} - 6.5490x_i + 0.000777x_{i+1}^2 - 0.011399x_{i+1}x_i + 0.010646x_i^2 + 0.0000036x_i^2x_{i+1} - 0.00000364x_i^3 + 0.072436$
	B	1.21674	
	C	-6.5490	
	D	0.000777	
	E	-0.011399	
	F	0.010646	
	G	0.0000036	
	H	-0.00000364	
	I	0.072436	

Sina	A	-0.58787434	$x_{i+3} = -0.58787434x_{i+1} + 1.053917x_{i+2} + 0.51122x_i - 0.0002396x_{i+1}^2 + 0.0009625x_{i+1}x_i - 0.000697x_i^2 - 0.00000011x_i^2x_{i+1} + 0.000000106x_i^3 + 0.01985$
	B	1.053917	
	C	0.51122	
	D	-0.0002396	
	E	0.0009625	
	F	-0.000697	
	G	-0.00000011	
	H	0.000000106	
	I	0.01985	
Tejarat	A	-0.7262868	$x_{i+3} = -0.7262868x_{i+1} + 1.068381x_{i+2} + 0.5905672x_i - 0.0001560x_{i+1}^2 + 0.0011159x_{i+1}x_i - 0.00086469x_i^2 - 0.000000251x_i^2x_{i+1} + 0.000000214x_i^3 + 0.090892$
	B	1.068381	
	C	0.5905672	
	D	-0.0001560	
	E	0.0011159	
	F	-0.00086469	
	G	-0.000000251	
	H	0.000000214	
	I	0.090892	

Table 26- The 20-day forecast results by designed model extracted from Rossler Hyper ChaosAttractor for EghtesadNovinbank

Working day	Actual values	Forecast values
1	3940	3926.84
2	4096	3952.72
3	4259	3973.16
4	4429	3998.14
5	4481	3998.14
6	4628	3995.62
7	4801	4021.70
8	4918	4014.25
9	4748	4042.25
10	4664	4037.63
11	4544	4062.17
12	4398	4061.82
13	4401	4082.52
14	4404	4085.91
15	4406	4103.56
16	4383	4109.78
17	4372	4125.28
18	4362	4133.49
19	4376	4147.57
20	4375	4157.14

Table 27- The 20-day forecast results by designed model extracted from Rossler Hyper ChaosAttractor for Karafarin bank

Working day	Actual values	Forecast values
1	3207	3195.54
2	3206	3182.58
3	3206	3170.25
4	3205	3159.72
5	3196	3159.72
6	3211	3160.87
7	3212	3150.61
8	3238	3150.91
9	3342	3139.87
10	3380	3142.18
11	3383	3129.59
12	3380	3134.06
13	3382	3119.42
14	3380	3126.59
15	3359	3109.30
16	3352	3119.83
17	3340	3099.12
18	3319	3113.86
19	3322	3088.75
20	3318	3108.75

Table 28- The 20-day forecast results by designed model extracted from Rossler Hyper ChaosAttractor for Parsianbank

Working day	Actual values	Forecast values
1	3460	3431.34
2	3441	3410.09
3	3438	3393.00
4	3440	3377.36
5	3383	3377.36
6	3369	3374.56
7	3349	3358.93
8	3333	3355.16
9	3328	3341.74
10	3336	3337.47
11	3346	3324.48
12	3373	3319.81
13	3381	3307.36
14	3381	3302.32
15	3362	3290.34
16	3304	3285.00
17	3296	3273.44
18	3300	3267.83
19	3300	3256.66
20	3283	3250.81

Table 29- The 20-day forecast results by designed model extracted from Rossler Hyper ChaosAttractor for Saderat bank

Working day	Actual values	Forecast values
1	1495	1471.13
2	1494	1440.43
3	1494	1409.57
4	1490	1382.23
5	1489	1382.23
6	1486	1391.47
7	1469	1365.75
8	1461	1374.35
9	1456	1339.84
10	1496	1360.59
11	1507	1312.94
12	1510	1352.06
13	1511	1283.06
14	1508	1350.93
15	1503	1248.33
16	1483	1361.36
17	1458	1207.06
18	1456	1390.79
19	1455	1159.51
20	1452	1452.57

Table 30- The 20-day forecast results by designed model extracted from Rossler Hyper ChaosAttractor for Sina bank

Working day	Actual values	Forecast values
1	3207	3196.19
2	3206	3183.95
3	3206	3172.32
4	3205	3162.37
5	3196	3162.37
6	3211	3163.45
7	3212	3153.79
8	3238	3154.08
9	3342	3143.70
10	3380	3145.86
11	3383	3134.06
12	3380	3138.21
13	3382	3124.54
14	3380	3131.18
15	3359	3115.10
16	3359	3124.82
17	3340	3105.62
18	3319	3119.18
19	3322	3096.01
20	3318	3114.35

Table 31- The 20-day forecast results by designed model extracted from Rossler Hyper ChaosAttractor for Tejarat bank

Working day	Actual values	Forecast values
1	1877	1841.80
2	1880	1804.12
3	1877	1769.54
4	1875	1736.05
5	1873	1736.05
6	1869	1741.56
7	1867	1710.76
8	1854	1718.59
9	1851	1685.20
10	1842	1695.84
11	1838	1661.15
12	1833	1674.85
13	1831	1638.61
14	1816	1655.53
15	1812	1617.34
16	1808	1637.71
17	1798	1597.12
18	1787	1621.21
19	1782	1577.77
20	1782	1605.94

Absolute value of the percent of difference of predicted value with actual values separated by various banks

Table 32- The absolute value of the percent of the difference of actual values with the predict values in EghtesadNovin bank

Working day	HENON	ROSSLER CHAOS	LORENZ	ROSSLER HYPERCHAOS
1	3.84	0.64	0.65	0.33
2	7.14	4.31	4.27	3.50
3	12.92	7.77	7.96	6.71
4	16.22	11.12	11.50	9.73
5	18.93	12.15	12.53	10.78
6	21.65	14.97	15.31	13.66
7	25.84	17.85	18.36	16.23
8	27.85	19.81	20.30	18.38
9	26.43	16.74	17.45	14.86
10	25.44	15.29	15.96	13.43
11	24.52	12.8	13.74	10.60
12	22.41	10	10.88	7.64
13	23.40	9.74	10.94	7.24
14	23.87	10.02	11.00	7.22
15	24.72	9.59	11.04	6.86
16	24.75	9.52	10.57	6.23
17	25.28	8.58	10.35	5.64
18	25.54	9.07	10.14	5.24
19	26.41	8.28	10.43	5.22
20	26.80	9.43	10.41	4.98

Table 33- The absolute value of the percent of the difference of actual values with the predict values in Karafarin bank

Working day	HENON	ROSSLER CHAOS	LORENZ	ROSSLER HYPERCHAOS
1	9.67	0.19	0.01	0.36
2	10.20	0.15	0.02	0.73
3	10.07	0.19	0.01	1.11
4	10.49	0.19	0.03	1.41
5	10.23	0.1	0.32	1.14
6	11.02	0.42	0.16	1.56
7	11.11	0.47	0.20	1.91
8	12.15	1.28	1.00	2.69
9	15.00	4.41	4.07	6.05
10	16.24	5.48	5.16	7.04
11	16.47	5.62	5.24	7.49
12	16.67	5.57	5.15	7.28
13	16.90	5.62	5.21	7.76
14	17.12	5.65	5.16	7.50
15	16.81	5.03	4.56	7.43
16	16.91	4.89	4.36	6.93
17	16.84	4.6	4.02	7.21
18	16.60	3.94	3.41	6.18
19	16.92	4.17	3.50	7.02
20	17.11	4.03	3.38	6.31

Table 34- The absolute value of the percent of the difference of actual values with the predict values in Karafarin bank

Working day	HENON	ROSSLER CHAOS	LORENZ	ROSSLER HYPERCHAOS
1	3.91	0.62	0.32	0.83
2	2.51	0.70	0.20	0.90
3	5.60	0.63	0.22	1.31
4	5.34	0.63	0.15	1.82
5	6.39	1.05	1.84	0.17
6	6.06	1.23	2.26	0.17
7	7.75	1.87	2.87	0.30
8	7.63	2.21	3.36	0.66
9	9.42	2.41	3.52	0.41
10	10.13	1.96	3.27	0.04
11	12.06	1.72	2.96	0.64
12	13.36	0.70	2.13	1.58
13	15.00	0.55	1.89	2.18
14	15.67	0.32	1.89	2.33
15	16.47	0.99	2.47	2.13
16	15.71	2.51	4.27	0.58
17	16.68	2.89	4.52	0.68
18	17.50	2.48	4.39	0.97
19	18.55	2.65	4.39	1.31
20	18.84	2.86	4.93	0.98

Table 35- The absolute value of the percent of the difference of actual values with the predict values in Saderat bank

Working day	HENON	ROSSLER CHAOS	LORENZ	ROSSLER HYPERCHAOS
1	0.78	0.61	0.16	1.6
2	1.06	1.24	0.37	3.59
3	1.55	1.35	0.1	5.65
4	1.76	0.46	0.59	7.23
5	2.21	0.39	0.66	7.17
6	2.56	0.63	0.65	6.36
7	2	0.52	1.93	7.03
8	2.07	1.02	2.52	5.93
9	2.36	1.88	2.68	7.98
10	5.6	1.27	0.01	9.05
11	6.94	1.31	0.59	12.88
12	7.79	2.63	0.95	10.46
13	8.53	0.96	0.97	15.09
14	9.05	3.29	0.64	10.42
15	9.45	1.04	0.47	16.94
16	8.96	3.73	0.88	8.2
17	8.14	7.49	2.76	17.21
18	8.76	6.99	2.75	4.48
19	9.45	15.43	2.81	20.31
20	10	18.72	3.18	0.04

Table 36- The absolute value of the percent of the difference of actual values with the predict values in Sina bank

Working day	HENON	ROSSLER CHAOS	LORENZ	ROSSLER HYPERCHAOS
1	5.39	0.19	0.01	0.34
2	5.60	0.15	0.03	0.69
3	6.19	0.19	0.02	1.05
4	6.53	0.18	0.03	1.33
5	7.39	0.10	0.31	1.05
6	7.29	0.41	0.17	1.48
7	7.83	0.46	0.20	1.81
8	7.46	1.28	1.00	2.59
9	4.69	4.41	4.08	5.93
10	4.06	5.47	5.17	6.93
11	4.60	5.61	5.25	7.36
12	5.32	5.56	5.16	7.15
13	5.95	5.61	5.22	7.61
14	6.72	5.64	5.16	7.36
15	8.17	5.02	4.57	7.26
16	8.99	5.08	4.57	6.97
17	10.49	4.58	4.02	7.02
18	12.13	3.93	3.42	6.02
19	13.04	4.15	3.50	6.80
20	14.26	3.96	3.39	6.14

Table 37- The absolute value of the percent of the difference of actual values with the predict values in Tejarat bank

Working day	HENON	ROSSLER CHAOS	LORENZ	ROSSLER HYPER CHAOS
1	0.13	0.07	0.01	1.88
2	0.35	0.15	0.21	4.04
3	0.28	0.02	0.04	5.72
4	0.26	0.2	0.07	7.41
5	0.26	0.31	0.17	7.31
6	0.15	0.46	0.39	6.82
7	0.17	0.68	0.49	8.37
8	0.40	1.27	1.20	7.30
9	0.42	1.52	1.36	8.96
10	0.75	2.01	1.86	7.94
11	0.80	2.14	2.08	9.62
12	0.89	2.57	2.36	8.63
13	0.80	2.52	2.47	10.51
14	1.41	3.48	3.32	8.84
15	1.40	3.7	3.55	10.74
16	1.36	3.81	3.77	9.42
17	1.64	4.59	4.35	11.17
18	1.97	5.01	4.99	9.28
19	1.92	5.45	5.29	11.46
20	1.57	5.45	5.29	9.88

Regarding the investigation of chaos time series of the banks, it can be said by considering the fact that the time series with correlation dimension above 1 is chaos (Khaluzade, 1998). Thus, as all investigated time series are above 2 in Table 2, entire time series of the studied banks are chaos. In prediction issue and selection of good model for each time series, it can be said that based on the results of predicted values and the percentage of the difference of the predicted values with actual values for each bank, are separately as shown in Table 38:

Table 38- Selected models for each bank

Source of optimal designed model by attractor	Bank
RoslerHyperChaos	EghtesadNovin
Lorenz Attractor	Saderat
Lorenz Attractor	Sina
Lorenz Attractor	Tejarat
Lorenz Attractor	Parsian
Lorenz Attractor	Karafarin

As shown in Table 38, in five banks of the six studied banks, the designed model is a good model by Lorenz attractor. This model couldn't act better than the designed model by Rosler Hyper Chaos regarding time series of EghtesadNovin bank. Based on the results and Table 5-2, it can be said as EghtesadNovin bank had high DM (correlation dimension) compared to other banks. Thus, we required a model more complex than other banks for forecast and based on the Table, the models order from complexity of model predicting with the highest chaos of time series, it is the model designed based on Rosler Hyper Chaos attractor.

REFERENCES

- Arabi M. (2005).** The comparison of neural network with ARIMA method in stock price forecasting (case study of investment company of petrochemical industry). MA thesis. Supervised by Dr. SeyedEbrahimHosseiniNasab. TarbiatModarres University.
- Fischer D. AND Ronald J. J. (1991).** "security analysis and portfolio management", 5d.ed., prentice-hill.
- Khaluzade H. (1998).** Non-linear mode and prediction of price behavior in TSE. Phd thesis of electricity engineering. Supervised by Dr. Ali Khaki Sadigh. TarbiatModarres University.
- Khaluzade H. and Asadollahzade B. (2010).** Modelling and prediction of tax revenues in the fifth development plan based on specific structure of non-linear neural networks. Economic research journal. Economy school of Tehran University.
- Manafi Sh. (2006).** Presenting the forecasting model in TSE. MA thesis. Supervised by Dr. Hessem Al-Din Zegardi. TarbiatModarres University.
- VonAltrock C. (1997).** Fuzzy Logic and Neuro fuzzy Applications in Business and Finance, New Jersey, prentice Hall.