APPLING GREY FORECASTING METHOD TO FORECAST THE PORTFOLIO'S RATE OF RETURN IN STOCK MARKET OF IRAN

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ABSTRACT

Stock market is one of the most important investment market, which influenced by many factors, therefore it needs a robust and accurate forecasting. In this study ,grey model used as a forecasting method and examined if it is the most reliable forecasting method in comparison of time series method. The information of portfolio's rate of return is gathered from 50 accepted companies in Tehran stock market, which were announced as the best companies last year. Mean Square of the errors (MSE) is computed by different value of α in grey model which could be varied between .1 to .9 ,to examined if α=.5 is the best value that our model could take .Then the predictive ability of the model is compared with different type of time series based forecasting methods Experimental results confirm forecasting accuracy of grey model. Tracking signal is computed for grey model to see whether grey model forecasting is in control or not. At the last portfolio's rate of return is forecasted for next periods.

Keywords: *Grey model, Stock market, Forecasting, time series*

1. INTRODUCTION

In general, people are highly interested in forecasting future tendency of some events, such as investment in stock market, which is necessary to be forecasted for obtaining higher profit and reducing the investment risk. Since the prediction is mainly used to reduce the uncertainty or risk in marketing decisions ,therefore prediction accuracy is crucial.

How to select an appropriate and accurate method to predict the output forecast for enterprises is a problem of highest importance. Consequently, a method with low cost and high accuracy of the prediction has always been the goal of management decision-maker.

In recent years, researchers have developed various quantitative forecasting methods. Even though there are many forecasting methods, there does not exist a method with predictive accuracy in all circumstances.

Unfortunately, the traditional prediction model often needs to meet with large number sample or normal distribution that cannot be used to short term forecasts. In recent years, to overcome these limitations, artificial intelligence was introduced to amend traditional forecasting methods. Artificial intelligence including the artificial neural network (Hsieh,Hsiao & Yeh, 20011; Ebrahimpour, Nikoo, Masoudnia Yousefi &Ghaemi,2010),fuzzy theory(Chen,Cheng &Teoh 2008),Neural-Fuzzy system(Atsalakis &Valvanis,2009), Markov-Fourier Grey model (Hsu,Liu,Yeh &Hung ,2009) are used to solve traditional forecasting problems .

The grey theory applies to the concern of sample of small data, in which systems for the "uncertainty" , "multi-input" , "discrete data" , and" incomplete data" can effectively be addressed. It fit well with today's fast-changing industrial environment. Hence the current study proposed grey model, for assisting investors in predicting the future behavior of stock market and help them to make a rational decisions.

The grey system theory was proposed by Deng (1982). The grey model (GM) is one of the best feature in grey system theory. Generally, the grey model is written as GM(m,n) , where m is the order and n is the number of variable of the modeling equation . GM(1,1) is the most widely used and is successfully demonstrated in many application.

This study choose stock market of Tehran as a database and gathered information of portfolio's rate of return from 50 accepted firms in Tehran stock market, which were announced as the best firms last year. At first different value of α examined for our model to see if α=.5 is the best value that α could take to produce the most accurate model, and after that the model with the least error will be chosen and, at the last the predictive ability of the models are compared with different type of forecasting in time series, which here is Naive method, Simple Average, Moving Average, Single Exponential Smoothing.

The reset of this paper is organized as follows. section 2 describes grey model which is used as a forecasting method in stock market. Section 3 presents the results and compares of the proposed model with α=.5 and the other value of α, and compares of grey model accuracy with time series forecasting method and also results of tracking signals which are computed for grey model, and at the last of this section future return rate is forecasted . section 4 summarized the findings.

2. METHODOLOGY

The procedure of the original GM(*1,1*) model will be briefly illustrated in the following.

Assume that $x^{(0)}$ stands for the raw data series of portfolio's rate of return ,namely,

$$x^{(0)} = \left(x^{(0)}(1), x^{(0)}(2), x^{(0)}(3), \ldots, x^{(0)}(n)\right) \quad (1)$$

Where n is the sample size. By 1-AGO(one time Accumulated Generating Operation) $x^{(0)}$,the preprocessed series, $x^{(1)}$

$$x^{(1)} = \left(x^{(1)}(1), x^{(1)}(2), x^{(1)}(3), \ldots, x^{(1)}(n)\right) \quad (2)$$

Where $x^{(1)}(k) = \sum_{m=1}^{k} x^{(0)}(m), \quad for \quad k = 1,2,\ldots,n$

By mean operation on $x^{(1)}$,the series $Z^{(1)}$

Where $Z^{(1)} = (Z^{(1)}(1), z^{(1)}(2), \ldots, z^{(1)}(n))$ (3)

Thus ,from grey system theory (Deng,1988)the grey differential equation of GM(*1,1*) and its whitening equation are obtained, respectively, as follows:

$$x^{(0)}(k) + aZ^{(1)}(k) = b \quad , \qquad k = 2,3,\ldots,n$$

$$\frac{dx^{(1)}}{dt} + ax^{(1)} = b$$

(4)

Where *a* and *b* is the developing coefficient and grey input, respectively. Let $\hat{\theta}$ be the parameters vector. By using least squares method (Hsia,1979), the parameters a and b can be obtain as

$$\hat{\theta} = \left(X^T X\right)^{-1} X^T Y = \begin{bmatrix} a \\ b \end{bmatrix} \quad (5)$$

Where $X = \begin{bmatrix} -Z^{(1)}(2) & 1 \\ -Z^{(1)}(3) & 1 \\ \vdots & \vdots \\ -Z^{(1)}(n) & 1 \end{bmatrix} \qquad Y = \begin{bmatrix} X^{(0)}(2) \\ X^{(0)}(3) \\ \vdots \\ X^{(0)}(n) \end{bmatrix}$ (6)

And x denotes the accumulated matrix and Y represent the constant vector. The approximate relation can be obtained by substituting the $\hat{\theta}$ into the differential equation, and solving equation (4)

$$\hat{x}^{(1)}(k+1) = \left[X^{(0)}(1) - \frac{b}{a}\right]e^{-ak} + \frac{b}{a} \quad (7)$$

Where$\hat{x}^{(0)}$(1)=$x^{(0)}$(1) . by IAGO (inverse AGO) equation (7) the recovered value $\hat{x}^{(0)}$(k) is:

$$\hat{x}^{(0)}(k) = \hat{x}^{(1)}(k) - \hat{x}^{(1)}(k-1) = \left(1 - e^{a}\right)\left[x^{(0)}(1) - \frac{b}{a}\right]e^{-a(k-1)} \quad (8)$$

Given *k=1,2,3,….n*, the predictive value is

$$\hat{x}^{(0)} = \left(\hat{x}(1), \hat{x}^{(0)}(2), \hat{x}^{(0)}(3), \ldots, \hat{x}^{(0)}(n)\right) \quad (9)$$

Finally, the forecasting data is further examined to see if it meets the residual error checking procedure. Usually, the following equation is utilized (Deng, 1988), where the residual error *e(k)* is between the actual $x^{(0)}(k)$ and the predicted $\hat{x}^{(0)}(k)$.

$$e(k)=\left|\frac{x^{(\circ)}(k)-\hat{x}^{(\circ)}(k)}{x^{(\circ)}(k)}\right|\times 100\% \tag{10}$$

But because in this case, the value of some raw data is zero, we use the square sum of the errors for comparing the errors as below:

$$s=\varepsilon^{T}\varepsilon=\begin{bmatrix}\varepsilon(2)\\ \varepsilon(3)\\ \vdots\\ \varepsilon(n)\end{bmatrix}^{T}\cdot\begin{bmatrix}\varepsilon(2)\\ \varepsilon(3)\\ \vdots\\ \varepsilon(n)\end{bmatrix} \tag{11}$$

3. EMPIRICAL ANALYSIS

In order to show the predictive ability of GM *(1,1)* model, its performance and comparison with other models(time series),we choose the Tehran stock market as a sample.

We use the information of portfolio's rate of return in 50 accepted firms in Tehran stock market. This information is gathered from March 2007 to February 2010 .

Some information of some company was missed. And we could just gather information of 45 company.

3.1.Diffrent value of back ground

At first we compute mean square of errors of grey model by different value of α , which could differ between .1 to .9*(.1<α<.9*). *α* is called generation coefficient (or weight). When *α>.5* the generation is said to have "emphasis more on new and less on old information ". When *α<.5*, the generation is said to have "emphasis more on old and less on new information". And when *α=.5*, the generation we get the best result.(liu & lin,2006) Mean square of errors computed by different value of α which started from .1,the procedure stops whenever errors increase in comparison of last error value which computed with lower value of α. By this way we can be sure that, *α=.5* gives us the best results and the most accurate model. The results are shown in table 1.

Firm	α=.1	α=.2	α=.3	α=.4	α=.5	A=.6
A	9961.2	9954.4	9949.2	9945.7	**9943**	9943.6
B	3120.9	3119.2	3118.3	3117.6	**3117.5**	3118
C	4745.9	4744.2	4742.7	4742	**4740**	4742
D	2695.3	2694.4	2693.7	2693.2	**2690**	2693.2
E	3543.1	3541.9	**3508**	3540	3570	
F	3055	3054	3053.2	3052.8	**3052**	3052.8
G	3395.3	3393.9	3392.5	3391.7	3391.1	**3390.9**
H	5010.9	5008.9	5007.1	5006.3	**5005**	5006.3
I	**3698.2**	3702.1	3706.5		3716	
J	25893	25879	25871	25867	**25867**	25872
K	3448.8	2447.7	3446.9	3446.5	**3440**	3446.4
L	6326.5	**6307.6**	6312.3		6324.8	
M	3565.6	3564.3	**3563.9**	3564.2	3565.6	
N	544.10	543.00	542.30	541.78	**541.51**	541.52
O	4719.2	4716.9	4715.2	4714.2	**4713.8**	47140
P	4671	4666.9	4663.8	4661.6	**4660**	4660
Q	**1190.2**	1192.4			1200	
R	4335.9	4334.2	4332.7	4332	**4260**	4331.9
S	7308.8	7304.3	7300.7	7298.8	**7298**	7299.1
T	5250.5	5248	5246.3	**5245.2**	5279.5	
U	9262.7	9258.2	9255	9253.2	**9250**	9253.8
V	3874.7	3873	3871.8	3870.7	**3870**	3870.8
W	1060.4	1060.3	1060.2	1060.3	**1059**	1061
X	1857.3	1250.9	1249.5	1248.8	**1248.6**	1249
Y	2562.1	2561	2560.3	2565.8	**2559.9**	2559.8
Z	2690.4	2689.3	2688.6	2688.4	**2688.1**	2688.2
AA					3410	
BB	3690.3	3689.1	3688.4	3687.9	**3680**	3688.7
CC	3211.5	3226.2	3210	3209.6	**3200**	3209.6

DD	9018.8	9011.5	9006.4	9003.6	**9002**	9003.6
EE	924.25	923.1271	922.3832	921.8877	**921.725**	921.8671
FF	2067.5	2066.7	2066.1	2065.8	**2065**	2065.9
GG	**1255.5**	1255.6			1257.2	
HH	2079.6	2078.6	2077.8	2077.4	**2077**	2077.6
II	2895.7	2894.5	2893.9	2893.3	**2893.2**	2893.4
JJ	2843.1	2841.7	2840.9	2840.4	**2840**	2840.5
KK	5696	5665.8	5636.1	**5629.6**	5720	
LL	3000.8	2998.8	2997	**2995.8**	3008	
MM	1107.7	1107.3	1106.9	1106.7	**1106.6**	1106.6
NN	4454.1	4452.2	4450.6	4449.6	**4449.2**	4449.4
OO	3240	3239.2	3238.6	**3238.3**	3328.3	
PP	5179.9	5179	5179	5179	**5079.7**	5177.3
QQ	1613.8	1613.2	1612.7	1612.5	**1612.4**	1612.5
RR	5001.5	5000.3	4999.4	4998.9	**4990**	4998.9
SS	8473.5	8466.9	8462.2	8459	**8450**	8458

Table1

As it shown in bold, there are just few companies (5 firms from 45) whose errors with the other value of α are less than what we have computed with the value of $\alpha=.5$. so the results confirm that when it is difficult to measure the reliability of new and old information due to a shortage of needed background information , the method of generation of equal weight or generation of "no preference " gives us better result.

3.2. Comparison of GM (1,1) with the other models

To examine whether the proposed model has made improvement in forecasting accuracy, the mean square of the errors defined in Eq (11) ,is employed as a evaluation criterion for the forecasting performance of grey model and comparison with the other models, which are time series model here.(Naive, Simple Average , Moving Average ,Single Exponential Smoothing). As we mentioned before we could not use the residual error *e(k)*as a evaluation criterion, because the portfolio's rate of return in some company in some months was zero. The results are shown in table 2 .

Table 2

Firm	Naive	Simple Average	Moving Average	Single Exponential Smoothing	GM(1,1)
A	379.9111	260.1798	279.68	259.123	**225.9773**
B	1496.16	796.2273	927.6875	858.7611	**70.85227**
C	177.0773	116.8865	974.0655	113.1108	**107.7273**
D	155.9702	67.10227	92.27514	82.24468	**61.13636**
E	167.0032	98.09498	119.206	236.467	80.45455
F	126.3532	71.25659	71.78109	76.85709	**69.36364**
G	127.0703	87.24909	100.6853	95.67861	**77.06591**
H	240.5305	128.5725	163.7755	139.5756	**113.75**
I	181.5904	77.125	**43.64255**	94.33664	**84.05**
J	1083.049	645.2045	846.4955	674.9161	**587.8864**
K	185.4861	88.06659	107.3971	94.11236	**78.18182**
L	341.4793	130.002	**110.378**	183.4363	**143.7455**
M	160.6766	87.88955	108.5902	92.46275	**80.99773**
N	68.18387	36.12533	42.84597	51.29547	**36.10067**
O	236.2933	125.2488	151.2079	127.697	**107.561**
P	190.5133	121.1048	126.2431	124.2766	**105.9091**
Q	125.0894	46.22818	39.00205	526.3186	**27.05**
R	157.2619	111.999	132.124	111.3686	**103.9024**
S	281.4505	192.0283	234.3811	180.3747	**165.8636**
T	196.0786	138.8283	183.5117	153.0255	128.7683
U	288.7777	226.3609	256.8027	230.6707	**210.2273**
V	177.6989	96.365	115.977	93.11395	**87.95455**
W	48.40377	28.25818	33.75352	25.87718	**24.06818**
X	104.1044	95.64481	59.79034	84.35656	**78.0375**
Y	290.3561	134.255	71.5123	1844.016	58.17955
Z	84.29095	569.1768	59.32485	**55.54941**	**65.56341**

AA	1441.206	838.9327	1113.668	857.3757	**775.9773**
BB	120.8151	97.0825	95.80602	92.06709	**83.63636**
CC	123.5421	80.20386	98.73995	99.12602	**72.72727**
DD	427.2098	218.9625	293.1125	212.4843	**204.5909**
EE	104.084	51.30318	50.74782	67.464	**41.89659**
FF	103.4005	59.89045	65.30234	53.03127	**46.93182**
GG	66.30182	34.34523	39.47159	32.32095	**28.53409**
HH	78.47632	54.84182	59.11041	58.57345	**47.20455**
II	143.9774	72.02909	94.03995	79.05884	**65.75455**
JJ	106.0909	95.53235	116.8493	97.12471	**83.52941**
KK	2593.718	1420.526	1863.201	1438.723	**127.9455**
LL	101.9635	76.45614	85.44248	82.63164	**68.08636**
MM	55.34564	28.7325	34.50777	30.70661	**25**
NN	153.3529	112.7168	125.5467	117.1564	**101.1182**
OO	127.5058	79.81295	82.96307	93.01141	**73.59773**
PP	175.0922	137.6459	162.3418	174.0962	**115.4477**
QQ	83.63027	40.64091	54.22693	47.16705	**36.64545**
RR	213.4828	126.2975	131.98	124.7506	**113.4091**
SS	387.725	216.9759	263.9334	228.1511	**192.2182**

As it is shown in table 2,the mean square of errors in grey model is less than the other models, except in two cases(I,L) which the errors of Moving Average method are less than the others and one case(z) which the error of Single Exponential Smoothing is less than the others. So the results confirm the predictive ability of grey model forecasting.

3.3. Tracking Signal

Tracking signal indicates if the forecast is consistently biased high or low. It is computed by dividing the Running Sum of Forecast Errors(RSFE) by the cumulative mean absolute deviation ,or MAD:

$$TS = \frac{RSFE}{MAD}$$

The tracking signal is recomputed each period , with updated , running value of cumulative error and MAD. The movement of the tracking signal is compared to control limits ,as long as the tracking signal is within these limits, the forecast is in control. Control limits are between $\pm$4MAD or $\pm 3\sqrt{MSE}$.

It computed for grey model to see if this model forecasting is in control or not. The result are shown in tables 3,4 and 5.

As it is seen, the forecast is completely in control and the plots of tracking signals visually display this.

Table 3

Firm	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
A	-3	1.8	1.3	0.7	0.1	-0.5	-1.3	-2.1	-3.0	-3.8	-4.7	-5.69	-6.6	-7.5
B	-0.6	-1.7	1.8	2.3	1.7	1.6	0.6	-0.4	-1.2	-2.4	-2.5	-2.8	-3.8	-5.1
C	-3	-4	1.05	2.8	1.09	1.0	0.1	0.7	-0.34	-1.19	-0.2	-1.7	-0.4	1.1
D	-2.5	1.8	2.4	1.6	1.5	0.41	1.1	-2.2	-3.9	-5.0	-5.4	-7.3	-8.9	-3.0
E	-8.0	0.79	1.02	4.4	1.8	1.2	0.87	0.28	-0.8	-2.3	-3.5	-3.1	-2.5	-1.3
F	3	3.01	3.2	3.2	2.7	2.4	2.9	2.14	1.4	0.19	-0.7	-0.3	-1.3	-1.16
G	-3	-4	-5	-6	-7	-8	-9	-10	-11	-8.1	-9.2	-6.0	-4.0	-5.07
H	-3	-0.1	1.2	1.3	-0.29	-1.5	-2.4	-3.2	0.65	-0.3	1.96	1.03	1.13	3.0
I	2.08	2.99	2.70	3.05	2.99	2.85	2.25	1.64	0.99	0.26	-0.4	-1.2	-1.7	-1.93
J	-3	-4	-5	-6	-7	-8	-9	-10	-11	-12	-13	-0.9	-0.74	-1.03
K	-3	-	-4.2	0.4	-0.2	-0.5	0.07	-1.4	-0.6	-2.2	-3.1	-1.3	-1.34	-1.5

		3.21												
L	1.7	2.8	2.8	2.5	2.0	1.6	1.8	2.8	2.5	2.08	1.3	0.78	0.3	-0.5
M	3	4	3.2	2.8	4.1	3.9	3.8	3.0	3.4	3.3	2.8	3.0	1.4	3.7
N														
O				-3	-4	-5	-6	-5.3	-6.3	-7.3	0.6	0.1	-0.4	-1.1
P	-0.9	3.4	3.1	2.3	1.4	3.1	4.3	4.9	5.1	4.8	3.8	2.9	2.1	1.7
Q	-3	-2.9	-0.3	1.6	0.002	2.8	1.5	2.7	2.7	1.3	1.3	-0.1	2.1	2.6
R	-3	-4	-5	-6	-5.6	-5.5	-5.8	-6.8	-8.0	-8.5	-9.75	-10	-7.0	0.1
S	-3	2.1	3.3	2.8	2.6	2.0	2.3	3.3	2.5	1.6	0.7	-0.08	-0.9	0.7
T	-3	-0.4	-0.5	0.2	1.1	0.3	0.6	1.9	1.4	-0.18	-0.9	-1.3	-0.05	1.1
U	-3	-2.5	-3.7	-4.8	-5.9	-6.9	-8	-6.1	-7.2	-8.3	-9.3	-10.2	-11.2	-3.5
V	-3	-4	-5	-6	-7	-8	-9	-5.0	-6.1	-7.3	-8.4	-9.0	-10	-1.5
W	-3	1.5	2.11	1.58	2.03	2.52	3.17	4.76	6.0	4.96	3.8	4.5	3.25	2.22
X														
Y	1.4	2.41	1.61	1.48	1.59	2.12	1.88	1.06	0.04	0.69	-0.28	-1.3	-0.84	0.29
Z	-0.8	-0.2	0.44	-1.5	-2.51	-4.15	-5.44	-6.67	-7.75	-8.91	-10.1	-3.82	-2.75	-1.21
AA	-3	-4	-5	-6	-7	-8	-9	-10	-3.7	-4.31	-5.02	-5.6	-5.87	-6.99
BB	3	2.45	1.86	1.44	0.72	-0.01	1.0	0.58	-0.28	-0.79	-1.7	-0.55	-1.09	-1.4
CC	-0.9	-0.5	-0.74	1.44	1.16	-0.75	-2.22	-3.46	-4.23	-4.81	-5.44	-6.69	-6.72	-1.48
DD	-1.3	-2.7	-3.93	-4.48	-3.22	-4.32	-4.42	-5.54	-6.84	-7.81	-7.86	-9.08	2.13	2.94
EE														
FF	0.71	0.52	0.19	0.54	0.36	-0.5	-1.21	-0.38	-0.19	1.35	1.63	1.83	1.52	1.54
GG	0.04	-0.07	-0.05	-0.86	-2.94	-4.3	0.42	-1.0	-1.4	-2.72	-4.2	1.18	-0.04	1.5
HH	-3	-4	-5	-6	-4.2	-5.0	-6.0	1.97	2.97	2.45	2.0	2.28	2.54	2.34
II	-2.3	-3.6	-1.87	-2.91	-4.24	-5.6	-2.4	-2.6	-3.4	-4.6	-5.9	-6.6	0.25	-1.2
JJ											-3	-4	-1.68	-0.26
KK	-3	-0.7	4.22	5.27	6.18	7.19	7.48	8.33	8.61	9.42	10.0	10.5	11.1	11.9
LL	-3	-4	-5	-6	-5.11	-5.94	-6.79	-7.9	-8.0	-3.4	-3.99	-0.28	-1.73	-2.77
MM	-3	-4	0.78	-0.52	1.85	2.2	1.66	1.87	1.01	0.4	-0.27	-0.62	4.3	3.66
NN	-3	-4	-5	-6	-4.53	-5.22	-1.91	2.62	2.4	1.83	1.6	1.4	1.81	0.85
OO	-0.5	0.54	1.59	2.8	1.37	0.89	0.37	-0.22	-1.32	-2.35	-3.7	-4.74	-5.45	-6.13
PP	-0.2	2.23	3.11	2.45	2.73	0.86	-0.33	-1.42	-2.3	-3.58	-5.08	-5.98	-2.89	-1.26
QQ	-3	1.47	-0.36	-1.93	-1.84	-3.04	-4.33	-1.34	-1.83	-2.12	-0.19	-1.4	0.005	-0.63
RR	0.16	2.44	1.99	1.85	2.98	1.56	0.26	1.47	1.11	0.08	-0.57	-1.66	0.37	0.57
SS	0.1	-1.22	-2.39	-3.5	-4.58	-5.64	1.12	1.34	1.14	0.37	3.17	2.56	2.3	2.08

Table 4

Firm	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
A	-8.4	-9.4	-4.0	-2.8	-3.6	-2.9	-3.2	-3.0	-2.5	-2.3	0.4	3.0	2.3	2.8	2.6
B	-3.4	-3.1	-2.7	-3.8	-3.5	-3.7	-4.5	-3.5	-3.6	-4.6	3.8	4.0	3.4	3.3	2.9
C	0.56	-0.5	-2.1	-1.9	1.03	2.1	0.67	-0.12	-1.3	-2.7	-2.13	-3.1	-0.9	-1.6	-3.01
D	-2.5	-3.4	-4.2	0.36	-0.22	-1.6	-2.02	-3.6	-0.16	1.4	-0.4	2.6	1.3	1.8	0.22
E	0.9	1.1	2.2	1.4	1.2	0.7	1.9	0.4	-0.2	0.02	-0.5	-1.8	-2.6	-4.0	0.4
F	-0.02	-0.8	-2.0	-2.4	-3.4	-4.3	-4.6	-5.0	-2.3	-3.3	-2.6	-3.5	-3.3	-4.3	-2.5
G	-6.07	-4.8	-2.5	-1.9	-2.9	-3.7	-3.0	-0.4	-1.3	-1.7	-1.0	1.05	1.06	1.41	4.15
H	4.06	3.84	3.05	1.9	1.6	0.8	0.1	-0.4	-0.7	-1.6	-2.2	-1.9	-2.7	-2.4	0.7
I	-2.3	-1.4	-2.1	-2.6	-1.8	-2.2	-2.8	-3.4	-4.2	-4.4	-4.9	-5.62	-6.2	-3.2	-3.0
J	-1.57	-2.0	1.7	2.98	2.5	2.5	3.7	5.0	6	5.2	4.4	4.3	4.9	4.3	4.7
K	-1.5	-1.5	-2.41	3.31	3.14	3.47	2.96	3.13	3.83	4.32	3.35	2.06	2.16	2.81	1.45
L	-1.1	-1.8	-2.5	-2.89	-3.65	-4.45	-5.25	-4.28	-4.08	-4.8	-5.11	-3.6	-1.43	-1.46	-0.29
M	2.4	1.24	0.09	-1.01	-2.08	-3.11	-4.13	-5.12	-6.1	-7.05	-8	-0.08	0.2	-0.39	-0.9
N													3	0.98	0.19
O	-0.6	-0.8	-1.68	-2.7	-2.6	-2.1	0.14	-0.6	-0.8	-1.1	-1.7	-1.8	0.17	-0.7	-1.0
P	3.7	2.6	1.4	1.5	0.4	-0.8	-1.5	-2.2	-3.2	-3.7	-5.2	-6.6	-8.05	-9.1	-10.4
Q	2.2	2.4	3.8	2.4	3.09	3.2	3.5	3.3	5	6.5	6.2	4.4	6.9	6.2	4.8
R	1.15	1.8	0.7	0.99	-0.17	-1.3	0.19	0.26	3.04	3.1	3.2	3.2	5.3	5.01	7.1
S	0.52	1.8	0.9	0.2	-0.5	-1.5	-2.4	-3.4	-4.3	-5.2	-6.2	-3.5	-1.5	-2.1	-1.09
T	4.04	3.9	3.9	4.98	3.5	2.03	0.8	1.5	2.1	1.2	0.2	-1.1	-2.01	4.9	6.8
U	-3.5	-3.3	-4.03	-4.3	-3.3	1.9	4.7	5.2	5.9	5.5	5.1	6.2	6.3	6.6	6.3
V	-2.7	-1.2	0.19	2.5	3.2	2.1	1.7	0.9	-0.05	-0.4	-1.5	1.3	2.2	4.4	3.5
W	1.81	0.96	1.36	0.08	-0.9	-1.2	-2.54	-2.7	0.24	-0.5	-1.7	-3.3	-2.2	-1.2	-2.0
X												2.06	2.96	1.66	1.24
Y	-0.3	-1.4	-2.2	-0.8	-0.5	-0.04	-0.31	-1.15	-0.95	-1.1	0.6	1.33	0.71	0.01	0.7
Z	-0.8	1.39	2.5	3.79	2.35	3.02	3.7	3.09	3.12	4.16	3.09	2.6	0.85	-0.03	-0.47
AA	-5.5	-6.27	-7.43	-8.58	-9.73	-10.7	-11.5	-12.2	1.61	2.86	2.34	1.42	0.43	2.5	1.77
BB	-1.7	-2.4	-3.2	-2.8	-2.4	-2.62	-3.48	-4.17	-3.23	-1.4	1.43	2.98	3.32	2.7	2.17
CC	1.67	2.31	1.53	0.86	1.89	0.59	-0.49	-0.5	0.60	-0.68	-1.06	-0.67	-0.54	-0.04	2.93
DD	2.67	2.2	2.35	1.86	1.62	1.52	0.63	0.3	3.27	2.39	2.16	1.96	0.92	0.03	1.84
EE									-2.1	-3.2	-4.3	-0.7	0.29	-1.0	0.13
FF	-2.2	-2.9	-2.7	0.85	1.68	1.64	0.97	0.36	0.69	0.49	-0.47	-0.9	-1.5	-0.6	-0.16
GG	1.05	0.84	-0.14	0.63	-0.1	-1.64	-1.95	-2.99	0.23	2.45	3.32	2.37	3.29	2.05	2.27
HH	1.77	1.46	1.52	0.72	1.75	1.93	2.36	2.15	1.55	0.88	0.92	0.6	0.35	-	-0.7

														0.08	
II	1.11	0.13	-1.0	1.13	1.43	0.55	-0.25	-1.25	-1.05	-1.8	1.74	4.1	3.34	2.34	4.14
JJ	-0.8	-2.4	-3.9	-4.6	-5.7	-2.82	-0.6	-1.13	-2.41	-0.02	2.55	3.43	4.41	3.57	2.45
KK	13.0	12.5	13.4	13.6	14.3	14.0	13.9	14.6	12.7	10.8	11.4	9.35	9.02	6.83	7.24
LL	-3.2	-4.2	0.13	1.51	-0.1	-1.48	-3.04	-3.96	-5.09	-6.4	-7.9	-9.2	-2.2	-1.4	3.61
MM	2.3	2.64	2.18	0.97	0.69	-0.46	-1.14	-1.56	-3.08	-3.3	-2.3	-3.9	-4.9	-2.9	-1.4
NN	-0.2	-0.9	-1.7	-2.3	-2.9	-3.77	-3.83	-2.68	-3.31	-2.2	1.33	1.8	0.65	1.66	1.93
OO	-5.37	-6.35	-6.07	-7.04	-2.81	-2.29	-3.59	-2.84	1.81	2.29	3.68	3.72	5.01	6.74	6.06
PP	-1.12	-0.03	-1.5	0.69	1.5	0.43	-0.64	-1.12	-2.22	-3.09	0.19	1.27	2.33	2.27	1.51
QQ	-1.9	1.89	3.08	3.07	2.11	1.07	1.33	1.02	1.56	1.05	-0.41	1.28	1.57	2.49	1.17
RR	-0.07	1.15	-0.13	-1.38	-2.03	-3.32	-3.97	-5.22	-5.8	-6.25	-3.85	-3.07	-1.68	-2.84	-1.41
SS	1.39	1.32	1.03	0.34	-0.65	-1.55	-2.55	-3.25	-3.69	-2.34	-2.13	-2.94	-3.85	-4.15	-0.54

Table5

Firm	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**
A	3.1	3.9	3.9	4.3	4.0	3.1	3.0	2.9	2.0	1.6	0.9	0.85	0.5	-0.4
B	5.6	5.9	5.3	5.2	4.4	4.5	4.0	3.7	2.9	1.9	2.6	1.9	1.0	0.3
C	-3.5	-2.6	-2.2	-3.6	-2.8	1.7	2.3	4.91	5.1	3.90	2.8	1.5	0.9	-0.07
D	4.55	3.5	2.16	1.07	1.25	0.20	-1.02	-1.92	1.9	0.69	0.05	0.07	0.26	-0.2
E	2.11	0.97	0.81	0.15	-0.7	-1.8	2.47	1.63	1.83	2.15	2.1	1.3	0.3	0.3
F	-1.31	-0.71	-0.6	1.4	1.46	1.51	0.76	0.82	-0.22	1.88	1.53	1.19	0.29	0.04
G	4.3	3.5	3.09	2.	1.73	1.51	2.4	1.48	0.75	-0.01	-1.1	-0.7	-0.09	-1.5
H	1.2	0.5	0.27	0.30	0.61	-0.49	-1.04	-1.7	-2.2	1.27	0.29	1.09	0.07	0.4
I	-1.6	-0.8	-1.3	-0.6	0.5	0.12	0.01	1.3	2.8	4.0	3.9	3.6	3.3	3.3
J	3.92	4.04	3.58	3.6	3.81	4.1	3.87	3.73	3.06	2.6	2.01	1.65	1	0.22
K	0.97	0.5	0.48	1.05	1.5	0.73	0.23	0.02	-0.1	1.23	2.4	2.57	1.02	0.61
L	-0.29	-0.51	-0.87	-0.7	-1.3	-1.3	-1.84	-2.16	1.11	0.67	1.04	2.67	2.27	2.98
M	-1.5	-1.29	-1.8	-2.2	-2.4	-2.8	-3.36	-3.88	-1.14	-1.16	-0.48	-1.07	-1.2	2.07
N	0.97	-0.28	-0.36	-1.31	-2.02	-1.2	0.31	-0.08	-0.73	-1.89	2.07	1.99	1.56	0.87
O	2.49	2.14	1.02	1.12	2.7	2.4	3.9	4.4	4.16	3.29	2.4	2.38	1.26	-0.1
P	-4.53	-5.2	-3.1	-2.5	-3.3	1.6	3.5	3.02	3.48	3.11	2.7	1.98	0.91	-0.11
Q	6.7	5.4	5.07	4.9	6.17	6.7	7.01	6.9	7.7	8.5	10.1	10.5	8.59	8.98
R	8.27	7.3	7.6	6.8	6.7	5.6	4.2	4.15	5.15	4.12	3.45	3.12	1.91	1.71
S	-0.92	-0.08	-0.53	-0.6	-0.97	1.13	0.53	0.54	0.7	0.92	0.98	1	0.78	0.14
T	6.02	5.49	4.57	3.47	2.68	1.95	1.29	0.61	2.05	2.33	2.28	1.96	1.08	-0.02
U	5.58	4.9	4.76	3.9	3.78	3.68	2.8	1.8	2.05	1.46	1.61	0.56	-0.48	0.12
V	3.5	3.2	1.9	1.8	1.4	0.3	-0.8	-1.1	0.25	-0.2	2.4	1.3	1.8	0.37
W	-2.06	-3.2	-3.62	-4.6	-2.3	-3.8	-3.0	-3.6	-0.68	1.24	1.17	1.09	0.29	-0.58

X	0.54	-0.86	-2.03	-2.9	-3.3	-1.86	-0.28	0.02	2.59	2.89	2.84	1.93	1.46	0.841
Y	-0.10	0.6	-0.49	-0.90	-0.99	-1.57	-2.05	-0.52	0.31	1.0	0.19	1.29	1.07	1.08
Z	1.74	1.42	1.46	4.63	4.16	2.11	0.75	-1.26	-0.57	-1.3	-1.26	2.11	3.74	1.6
AA	2.2	1.194	0.12	0.08	-0.01	-0.07	-0.21	-0.99	-2.05	-0.47	-1.0	-0.66	-1.53	-2.37
BB	2.15	2.89	2.29	1.79	1.74	1.64	1.13	1.32	1.28	2.6	1.87	1.71	1.2	0.91
CC	2.4	2.97	2.72	3.01	2.6	2.2	1.03	2.26	1.37	0.82	2.57	1.15	1.42	0.14
DD	1.2	0.25	-0.69	-1.6	2.89	2.85	2.28	1.81	1.35	1.07	2.06	1.93	0.89	0.15
EE	0.94	0.5	-0.12	-0.7	-0.52	-0.07	0.95	-0.23	3.89	2.47	1.31	1.88	0.96	0.15
FF	0.7	0.52	0.19	0.54	0.36	-0.5	-1.21	-0.38	-0.19	1.3	1.63	1.83	1.52	1.54
GG	0.94	2.21	0.58	1.02	0.94	-0.51	1.82	1.11	1.33	3.16	4.4	5.5	4.86	2.52
HH	-0.81	-0.37	1.23	3.53	4.75	5.19	5.51	4.69	4.09	3.22	2.57	2.66	1.73	0.82
II	3.44	2.88	2.03	1.8	1.15	0.71	0.33	-0.36	-0.82	1.1	1.4	0.99	0.67	0.13
JJ	2.52	1.75	1.26	0.53	0.25	1.7	1.84	2.54	1.78	1.71	1.92	1.33	0.46	0.32
KK	9.39	11.28	9.1	7.79	8.78	6.77	3.94	4.18	5.31	22.1	20.45	18.34	16.81	14.94
LL	4.73	3.24	1.76	0.21	-1.27	-2.22	-3.09	-4.09	-4.26	-5.5	-6.22	-5.2	-3.02	-3.97
MM	-1.0	-1.7	-0.48	-1.64	-2.9	-0.62	0.93	0.79	1.17	-0.43	2.14	2.07	0.4	-0.27
NN	2.21	1.32	0.32	2.96	2.99	1.78	1.2	0.5	0.001	0.66	0.48	0.2	-0.31	-0.22
OO	5.1	4.42	3.93	3.31	2.68	2.38	2.08	1.03	0.35	0.20	0.35	0.87	0.45	0.24
PP	1.07	1.22	1.36	0.36	0.63	2.43	2.83	2.08	2.44	3.33	2.93	2.58	1.55	0.41
QQ	1.15	0.04	-0.79	-1.34	-2.62	-1.0	2.27	1.74	0.71	-0.26	2.61	1.44	1.29	0.29
RR	0.38	2.54	3.0	2.96	2.99	2.71	2.59	3.97	3.61	2.66	1.76	1.79	0.99	0.2
SS	0.48	0.07	2.7	2.91	1.83	0.85	0.1	-0.69	-1.2	0.38	-0.73	-1.53	-0.94	-0.57

3.4. T-test exam

The two sample t-test simply tests whether or not two independent populations have different mean values on some measure. Here the mean square of errors in grey model as a measure of comparison are compared with mean square of errors in time series forecasting models. As it is seen in tables 7 and 8 the null hypothesis has been accepted("p-value" is bigger than .05), which can be concluded, grey model has the same mean square of errors with moving average and simple average forecasting models. But in comparison of grey model with naive and single exponential smoothing forecasting models(table6 and9), the null hypothesis rejected, which mean they have a different mean square of errors. As it seen in table 7 and 11 for both models, lower and upper interval difference have the negative value which can be concluded that mean square of errors in grey model are less than mean square of errors in naive and single exponential smoothing model. So with more emphasis ,we can accept that grey model has the better ability in forecasting in comparison of naive and single exponential smoothing models.

Table 6

GM(1,1) VS naive	t-test for equality of means		
	Sig.(2-tailed)	95% Confidence Interval of the Difference	
		Lower	Upper
Equal variance assumed	.012	-186.5145	-42.3959
Equal variance not assumed	.013	-186.5145	-40.9358

Table 7

GM(1,1) VS simple average	t-test for equality of means		
	Sig.(2-tailed)	95% Confidence Interval of the Difference	
		Lower	Upper
Equal variance assumed	.118	-157.4106	18.1313
Equal variance not assumed	.12	-157.8403	18.5610

Table 8

GM(1,1) VS moving average	t-test for equality of means		
	Sig.(2-tailed)	95% Confidence Interval of the Difference	
		Lower	Upper
Equal variance assumed	.059	-221.9907	4.3240
Equal variance not assumed	.061	-222.8945	5.2278

Table 9

GM(1,1) VS Single Exponential Smoothing	t-test for equality of means		
	Sig.(2-tailed)	95% Confidence Interval of the Difference	
		Lower	Upper
Equal variance assumed	.044	-232.7626	-3.21150
Equal variance not assumed	.046	-233.6962	-2.2778

3.5. Forecast next year's portfolio's rate of return

After the predictive ability of grey model ,in comparison of time series based forecasting methods, was proved ,we forecast portfolio's rate of return for 12 months later.(march 2010 to march 2011).The result is shown in table 10.

Firm	2010									2011		
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
A	12.37	12.46	12.56	12.65	12.74	12.84	12.93	13.03	13.13	13.22	13.30	13.42
B	16.37	16.23	16.098	15.960	15.82	15.68	15.55	15.42	15.28	15.15	15.02	14.89
C	11.43	11.44	11.46	11.48	11.50	11.52	11.54	11.56	11.58	11.60	11.62	11.64
D	8.78	8.80	8.82	8.85	8.87	8.89	8.91	8.93	8.96	8.98	9.00	9.02
E	8.09	8.04	8.00	7.95	7.91	7.86	7.82	7.77	7.73	7.68	7.64	7.60
F	9.31	9.30	9.28	9.27	9.25	9.24	9.23	9.21	9.20	9.19	9.17	9.16
G	11.29	11.44	11.60	11.75	11.91	12.06	12.22	12.39	12.55	12.72	12.89	13.06
H	8.45	8.38	8.31	8.24	8.17	8.10	8.03	7.97	7.90	7.83	7.77	7.70
I	2.17	2.09	2.01	1.93	1.86	1.79	1.72	1.65	1.59	1.53	1.47	1.41
J	12.56	12.44	12.33	12.21	12.10	11.98	11.87	11.76	11.65	11.54	11.43	11.33
K	8.59	8.52	8.45	8.38	8.31	8.24	8.17	8.10	8.03	7.96	7.89	7.83
L	3.42	3.31	3.19	3.09	2.98	2.88	2.78	2.69	2.60	2.51	2.42	2.34
M	3.04	2.96	2.89	2.81	2.74	2.67	2.61	2.54	2.48	2.41	2.35	2.29
N	5.13	4.99	4.85	4.72	4.59	4.47	4.35	4.23	4.12	4.01	3.90	3.79
O	9.01	9.04	9.06	9.09	9.12	9.14	9.17	9.20	9.22	9.25	9.28	9.30
P	12.54	12.79	13.04	13.30	13.56	13.83	14.10	14.38	14.67	14.96	15.25	15.56
Q	7.63	7.69	7.75	7.81	7.87	7.92	7.98	8.04	8.10	8.17	8.23	8.29
R	10.84	10.94	11.04	11.15	11.26	11.36	11.47	11.58	11.69	11.80	11.92	12.03
S	9.92	9.89	9.86	9.83	9.80	9.77	9.73	9.70	9.67	9.64	9.61	9.58
T	9.20	9.19	9.19	9.18	9.17	9.16	9.15	9.15	9.14	9.13	9.12	9.11
U	9.61	9.59	9.58	9.56	9.54	9.52	9.51	9.49	9.47	9.46	9.44	9.42
V	11.03	11.18	11.33	11.48	11.64	11.80	11.96	12.12	12.28	12.45	12.62	12.79
W	8.44	8.54	8.65	8.76	8.87	8.98	9.10	9.21	9.33	9.45	9.57	9.69
X	6.22	6.02	5.84	5.65	5.48	5.31	5.14	4.98	4.82	4.67	4.53	4.39
Y	6.51	6.42	6.34	6.26	6.18	6.10	6.02	5.95	5.87	5.80	5.72	5.65
Z	13.53	13.82	14.12	14.42	14.72	15.04	15.36	15.69	16.02	16.36	16.71	34.51
AA	22.46	22.89	23.32	23.76	24.21	24.67	25.13	25.61	26.09	26.58	27.08	27.60

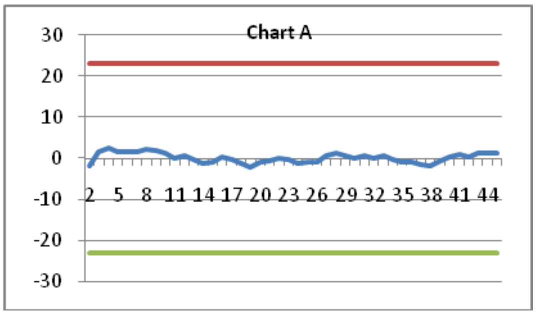
BB	5.23	5.14	5.05	4.95	4.87	4.78	4.69	4.61	4.52	4.44	4.36	4.28
CC	9.40	9.38	9.36	9.35	9.33	9.31	9.29	9.28	9.26	9.24	9.22	9.21
DD	8.79	8.77	8.75	8.72	8.70	8.68	8.66	8.63	8.61	8.59	8.57	8.54
EE	6.69	6.67	6.64	6.62	6.59	6.56	6.54	6.51	6.48	6.46	6.43	6.41
FF	3.97	3.90	3.82	3.75	3.67	3.60	3.53	3.47	3.40	3.33	3.27	3.21
GG	9.68	9.91	10.14	10.37	10.61	10.85	11.10	11.36	11.62	11.89	12.17	12.45
HH	3.37	3.31	3.26	3.20	3.15	3.09	3.04	2.99	2.94	2.89	2.84	2.79
II	7.32	7.30	7.27	7.25	7.23	7.21	7.19	7.17	7.14	7.12	7.10	7.08
JJ	9.24	9.18	9.11	9.05	8.99	8.93	8.87	8.81	8.76	8.70	8.64	8.58
KK	27.72	29.39	31.15	33.01	34.99	37.09	39.31	41.67	44.17	46.81	49.62	52.59
LL	11.67	11.92	12.18	12.45	12.72	13.00	13.28	13.58	13.87	14.17	14.48	14.80
MM	6.76	6.84	6.92	7.00	7.08	7.16	7.25	7.33	7.42	7.51	7.60	7.69
NN	10.15	10.21	10.27	10.32	10.38	10.44	10.49	10.55	10.61	10.67	10.73	10.79
OO	8.76	8.71	8.67	8.62	8.58	8.53	8.49	8.44	8.40	8.35	8.31	8.26
PP	11.55	11.48	11.41	11.34	11.28	11.21	11.14	11.08	11.01	10.95	10.88	10.82
QQ	5.75	5.72	5.69	5.65	5.62	5.59	5.55	5.52	5.49	5.46	5.42	5.39
RR	11.33	11.28	11.23	11.19	11.14	11.09	11.05	11.00	10.95	10.91	10.86	10.82
SS	13.43	13.59	13.75	13.92	14.08	14.25	14.42	14.59	14.76	14.94	15.11	15.29

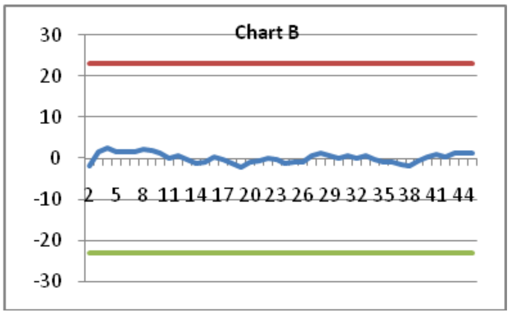
Table 10

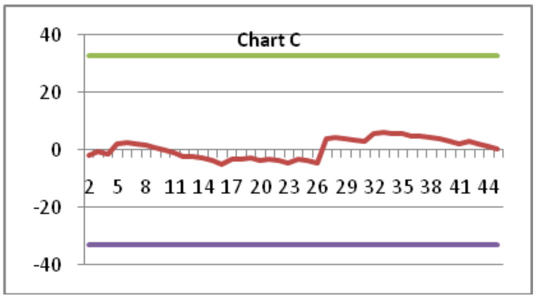
4. CONCLUSIONS

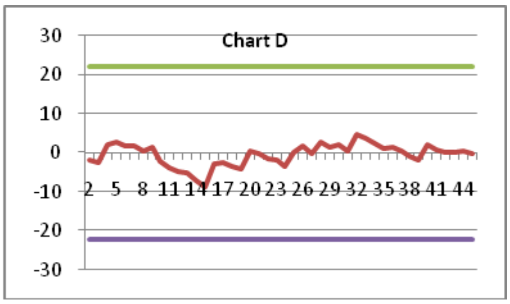
We proposed grey model as an accurate forecasting method for predicting stock market. We choose stock market of Tehran as a data base and gathered information of portfolio's rate of return of 50 companies in stock market which was announced as the best companies last year. At first we computed squares sum of errors with different value of α, which could differ from .1 to .9, to insure that grey model with α=.5 is the most appropriate model in forecasting. The results showed just 5 companies from 45 have the less value of errors with α=.5, in comparison of model with the other value of α. Then we computed mean squares sum of errors with different type of time series based forecasting methods, which is here, Naïve method, Simple Average method , Moving Average method, single Exponential Smoothing method. The comparison of grey model's errors and the errors of timed series forecasting method confirmed the predictive ability of grey model. by tacking signals we confirmed that grey model forecasting was in control. At the last, portfolio's rate of return computed for next 12 periods.

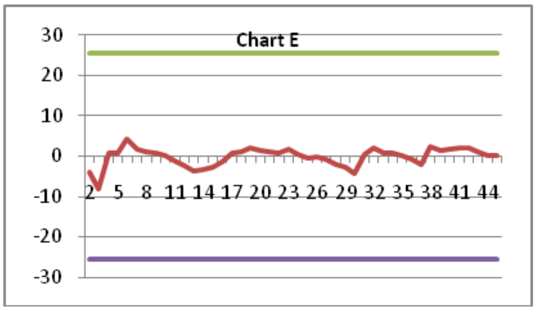
Plots:







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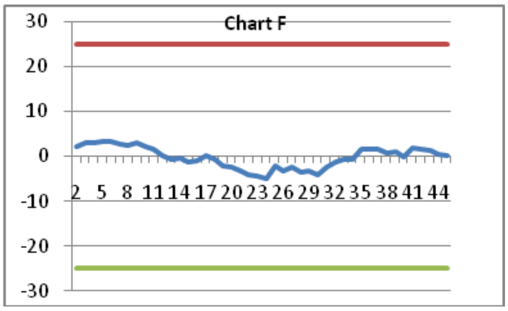
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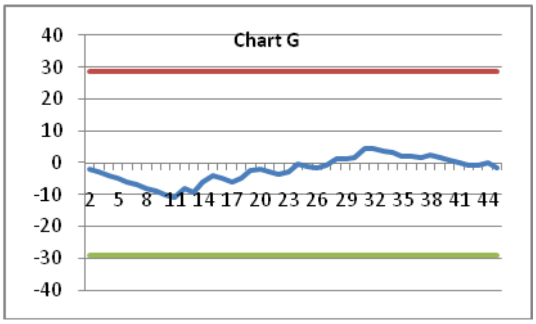
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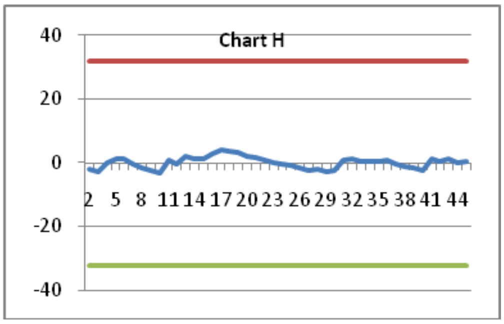
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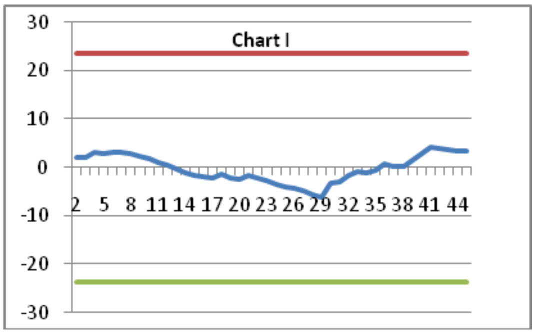
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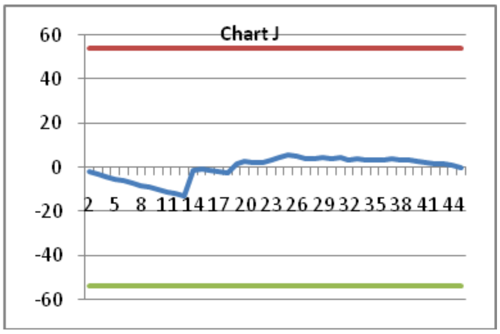
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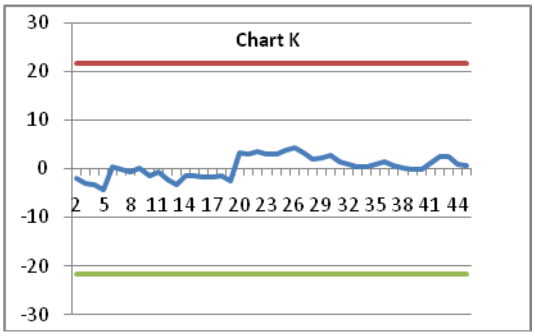
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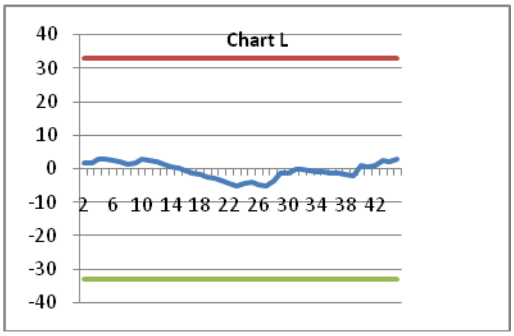
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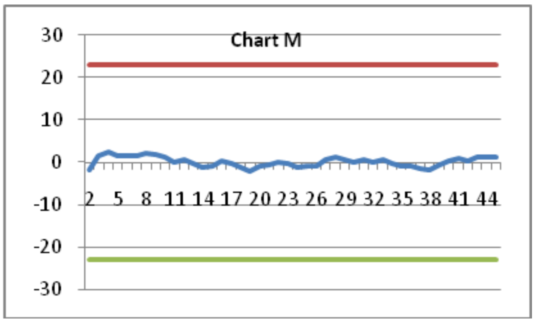
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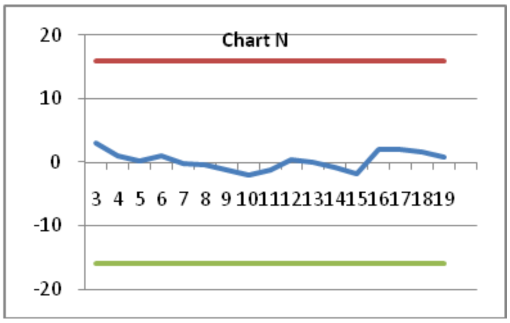
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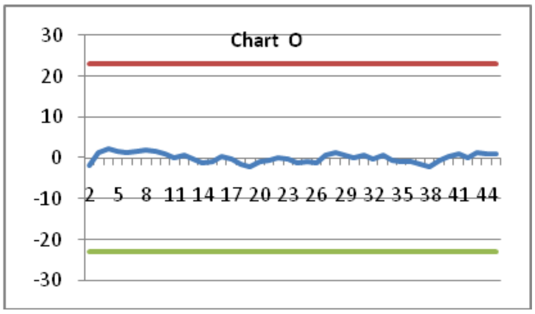
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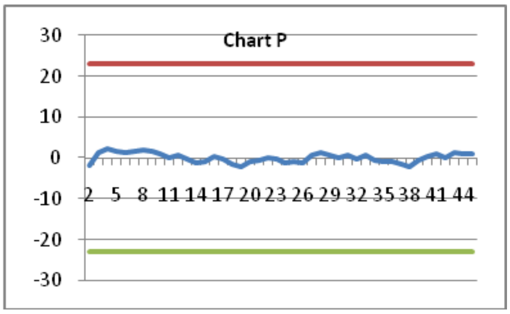
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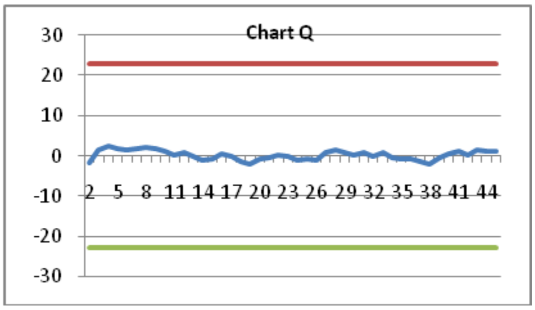
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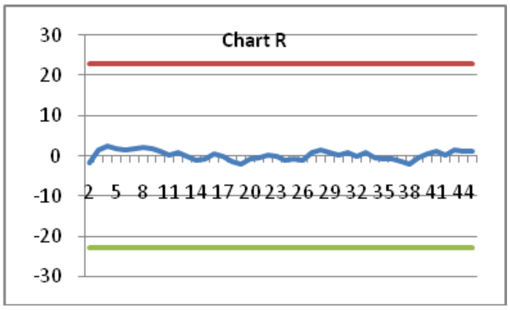
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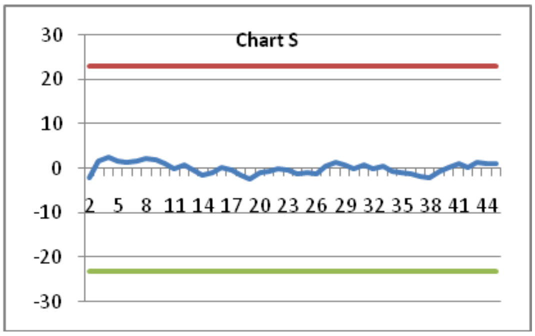
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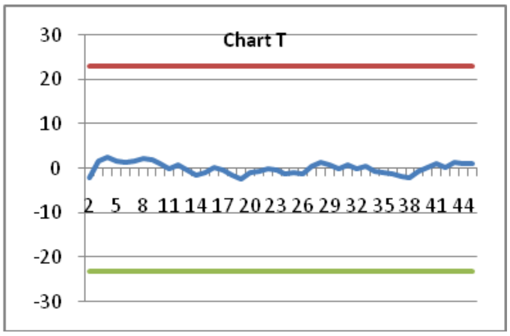
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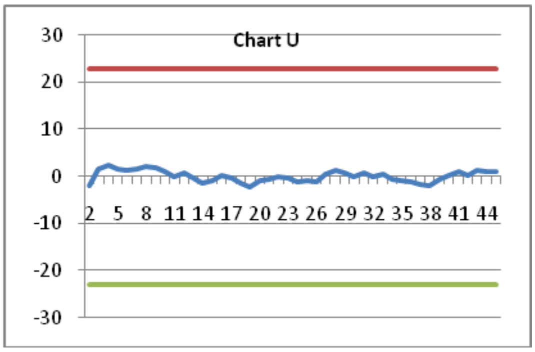
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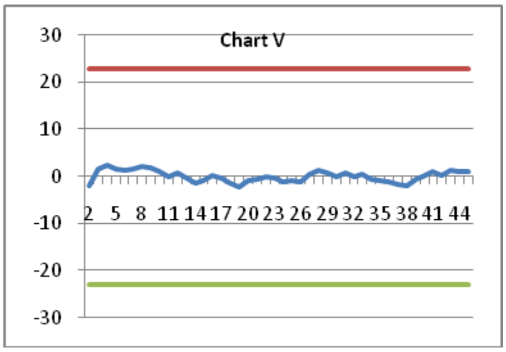
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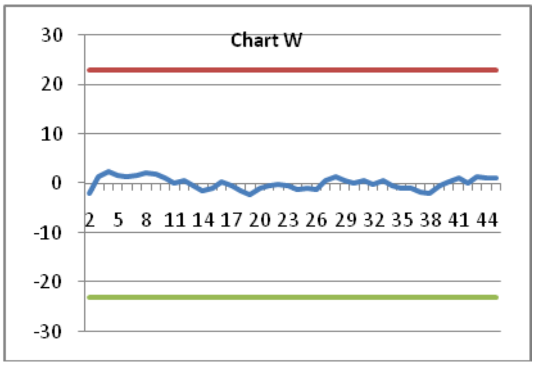
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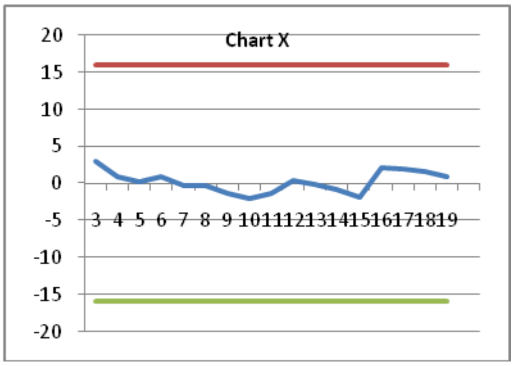
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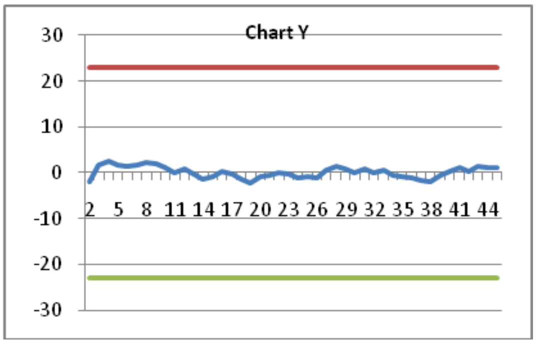
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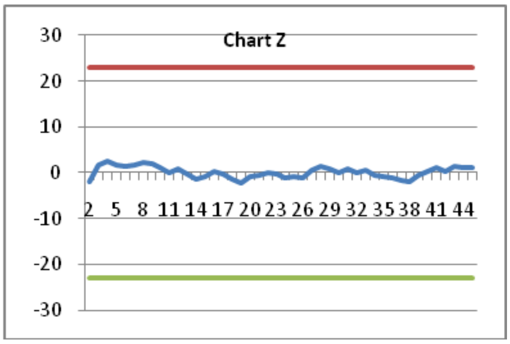
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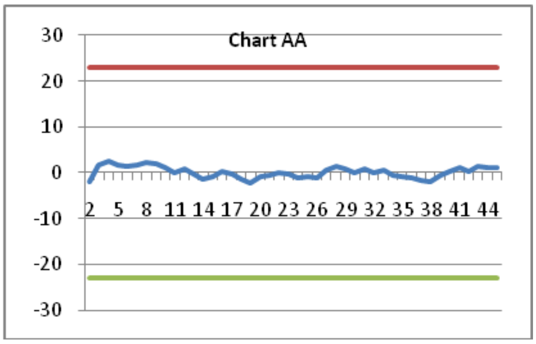
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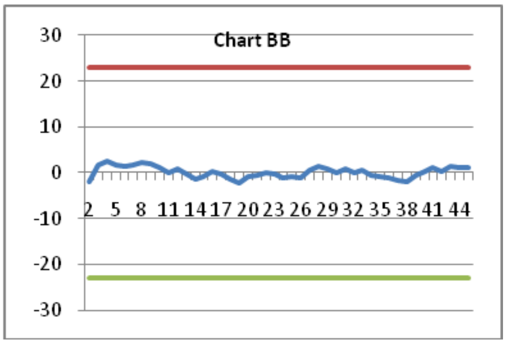
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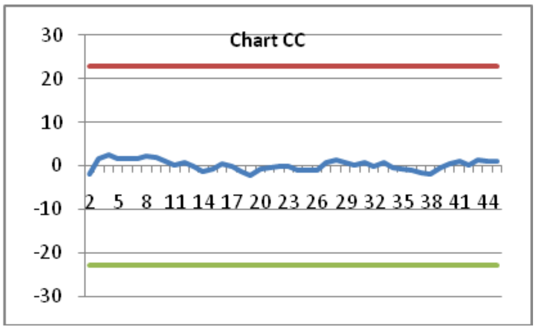
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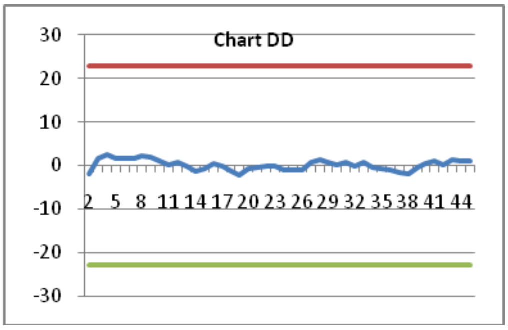
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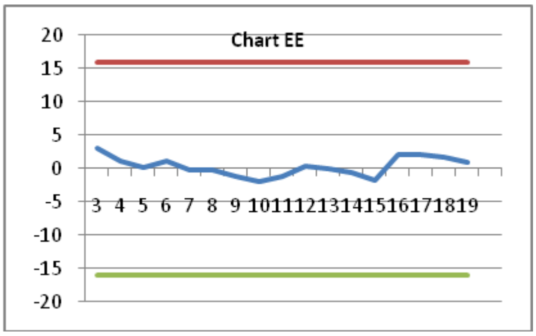
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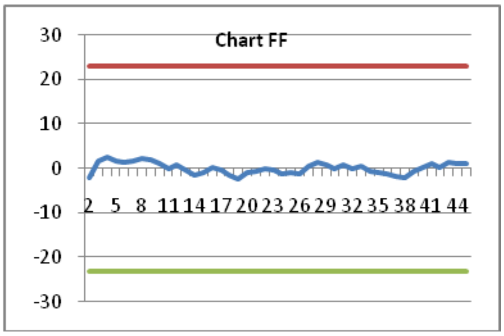
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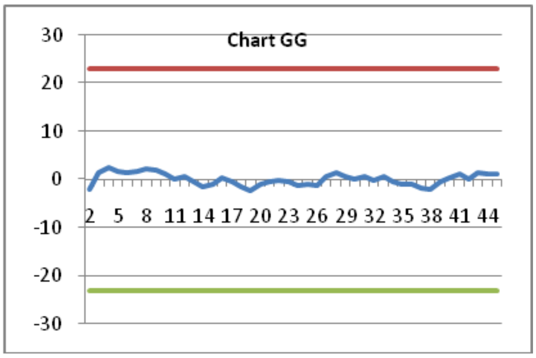
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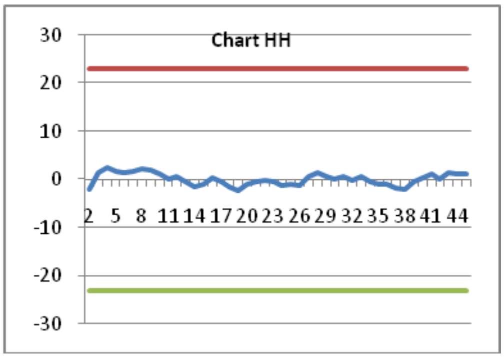
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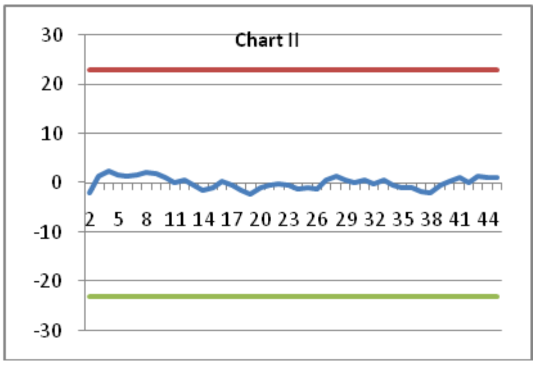
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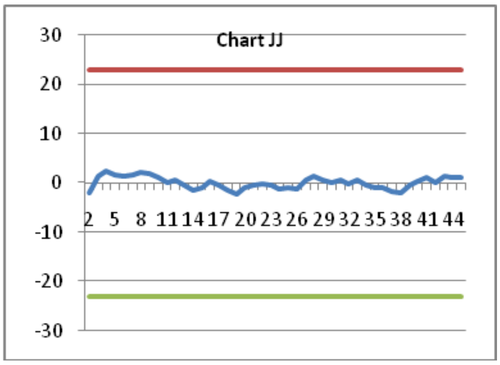
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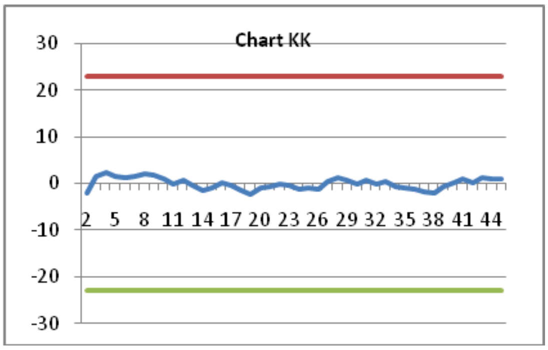
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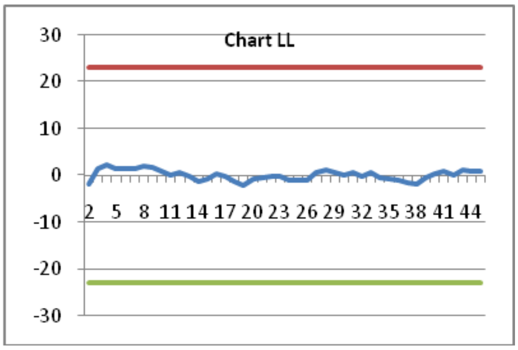
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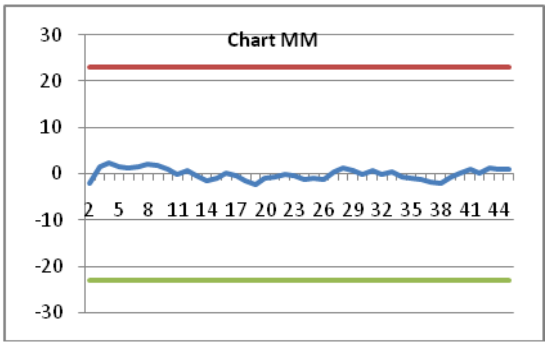
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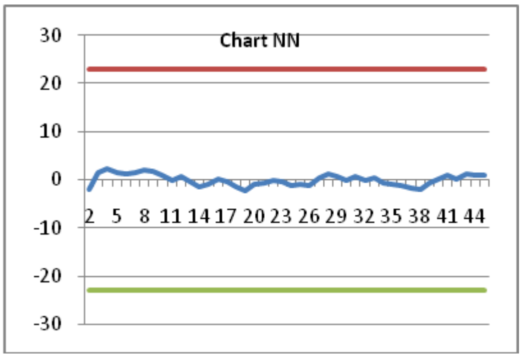
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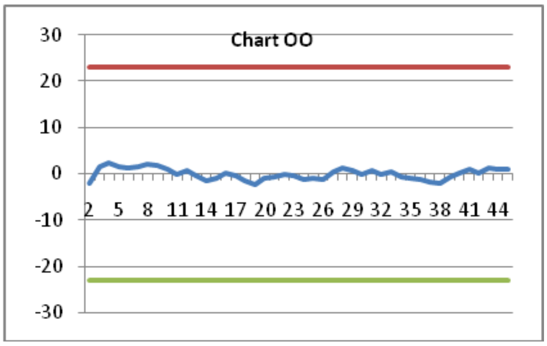
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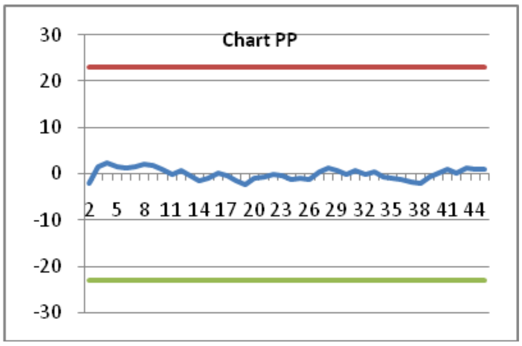
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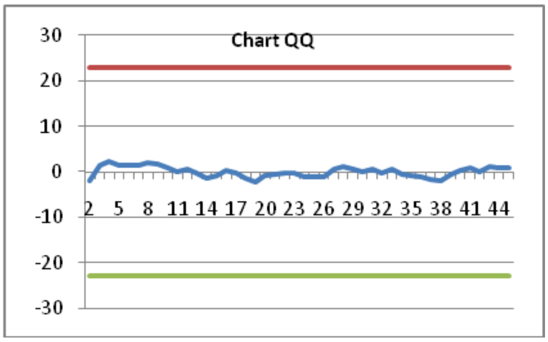
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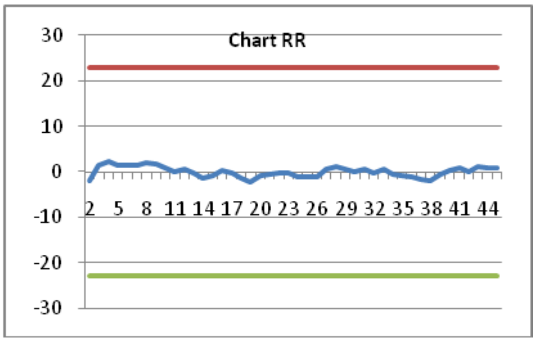
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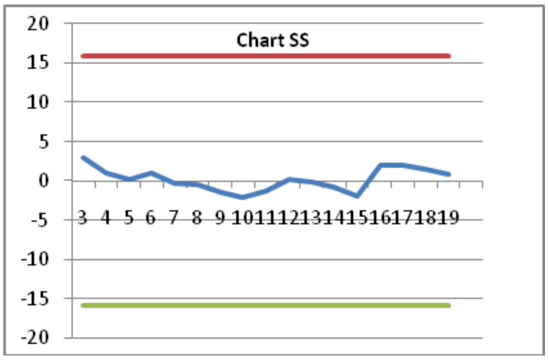

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