Asian Journal of Research in Computer Science

7(4): 34-47, 2021; Article no.AJRCOS.66614
ISSN: 2581-8260

Improved the Least Square Regression Line Method to Develop A Predict Method for Discriminate the Trend of Stock Price in Future

Ming-Jong Lin[1*]

[1]Southern Taiwan University of Science and Technology, No. 13, Ln. 388, Sec. 1, Anzhong Rd., Annan Dist., Tainan City 709, Taiwan (R.O.C.).

Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

Article Information

DOI: 10.9734/AJRCOS/2021/v7i430186
Editor(s):
(1) Dr. R. Gayathri, Anna University, India,
Reviewers:
(1) Jakub HORAK, Institute of Technology and Business in Ceske Budejovice, Czech Republic.
(2) Brad Raluca, Lucian Blaga University of Sibiu, Romania.
(3) Qinghua Li , Lingnan Normal University, China.
Complete Peer review History: http://www.sdiarticle4.com/review-history/66614

Original Research Article

Received 07 February 2021
Accepted 12 April 2021
Published 16 April 2021

ABSTRACT

The paper described the least square regression line method has been improved as a novel method for tendency discrimination on future stock price. A new method is established, which is obtained from one dataset of known strain variables. The result is been calculated from 10 strain variables consist of one dataset through a few unique managing approaches to calculate out four different tendencies, and encode them. Those codes are added into the least square regression line method by the application software of MATLAB to develop a diagnostic method, which can predict the tendency by the text and graphics. The new method predicts trends more clearly and easily than the least square regression line method. In this paper, firstly establish any of the four standard graphics that can be generated from known data. Finally, it is verified by historical data and the graphics are compared. The result is consistent with both text recognition and graphics trend. The new novel method of the least square regression line was as accurate and alike as we had expected. So that it is enough to prove that it is not only easy to understand but also easy to operate for discriminating the trend of stock price in future.

**Corresponding author: E-mail: l430107@yahoo.com.tw;*

Keywords: Least square regression line method; application software of MATLAB; trend of stock price.

1. INTRODUCTION

In the process of studying the least squares regression estimation method, I came up with a good idea what if the method is been employed in the stock market, it will help me to select the best trading point. So I started to discuss this topic in depth, then add research and development methods and finally make the two curves matches. The method of the least squares regression estimation only presents the number to be measured (unknown) either a positive (increase) or a negative (decrease). The aim of this paper is how to use known data to accurately and effectively predict future prices.

The interval of this paper, the known time period is divided into multiple segments which are regarded as X and Y are regarded as corresponding price. How to improve it that the two curves tend to be similar will be an issue in this paper and will be explained later.

2. LITERATURE REVIEW

Among the many methods in the literature, only the Least Squares Regression Line (LSRL) method is suitable for application, so that it is used as a blueprint for improvement. When it comes to the method of a mathematical optimization modeling, it is to find what the best function match of the data by minimizing the sum of squares of errors. If we adopt it to calculate can obtain unknown data values, and the sum of squares of errors between the data and the actual data is the smallest. So we learned the attributes and characteristics of the formula from the literature, [1,2,3,4,5] and made some improvements to make its application more flexible and feasible.

Follow the below tutorial to learn least square regression line equation with its definition formula and example. Least Square Regression is a method for finding a line that summaries the relationship between the two strain variables, at least within the domain of the explanatory variable x. How to calculate the last number value of Least Square Regression, we can obtain from the description of X, Y variables and slope value of the formula (1), the variables number are shown as in Table 1.

Formula:

$$Y = a + b\,X \tag{1}$$

Where $b = r\frac{SDY}{SDX}$

$a = \overline{Y} - b\overline{X}$

Table 1. The relationship between X and Y variable values

Strain variables	X values	Y values
To find LSRL equation	60	3.1
	61	3.6
	62	3.8
	63	4.0
	64	4.1

Another formula for slope:

Slope = $\frac{(N\sum XY - (\sum X)(\sum Y))}{(N\sum X^2 - (\sum X^2))}$

The relationship among X, Y, XY, and X^2 variable values is shown as in Table 2.

Where, b = the slope of the regression line, a = the intercept point of the regression line and the y axis, $\overline{X}$, $\overline{Y}$ = mean of X and Y values, SDX = standard deviation of X, SDY = standard deviation of Y.

Step 1: Count the number of given X values, N = 5.

Step 2: To find XY, $X^2$for the given values

Table 2. The relationship among X, Y, XY, and X^2 variable values

X values	Y values	XY	X^2
60	3.1	186.0	3600
61	3.6	219.6	3721
62	3.8	235.6	3844
63	4.0	252.0	3969
64	4.1	266.5	4225

Step 3:$\sum X$ = 311, $\sum Y$ = 18.6, $\sum XY$ = 1159.7, $\sum X^2$ = 19359.

Step 4: Substitute the values in the above slope formula given

Slope (b) = $\frac{(N\sum XY-(\sum X)(\sum Y))}{(N\sum X^2-(\sum X)^2)}$ = 0.1878

Step 5: Intercept (a) = $\frac{(\sum Y-b(\sum X))}{N}$ = -7.964

Step 6: Then substitute these values in regression equation formula = a + b*(X) = -7.964 + 0.188*X

Suppose if we want to calculate the approximate Y value for the variable X = 65 then, we can substitute the regression equation = -7.964 + 0.188 * 65 = 4.256

From the above calculation formula (1), the b value has positive or negative value, so that the predicted strain variable $(\overline{Y})$ has discriminated a positive slope as shown in Fig. 2 or a negative slope as shown in Fig. 4. However, if the straight line encounters a turning point, it will not be able to clearly discriminating the direction and lose accuracy. In order to improve the above shortcomings, this paper adds two way kinds of discriminating for text and graphics through the strain variable data. One way shifts from negative slope to positive slope as shown in Fig. 1 and another way from positive slope to negative slope as shown in Fig. 3, a total of four graphics' and texts are used for discriminating and more accurate.

3. IMPROVING METHODS

In order to make the estimated value more accurate and effective, we added a unique technique to the least square regression line method. The dataset of the least square regression line equation is taken 10 strain variables, divided it into two segments in sequence, such as Y1 ~ Y5 and Y6 ~ Y10. then Let D1 represents what Y5's value reduces Y1's value , likewise D2 represents what Y10's value reduces Y6's value , and C represents what the value via the average of sum from Y6's value to Y10's value reduces the average of sum from Y1's value to Y5's value. The B value generated by equation (1) compiles with the new parameters C, N, D1 and D2, combining the MATLAB application software is used to perform the text and graphics discrimination out. The procedure for discriminating of the program is as follows:

- D1< 0 & D2 > 0 , if those conditions meet to show 〝positive slope transforms negative slope (C Area)〞 and graphics' trend , otherwise jumps to step b.
- D1 > 0 & D2 > 0 & B > 0 & C > 0 , if those conditions meet to show 〝positive slope raise up (B Area)〞 and graphics' trend, otherwise jumps to step c.
- D1 > 0 & D2 < 0 , if those conditions meet to show 〝negative slope transforms positive slope (A Area)〞 and graphics' trend, otherwise jumps to step d.
- If the above three steps are not consistent to show 〝negative slope drop down (D Area)〞 and graphics' trend.

In order to understand the content of the code will be explained in Table 3.

Table 3. The explained of content for the code

Codes	Symbols	Content
N	Y1 to Y10	Digits of strain variable from Y1 to Y10
C	Σ(Y6~Y10)/5 -Σ(Y1~Y5)/5	The average of the sum of Y6's to Y10's value minus the average of the sum of Y1's to Y5's value
D	Y10 – Y1	Y10's value minus Y1's value
D2	Y10 – Y6	Y10's value minus Y6's value
D1	Y5 – Y1	Y5's value minus Y1's value
B	$\frac{(N\sum XY-(\sum X)(\sum Y))}{(N\sum X^2-(\sum X)^2)}$	the slope value of least square regression line

4. ESTABLISHING 4 CONDITIONS OF STANDARD FOR DISCRIMINATION

According to the improvement criteria described in the previous paragraph, the MATLAB application software program is used to calculate the most appropriate one condition from the four different texts and graphics. First establishing four conditions of standard for discrimination include text, graphics, and a program. The text descriptions and graphics of the four different conditions will be described separately in the following. However, these are divided negative slope transforms positive slope (A Area), positive slope raise up (B Area), positive slope transforms negative slope (C Area), negative slope drop down (D Area) of four conditions.

Relatively an appropriate graphics is displayed, those standardized graphics of four kinds are shown as Fig. 1 ~ Fig. 4. The least square regression line, text, and graphics performed by MATLAB application software that the produce steps are shown below on case 1 of executive program in appendix.

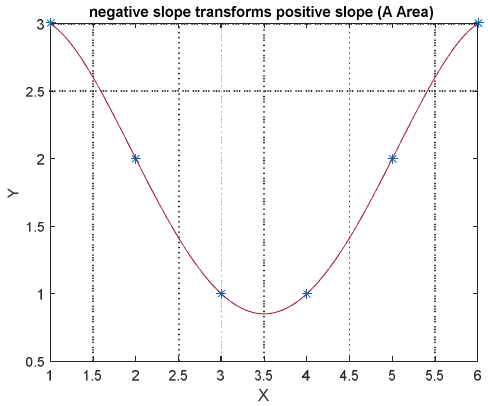


Fig. 1. Negative slope transforms positive slope (A Area)

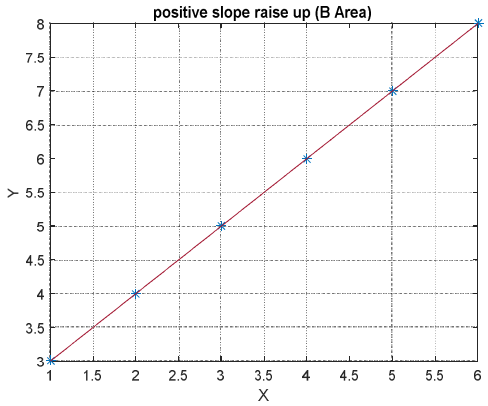


Fig. 2. Positive slope raise up (B Area)

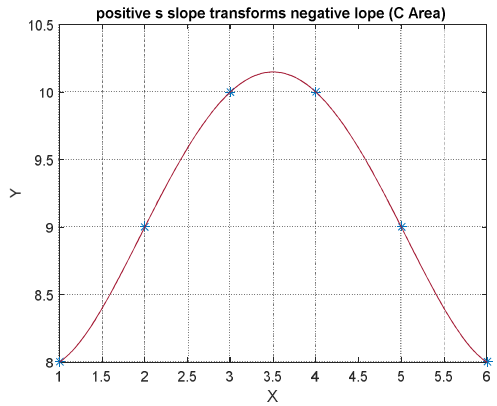


Fig. 3. Positive slope transforms negative slope (C Area)

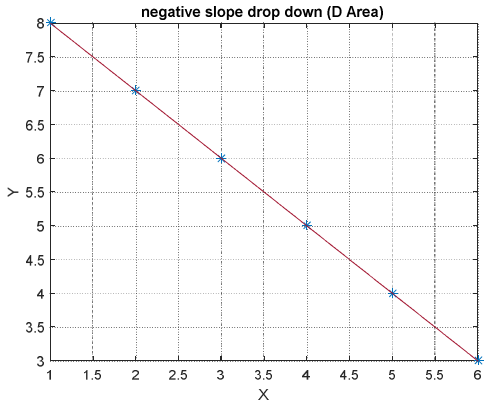


Fig. 4. Negative slope drop down (D Area)

4.1 Instructions of Operation

To enter the developed program into the MATLAB software system, which this program must to set the number of digits of variable (X) and strain variable (Y) to be 10 at least. Then the result of the execution will be shown text and graphics trend of discrimination out, which (X(11) and Y(11)) are shown in Table 4. A case in the point, the corresponding stock price of X(1) is called Y(1). By analogy, find the estimated stock price Y(11) when X(11) is unknown from the known X(1) to X(10) data. From in Fig. 5, there have two lines, one the blue line represents strain variables of discrete connection line, another the red curve represents which converted by curving fitting. The majority point of the paper is to introduce what to improve the method of least square regression line to compare condition so that it easily diagnose what tendency of condition belong to out.

Table 4. Results of execution are shown text and graphics

Using the least square regression line (LSRL) method to discriminate trend of stock price in future Type the X axis number value : X1=[X(1) X(2) X(3) X(4) X(5) X(6) X(7) X(8) X(9) X(10)];= [1 2 3 4 5 6 7 8 9 10]; Type the Y axis strain variable value: Y1=[Y(1) Y(2) Y(3) Y(4) Y(5) Y(6) Y(7) Y(8) Y(9) Y(10)];= [23.1 23.0 23.1 23.0 22.8 23.1 23.0 23.2 23.2 23.2]; Y = A + B*X; Type the X axis number value (X)= 11 Y = 23.1733 to discriminate "negative slope transforms positive slope (A Area)"

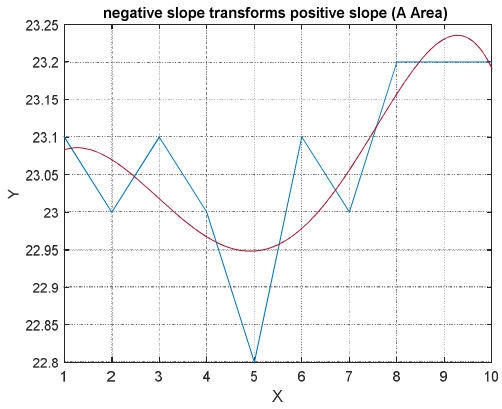


Fig. 5. Negative slope transforms positive slope (A Area)

4.2 The Execution Program

The execution procedure is shown on case 2 in the appendix.

5. VERIFICATION

This paragraph will be divided into two parts: Principle operation description and examples implementation comparison description.

5.1 Principle Operation Description

Taking a few historical data from the stock price analysis chart of A company in the Taiwan stock market from July 30, 2019 to September 30, 2019 (Fig. 6) used for verification. The period of stock price which as strain variables is divided into 4 segments, each segment is 10 days and each segment has 10 variables, and its corresponding strain variables – as Table 5, Table 6, Table 7 and Table 8. The results of the execution are shown in Fig. 7, Fig. 8, Fig. 9 and Fig. 10 [6].

From the date set in Fig. 6 from 6.0.2019 to 9.30.2019, the prices of 10 stocks are taken out equally (as shown in Table 9) when the data is entered in the program, and the display graph is shown in Fig. 11.

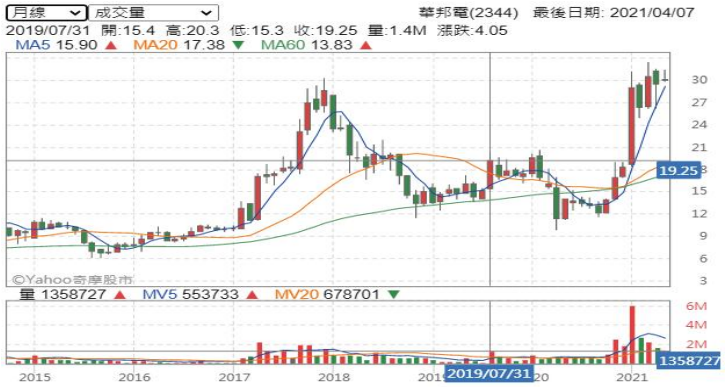


Fig. 6. The stock price analysis chart of A company

Table 5. Results of execution are shown text and graphics

Using the least square regression line (LSRL) method to discriminate trend of stock price in future Type the X axis number value : X1=[X(1) X(2) X(3) X(4) X(5) X(6) X(7) X(8) X(9) X(10)];= [1 2 3 4 5 6 7 8 9 10]; Type the Y axis strain variable value: Y1=[Y(1) Y(2) Y(3) Y(4) Y(5) Y(6) Y(7) Y(8) Y(9) Y(10)];= [17.5 17 16.9 17.2 16.7 16.6 17.5 16.8 16.9 17.4]; Y = A + B*X; Type the X axis number value (X)= 11 Y = 17.0067 to discriminate "negative slope transforms positive slope (A Area)"

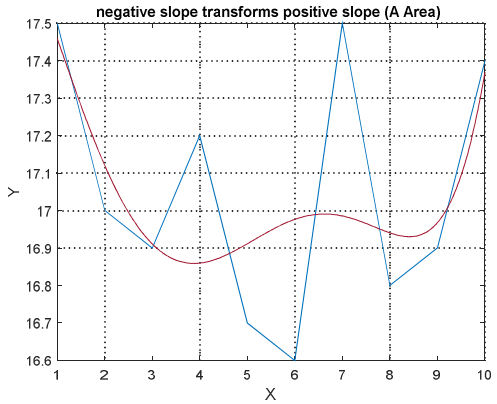


Fig. 7. Negative slope transforms positive slope (A Area)

Table 6. Results of execution are shown text and graphics

Using the least square regression line (LSRL) method to discriminate trend of stock price in future Type the X axis number value : X1=[X(1) X(2) X(3) X(4) X(5) X(6) X(7) X(8) X(9) X(10)];= [1 2 3 4 5 6 7 8 9 10]; Type the Y axis strain variable value: Y1=[Y(1) Y(2) Y(3) Y(4) Y(5) Y(6) Y(7) Y(8) Y(9) Y(10)];= [17.5 17.8 18 18.3 18.2 18.3 18.3 18.6 18.5 18.9]; Y = A + B*X;Type the X axis number value (X)= 11 Y = 18.9267 to discriminate "positive slope raise up (B Area)"

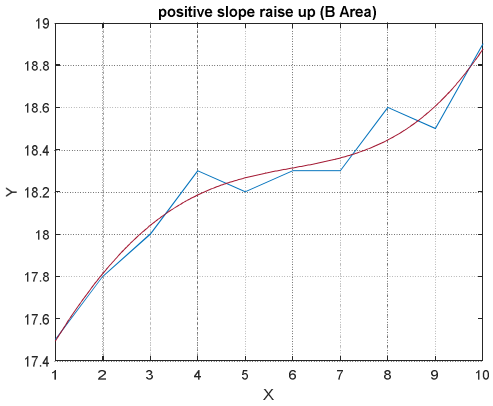


Fig. 8. Positive slope raise up (B Area)

Table 7. Results of execution are shown text and graphics

Using the least square regression line (LSRL) method to discriminate trend of stock price in future Type the X axis number value : X1=[X(1) X(2) X(3) X(4) X(5) X(6) X(7) X(8) X(9) X(10)];= [1 2 3 4 5 6 7 8 9 10]; Type the Y axis strain variable value: Y1=[Y(1) Y(2) Y(3) Y(4) Y(5) Y(6) Y(7) Y(8) Y(9) Y(10)];= [18.3 18.6 18.5 18.9 18.7 18.8 18.7 18.6 18.5 18.1]; Y = A + B*X;Type the X axis number value (X)= 11 Y = 18.4867 to discriminate "positive slope transforms negative slope (C Area)"

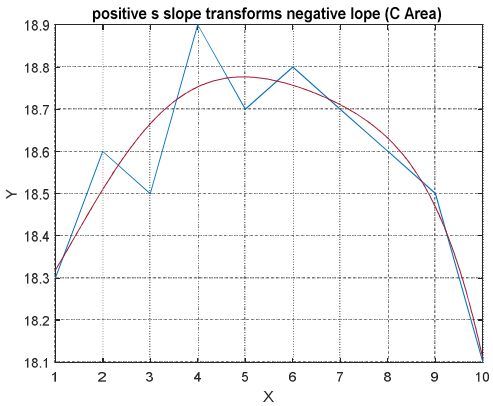


Fig. 9. Positive slope transforms negative slope (C Area)

Table 8. Results of execution are shown text and graphics

Using the least square regression line (LSRL) method to discriminate trend of stock price in future Type the X axis number value : X1=[X(1) X(2) X(3) X(4) X(5) X(6) X(7) X(8) X(9) X(10)];= [1 2 3 4 5 6 7 8 9 10]; Type the Y axis strain variable value: Y1=[Y(1) Y(2) Y(3) Y(4) Y(5) Y(6) Y(7) Y(8) Y(9) Y(10)];= [19.8 19.2 19.4 18.6 18.3 18.2 17.8 17.2 16.9 17.5]; Y = A + B*X;Type the X axis number value (X)= 11 Y = 16.6133 to discriminate "negative slope drop down (D Area)"

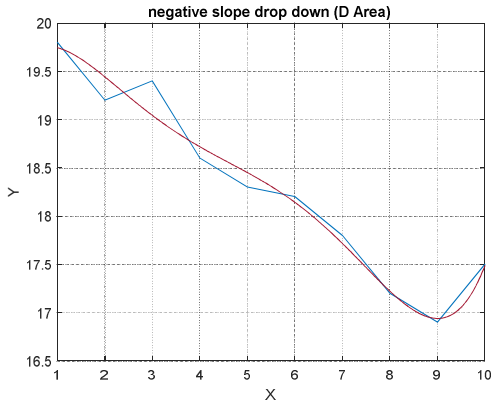


Fig. 10. Negative slope drop down (D Area)

Table 9. Results of execution are shown text and graphics

Using the least square regression line (LSRL) method to discriminate trend of stock price in future Type the X axis number value : X1=[X(1) X(2) X(3) X(4) X(5) X(6) X(7) X(8) X(9) X(10)];= [1 2 3 4 5 6 7 8 9 10]; Type the Y axis strain variable value: Y1=[Y(1) Y(2) Y(3) Y(4) Y(5) Y(6) Y(7) Y(8) Y(9) Y(10)];= [17.5 17.2 16.8 17.8 18.3 18.9 18.9 18.6 19.2 17.8]; Y = A + B*X;Type the X axis number value (X)= 11 Y = 19.0867 to discriminate "positive slope transforms negative slope (C Area)"

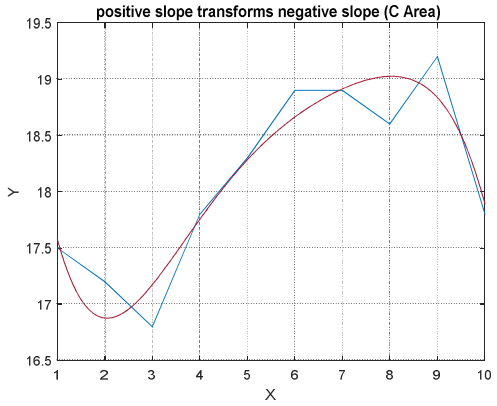


Fig. 11. Positive slope transforms negative slope (C Area)

Table 10. Results of execution are shown text and graphics

Using the least square regression line (LSRL) method to discriminate trend of stock price in future Type the X axis number value : X1=[X(1) X(2) X(3) X(4) X(5) X(6) X(7) X(8) X(9) X(10)];= [1 2 3 4 5 6 7 8 9 10]; Type the Y axis strain variable value: Y1=[Y(1) Y(2) Y(3) Y(4) Y(5) Y(6) Y(7) Y(8) Y(9) Y(10)];= [17.5 17.2 16.8 17.8 18.3 18.9 18.9 18.6 19.2 17.8]; Y = A + B*X; Type the X axis number value (X)= 11 Y = 19.0867 to discriminate "positive slope raise up"

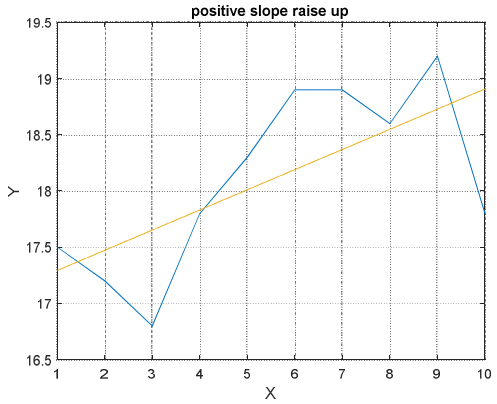


Fig. 12. Positive slope raise up

The results are consistent during the same period. In particular, Fig. 6 is very similar to Fig. 11. If the data of Table 9 is used in the traditional way of least square regression line, the test of the discriminating result is only shown "positive slope raise up" and the graphics of discriminating result is shown in Fig. 12, the red line of Fig. 6 and Fig. 12 are obviously different.

5.2 Cases Comparison Description

In order to further prove the paper's method, taken four companies of closed trading prices those data have been continuously in the previous 10 days, as shown in Table 11 [7].

From the Taiwan Stock Market took four companies' data, the period time is from March 17 2021 to March 31 2021, its sum up 10 days of trading day that were divided into 10, any value referred as X, then the corresponding closed price referred as Y.

Those companies' names were coded as 2002, 2836, 2880, and 2892 by Taiwan Stock Market. It's represented as 1, 2, 3 and 4 and the corresponding closed price (Y) and interval number (X), as shown in Table 11. Enter the known data into this paper proposed method and the Least Squares Regression Line method to calculate the predicted values as R and L respectively, as shown in Table 11. Using the proposed method in this paper to compare with Least Square Regression Line method to predict the closing price of the 11th day, the results and error ratio are shown in Table 12.

The error yields from before the paper's method calculation price (T) minuses the stock market closed real price (R) after again divides by the stock market closed real price and the Least Square Regression Line prediction price (L) minuses the stock market closed real price after again divides by the stock market closed real price. Cases prediction results and graphics compare with stock market curve, as shown in Fig. 13. The comparison results are extremely similar.

Finally, the comparison results show that the proposed method in this paper is better than the method of LSRL as shown in Table 13. Testing result paper's method got the error value being 3 less than the Least Square Regression Line is 1. So this method is sufficient to prove the feasibility and accuracy of the discriminant analysis method.

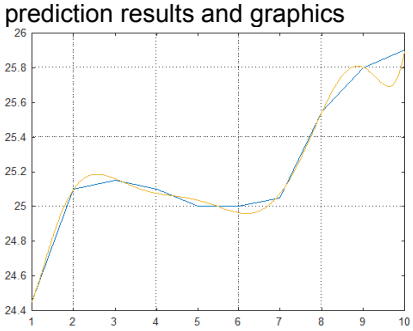
Table 11. Four sets data (date from 3.18, 2021 to 3.31, 2021)

C	1	2	3	4	5	6	7	8	9	10	R	T	L
1	24.45	25.10	25.15	25.10	25.00	25.00	25.05	25.55	25.80	25.90	25.80	25.87	24.91
2	10.05	10.00	10.15	10.20	10.20	10.25	10.30	10.35	10.45	10.45	10.50	10.51	10.33
3	18.35	18.30	18.20	18.20	18.25	18.35	18.35	18.45	18.60	18.65	18.65	18.59	18.51
4	21.95	21.50	21.85	21.85	21.90	22.05	22.05	22.20	22.25	22.20	22.05	22.31	220.00

Remarks: C represent for the No. case.
R represent for the stock market closed real price.
T represent for the paper's method calculation price.
L represent for the Least Square Regression Line prediction price.
E represent for the error is calculated from between (T-R)/R and (L-R)/R.

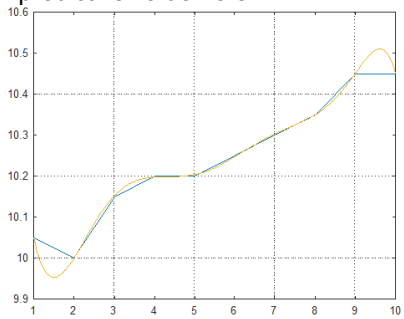
C prediction results and graphics

1



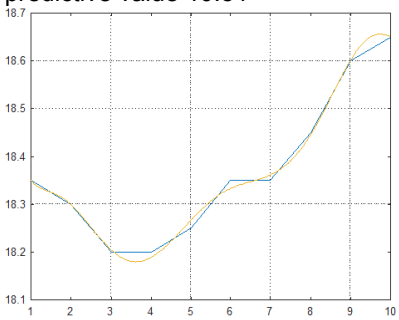
"positive slope raise up (B Area)" predictive value 25.87

2



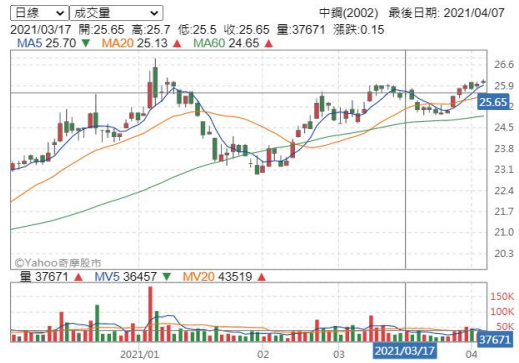
"positive slope raise up (B Area)" predictive value 10.51

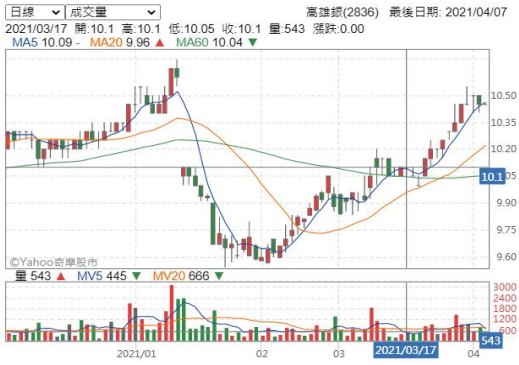
3

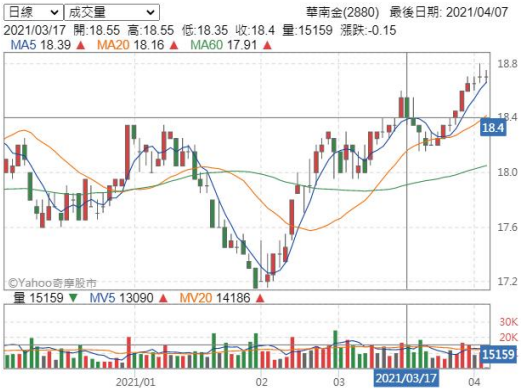


"negative slope transforms positive slope (A Area)" ; predictive value 18.59

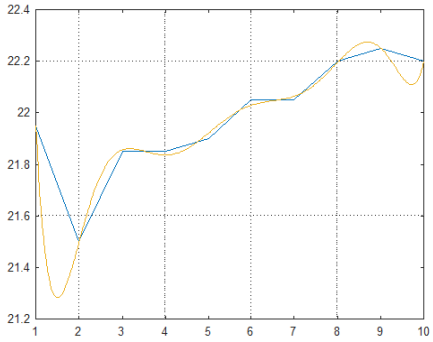
stock market curve







4



"negative slope transforms positive slope (A Area)" ; predictive value 22.31

Fig. 13. Cases prediction results and graphics compare with stock market curve

Table 12. Testing compare with paper's method and the Least Square Regression Line

C	R	T	L	E((T-R)/R (%))	E((L-R)/R(%))
1	25.80	25.87	24.91	0.27	-3.45
2	10.50	10.51	10.33	0.09	-1.62
3	18.65	18.59	18.51	-0.32	-0.75
4	22.05	22.31	22.00	1.18	-0.22

Table 13. The relationship between the number of companies, the number of successes and the test data

Testing companies	Number of success	Number of sequence	T	L
4	4	10	3	1

6. CONCLUSION

The method proposed in this paper is that discriminates the originally least square regression line method - positive slope raise up and negative slope drop down, improving to increasing - negative slope transforms positive slope (concave graphics) and positive slope transforms negative slope (convex graphics) to four kinds of conditions total. And with the MATLAB application software, the text and the graphics will be discriminated out from the program.

The feasibility and accuracy of the practice verification is very high, it can be used by stock market investors to predict the trend of stock price in future. This method of predicting stock prices must exclude natural and man-made disasters and other irresistible risk factors.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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APPENDIX

Executive Program

Case 1

```
>> clear;
x=[1 1;1 2;1 3;1 4;1 5;1 6];
y=[8;9;10;10;9;8];
x'
x'*x
x'*y
inv(x'*x)
a=inv(x'*x)*x'*y
x1=x(:,2)
polyfit(x1,y,1)
t=(0:0.1:6);
plot(x1,y,'*');
grid on
```

Case 2

```
>> clear;
fprintf(' Using the least square regression line (LSRL) method to discriminate trend of stock price in future\n')
X1=input ('Type the X axis number value : X1=[X(1) X(2) X(3) X(4) X(5) X(6) X(7) X(8) X(9) X(10)];= ');
Y1=input ('Type the Y axis strain variable value: Y1=[Y(1) Y(2) Y(3) Y(4) Y(5) Y(6) Y(7) Y(8) Y(9) Y(10)];= ');
N=(X1(10)-X1(1))+1;
XY1=X1(1)*Y1(1);XY2=X1(2)*Y1(2);XY3=X1(3)*Y1(3);XY4=X1(4)*Y1(4);
XY5=X1(5)*Y1(5);XY6=X1(6)*Y1(6);XY7=X1(7)*Y1(7);XY8=X1(8)*Y1(8);
XY9=X1(9)*Y1(9);XY10=X1(10)*Y1(10);XX1=X1(1)*X1(1);XX2=X1(2)*X1(2);
XX3=X1(3)*X1(3);XX4=X1(4)*X1(4);XX5=X1(5)*X1(5);XX6=X1(6)*X1(6);
XX7=X1(7)*X1(7);XX8=X1(8)*X1(8);XX9=X1(9)*X1(9);XX10=X1(10)*X1(10);
X2=sum(X1(1)+X1(2)+X1(3)+X1(4)+X1(5)+X1(6)+X1(7)+X1(8)+X1(9)+X1(10));
Y2=sum(Y1(1)+Y1(2)+Y1(3)+Y1(4)+Y1(5)+Y1(6)+Y1(7)+Y1(8)+Y1(9)+Y1(10));
X3=sum(XY1+XY2+XY3+XY4+XY5+XY6+XY7+XY8+XY9+XY10);
Y3=sum(XX1+XX2+XX3+XX4+XX5+XX6+XX7+XX8+XX9+XX10);
B=(N*X3-(X2*Y2))/(N*Y3-(X2*X2));
A=(Y2-(B*X2))/N;
X=input ('Y = A + B*X; Type the X axis number value (X )= ');
Y=A+B*X
C=(Y1(6)+Y1(7)+Y1(8)+Y1(9)+Y1(10))/5 - (Y1(1)+Y1(2)+Y1(3)+Y1(4)+Y1(5))/5;
D= (Y1(10) - Y1(1));

D1= (Y1(10) - Y1(6));
D2= (Y1(5) - Y1(1));

if (D1<0 & D2 >0 ),
  disp(' to discriminate "positive slope transforms negative slope (C Area)" ');
   elseif(D1>0 & D2 >0 & B>0 & C>0) ,
     disp(' to discriminate "positive slope raise up (B Area)" ');
```

```
    elseif(D1>0 & D2 <0) ,
       disp(' to discriminate 〝negative slope transforms positive slope (A Area)〞 ');
         else,disp(' to discriminate 〝negative slope drop down (D Area)〞 ');

end
plot(X1,Y1)
grid on
```


Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/66614