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New Method of Financial Technical Analysis Based on the Perspective of Mathematical Modeling

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ABSTRACT

In this study, the core of this study is to obtain the extreme values of share price function with the similar curve method. This study follows the four stages of mathematical modeling: Questioning, modeling, verification and comparison, redefines the new method of financial technical analysis-similar curve method and gives two original new concepts-curve similarity and WP indicator, as well as the visually achieved key source mode. With SPSS software, it is obtained that the probabilities for the increasing function to gain the maximum and minimum WP values are, respectively 34.28 and 22.86% and those for the decreasing function to obtain the maximum and minimum WP values are, respectively 33.33 and 25.71%. The test results of the original WP expert system to the 4 management objectives, i.e., win rate, annual rate of return, net profit rate and annual number of transactions are, respectively 87.57, 75.70, 31.54 and 6,837.60. Compared with other 6 expert systems, the above results are optimal. Due to similar methods of financial technical analysis, the similar curve method can be applied to the analysis of all transactions.

Key words: Mathematical modeling, similar curves, WP expert system, extreme values of functions

INTRODUCTION

Mathematics is an important foundation for all kinds of sciences. With the widespread use of computer in various fields as well as the combination of mathematical science and computer technology, a kind of popular and achievable key technology-mathematical technique, has formed and become an important part of contemporary high technology. To put mathematics into application and truly show its key and decisive role in multi-field and multi-level applications, as well as its strong vitality, a bridge must be set up between actual problems and mathematics. This bridge is mathematical modeling (Li, 2014).

Figure 1 is a flow chart to solve practical problems, the first step of the whole procedure above is called mathematical modeling which means establishing a mathematical model for the practical problem that is to be studied.

From the angle of development history of mathematics, the mathematical development of various civilizations is a process of mathematical modeling. Ancient Egyptian Papyrus, or ancient Chinese “Nine Chapters on Mathematical Art”, or subsequent “Notes of Nine Chapters on Mathematical Art” summarized the same kind of several problems into a typical problem which is

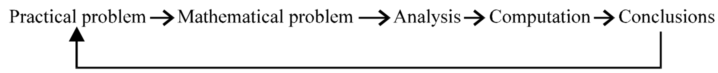

Fig. 1: Flow chart to solve practical problems

just an elementary mathematical model. Therefore, instead of saying that ancient Egyptian and ancient Chinese mathematical works generally use the form of problem set, it is better to say that they are the integrations of various mathematical models. In terms of writing detail, exampled by “Nine Chapters on Mathematical Art”, each typical problem is divided into different entries, such as “asking”, “answering”, “method” and “note”. “Asking” is to ask a specific question. “answering” is to give a specific answer; “method” means the algorithm, formula or theorem of solving a kind of problems. “note” refers to explanation of “method”, often a certification (Zhang, 1997). Ancient Babylonians living nearby Tigris and Euphrates directly prepared the mathematical results into figures and engraved them on clay tablets (Liu, 1993). The No. 322 clay tablet collected in the Plimpton (G•A•Plimpton) University shows that, ancient Babylonians had mastered the law of Pythagorean Triples. The ancient Greek mathematics established the first human axiomatic system. Greek people took the lead in the history of civilization and they were paramount in the history of mathematics. Although, they also learnt from other surrounding civilizations, they created their own civilization and culture which is the most magnificent among all civilization, has the greatest impact on the development of modern western culture and has a decisive role in the foundation of modern mathematics (Kline, 1990).

In essence, mathematical modeling is to turn a practical problem to be solved into a mathematical problem and then to solve this problem with existing mathematical knowledge. From the angle of educational psychology, the solution process of mathematical modeling should be consistent with the law of problem-driven solving approach. The model is not a meaningful thing until understood. The model can be meaningful only if it is changed to be knowledge in cognitive structure through individual active construction. To this end, in the problem-driven solution, it is necessary to pay attention to two principles, namely constructivism principle and student’s subjectivity principle (Chen, 2010).

METHODOLOGY

Brief introduction of constructivism: Constructivism was first proposed by Piaget (1982), a Swiss and the most influential psychologist in the field of cognitive development. The school on children’s cognitive development created by him is known as the Geneva school. Piaget’s theory is full of materialist dialectics. He insisted on studying children’s cognitive development from the perspective of interaction of internal and external causes. He believed, in the process of their interactions with surrounding environment, children gradually constructed knowledge outer world, thus developing their own cognitive structures.

Constructivism in the field of cognitive development: Children’s interaction with environment involves two basic processes: “Assimilation” and “Adaptation”. Assimilation refers to absorption of relevant information in the external environment and combination with children’s existing cognitive structure (also called “schema”), namely the process of individuals integrating the information provided by external stimuli into their original cognitive structure. Adaptation refers to process of reconstructing and modification of children’s cognitive structure because the external environment changes and original cognitive structure fails to assimilate the information provided by the new environment, namely, the process of change of individual cognitive structure due to the impact of external stimuli. It can be seen that, assimilation is the expansion in the number of cognitive structure (schemata expansion) while adaptation is the change in the property of cognitive structure (schemata change). Cognition individuals (children) achieve a balance with surrounding environment through assimilation and adaptation. When children are able to assimilate new information through schemata, they are in a balanced state of cognition, when they cannot do it, then the balance is broken. The process of modifying or creating new schemata (namely assimilation) is a process of seeking for a new balance. Children's cognitive structure is gradually constructed through the process of assimilation and adaptation and it is constantly enriched, improved and developed in the cycle of "Balance-imbalance-balance". This is Piaget's basic point of view about constructivism.

Teaching design principles in constructivist learning environment: Constructivist learning theory emphasizes the student-centered principle and thinks students as the main subjects of cognition as well as the active constructors of knowledge meaning. Teachers only play a helpful and promoting role in the children's meaning construction and they are not required to directly impart knowledge to students. In the constructivist learning environment, the positions and roles of teachers and students have changed a lot compared to those in traditional teaching. Experts in the field of educational technology have done a lot of studies and explorations, trying to establish a new teaching design theory and method system adaptive to constructivist learning theory and constructivist learning environment. Although, the establishment of such a theoretical system is an arduous task and cannot be completed in a short period, its basic ideal and main principles have become increasingly clear and it has initially been applied to guide the teaching design in constructivist learning environment based on multimedia and internet.

Constructivism theory is student-centered, emphasizing students' active exploration and discovery of knowledge as well as active construction of knowledge meaning. Since the learning environment required by constructivism obtains the strong support from the results of the latest contemporary information technology, the constructivism theory is increasingly combined with the teaching practice of the majority of teachers. Mathematical technology and mathematical modeling fully meet the teaching design principles in the constructivist learning environment, so a good platform is provided for teachers and students.

Model establishment:

- Raised question: How to make market in the securities market?
- Answer to question is tantamount to answering the questions below:
- Can we make money in the securities market?
- What's the principle for such money-making?
- What are the methods under the basic principle?
- Is the essence of technical analysis on securities?

Figure 2 is based on the K chart of stock technical analysis diagram. From Fig. 2 we know that stock prices do have high and low points and investors could make money according to the transaction system of each country through long selling (buying at low points first and selling at high points later) or short selling (selling at high points first and buying at low points later). Figure 2 contains most frequently used 6 technical indexes. Let's take a look at a Fig. 2 from mathematical perspectives: K chart has four variables, opening price, closing price, highest price and lowest price; MA has four lines, corresponding to four variables, the turnover has one variable,

Fig. 2: Technical analysis based on K chart

RSI has three lines, i.e., three variables, KDJ has three lines, i.e., three variables, MACD has two lines and a column line, i.e., three variables. In all, there are 18 variables to predict the price of the stock the next day. It is a multi-variable function with 18 intermediary variables and the development of modern mathematics is still unable to process such a function (Wang and Huang, 2013f).

Obviously it can be seen from Fig. 2 that the valley value of stock price is the minimum value of the stock price function while the peak value of the stock price is the maximum value of the stock price function. The question now is how to get the stock price function? The definition of a function tells us that function is a curve. Further, what are the points of the curve? Although, in a single transaction day the data of transaction prices is nearly extremely vast the common sense in the industry is that the most important is the closing price.

As technical analysis only considers the closing prices, the mathematical expression would be just points. As time could not be reversed and the transaction time is counted on days, then the stock price function would be a continuous line chart of scattered points. As the images are computer images, the data collection and the acquisition of the mathematical expression of the stock price function are a hundred times more difficult than solving the extreme values. In other words, using strict function expressions to find answers are impossible or would entail unacceptable costs. Let’s consider that similar triangles have one-to-one correspondence relation of their tops and bottoms (Fig. 3).

Figure 3 is two similar triangles, geometry similar concepts derived from ancient Greek mathematics.

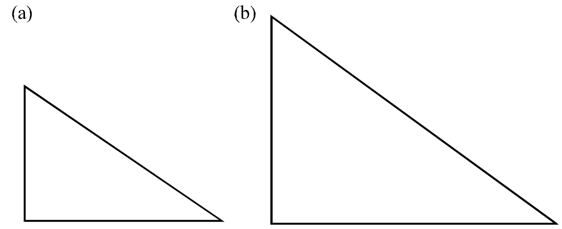

Fig. 3(a-b): Similarity of two similar triangles

If we can find a transaction index the geometrical shape of which is similar to the stock price function similar, then we could find out the extreme values of such index and further the stock price function's extreme values.

Definition of similar broken lines: The definition of limit tells us that broken lines are not differentiable (unequal left and right derivatives) at tip points but obviously the left and right derivatives exists. To facilitate the solution of the problem, we could define the left or right derivative as the derivative of the broken line at a tip point. Obviously, the first order derivative of the broken line exists everywhere.

Assuming that y = f(x), y = g(x) are, respectively the mathematical expression of l_1, l_2, $x \in (a,b)$ and:

$$w(x) = \lim_{\Delta x \to 0} \frac{f(x+\Delta x) - f(x)}{\Delta x},\ z(x) = \lim_{\Delta x \to 0} \frac{g(x+\Delta x) - g(x)}{\Delta x},\ x+\Delta x \in (a,b)$$

If the first order derivative function w(t) = z(t), $t \in (x, x+\Delta x)$ then f(x) and g(x) are in absolute similarity, if linear correlation analysis on variables w(t), z(t) is conducted, then the correlation coefficient y = 1.

Assuming that y = f(x) and y = g(x) are, respectively the mathematical expressions of broken lines l_1, l_2, $x \in (a,b)$ and:

$$w(x) = \lim_{\Delta x \to 0} \frac{f(x+\Delta x) - f(x)}{\Delta x},\ z(x) = \lim_{\Delta x \to 0} \frac{g(x+\Delta x) - g(x)}{\Delta x},\ x+\Delta x \in (a,b)$$

If the first order derivative function w(t) = z(t) and the linear correlation coefficient of $t \in (x, x+\Delta x)$ is y:

- If $|\gamma| \leq 0.3$, then f(x) and g(x) are not similar
- If $0.3 \leq |\gamma| \leq 0.5$ then f(x) and g(x) are in weak similarity
- If $0.5 \leq |\gamma| \leq 0.8$ then f(x) and g(x) are in significant similarity
- If $0.8 \leq |\gamma|$ then f(x) and g(x) are in strong similarity (Wang and Huang, 2013e)

Definition of WP index: Computation equation:

$$WP_{N\text{-}day} = \frac{\text{Average growth of closing prices within N days}}{\text{Average growth of closing prices within N days+average decline of closing prices within N days}} \times 1000\% \quad (1)$$

Equation 1 tells the technical meaning of WP index, i.e., the transaction subject uses the ratio of the growth to decline within several days to describe the function.

As the transaction time is counted on days, the change of the independent variable, Δx, must be equal to 1. Also, time could not be reversed, so $\Delta x>0$. Then, the slope is equal to the change of the function value, $f(x+\Delta x)-f(x)$. The same applies to technical indexes. Therefore, taking WP for example, the algorithm is designed as:

```
Today's closing prices-yesterday's closing prices; today's WP-yesterday's WP;
The source code is:
CLOSE-REF(CLOSE,1);
SMA(MAX(CLOSE-REF(CLOSE,1),0),N1,1)/SMA(ABS(CLOSE-
REF(CLOSE,1)),N1,1)*100-REF(SMA(MAX(CLOSE-
REF(CLOSE,1),0),N1,1)/SMA(ABS(CLOSE-REF(CLOSE,1)),N1,1)*100,1);
```

The two source codes above could derive through computers the mathematical expressions of the daily price differences and corresponding WP values transaction stock of the transaction subject's closing prices.

Use the equation editor of the securities software and respectively enter the following:

```
Master graph: CLOSE-REF (CLOSE,1);
Sub-graph:
SMA(MAX(CLOSE-REF(CLOSE,1),0),N1,1)/SMA(ABS(CLOSE-
REF(CLOSE,1)),N1,1)*100-REF(SMA(MAX(CLOSE-
REF(CLOSE,1),0),N1,1)/SMA(ABS(CLOSE-REF(CLOSE,1)),N1,1)*100,1);
```

Figure 4 is the graph made by computer under the definition of similar curves.

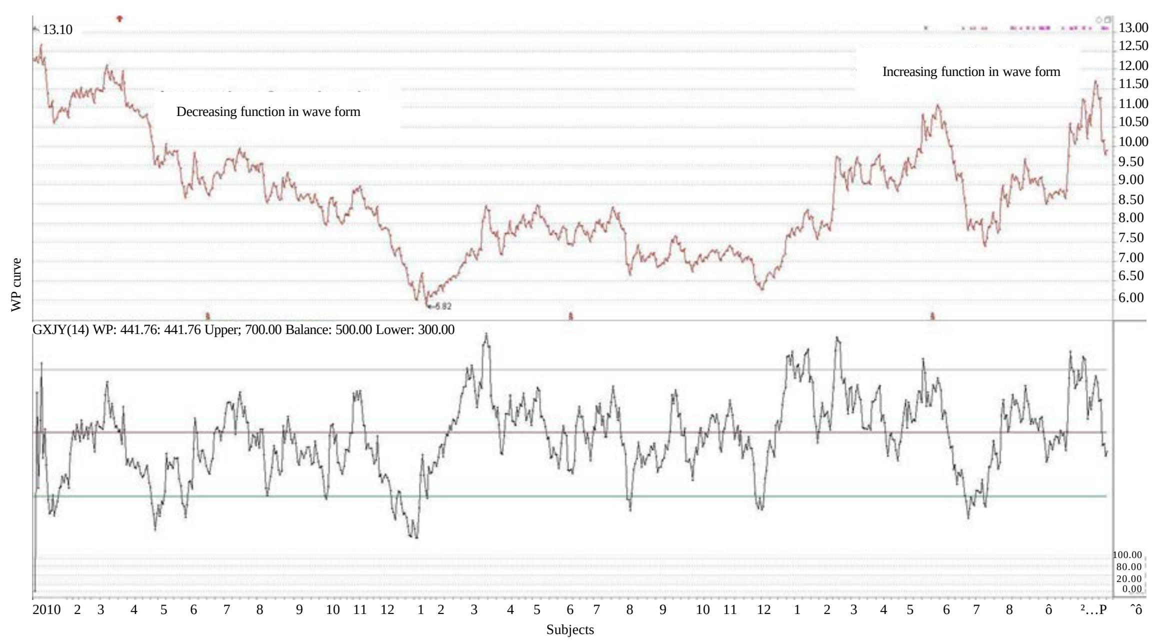

Fig. 4: WP curve similar to the price curve of the transaction subject

RESULTS

Validation: Observation time: June 30, 2010 to September 30, 2011 (15 months). Corresponding Shanghai Stock Index 2398.37-2359.22 (amount of increase-1.6%). Take all Shanghai and Shenzhen A-shares as the total capital, divide the price function into waveform increasing function and waveform decreasing function and randomly extract several samples (more than 30). Starting from actual problems and to avoid the deviation of price function and analysis index and improve reliability, it is required that, the defined correlation coefficient>0.9.

Take the defined f(x) as Shanghai and Shenzhen closing price function and g(x) as WP (14) (Eq. 1) function. The random sampling list is shown as follows in Table 1 and 2.

Table 1 offers 70 samples of the increasing waveform function f(x). Table 2 offers 68 samples of the decreasing waveform function f(x).

Table 1: Waveform increasing function

Stock code and γ value (Time)	WP value corresponding to $\max_{x\in I_k} f(x)$	WP value corresponding to $\min_{x\in I_k} f(x)$
002353,0.94		
2010.07.09	53.06	
2010.07.15		46.11
2010.08.18	69.84	
2010.08.25		52.99
2010.09.13	66.34	
2010.09.15		54.02
2010.09.30	76.95	
2010.10.15		51.17
2010.11.01	70.54	
2010.11.03		58.57
2010.11.11	72.65	
2010.11.17		50.72
2010.12.14	66.97	
2010.12.20		56.94
2010.12.23	64.97	
600111,0.92		
2010.07.05		28.94
2010.07.12	47.95	
2010.07.16		41.44
2010.08.17	78.58	
2010.08.20		60.20
2010.09.13	84.74	
2010.09.20		58.04
2010.10.27	75.28	
2010.12.28		33.56
2011.04.06	72.09	
2011.05.05		43.30
2011.05.11	66.49	
2011.05.18		49.87
2011.05.24	68.88	
2011.05.30		59.08
2011.06.07	73.83	
2011.06.22		44.65
002176,0.94		
2010.06.30		39.67

Table 1: Continue

Stock code and γ value (Time)	WP value corresponding to $\max_{x \in Ik} f(x)$	WP value corresponding to $\min_{x \in} I_k f(x)$
2010.07.13	79.87	
2010.07.21		71.63
2010.08.05	81.74	
2010.08.10		70.80
2010.09.03	72.59	
2010.09.17		43.15
2010.10.26	73.82	
2010.12.29		38.40
2011.02.21	72.86	
2011.02.25		63.64
2011.03.09	78.09	
2011.04.15		41.70
2011.07.25	69.07	
600160,0.88		
2010.07.01		33.63
2010.07.07	49.62	
2010.07.16		43.93
2010.08.09	66.07	
2010.08.10		53.81
2010.08.17	63.89	
2010.08.20		53.09
2010.08.30	65.15	
2010.09.01		58.03
2010.09.10	82.09	
2010.09.17		58.18
2010.10.13	73.20	
2010.10.18		50.96
2010.11.10	72.62	
2010.11.17		47.10
2010.11.29	73.12	
2011.01.25		31.66
2011.02.28	74.71	
2011.03.03		57.05
2011.03.28	75.64	
2011.03.31		59.31
2011.04.15	84.49	
2011.05.23		38.65
2011.07.06	73.79	

Statistical analysis of WP corresponding to extreme values of two kinds of price functions:

- Waveform increasing function
- Waveform decreasing function

Table 3 is the corresponding statistical analysis table of WP, the maximum value of the increasing waveform function f(x). Table 3 helps to derive the corresponding Histogram 5 (Fig. 5). Table 4 is the corresponding statistical analysis table of WP, the minimum value of the increasing waveform function f(x). Table 4 helps to derive the corresponding Histogram 6 (Fig. 6). Table 5 is the corresponding statistical analysis table of WP, the maximum value of the decreasing waveform

Table 2: Waveform decreasing function

Stock code and γ value (Time)	WP value corresponding to $\max_{x\in I_k} f(x)$	WP value corresponding to $\mathrm{mix}_{x\in I_k} f(x)$
002351,0.96		
2010.07.02		36.92
2010.08.02	60.43	
2010.10.18		30.40
2010.12.02	66.54	
2011.01.24		27.19
2011.03.28	62.77	
2011.06.20		24.21
2011.07.14	64.37	
2011.08.09		28.90
2011.08.25	67.09	
2011.10.24		30.97
002362,0.893		
2010.07.16		30.31
2010.08.17	57.93	
2010.09.29		24.66
2010.11.24	64.19	
2011.01.25		24.15
2011.02.17	58.30	
2011.05.23		13.54
2011.06.10	63.37	
2011.08.09		24.52
2011.08.15	40.70	
002373,0.94		
2010.07.16		29.31
2010.08.09	70.41	
2011.01.25		29.92
2011.03.22	60.07	
2011.05.27		19.62
2011.06.15	58.12	
2011.08.09		23.02
2011.08.26	45.17	
2011.09.29		26.60
002379,0.96		
2010.09.20		44.32
2010.10.12	55.83	
2010.10.18		37.90
2010.11.10	56.40	
2010.11.17		37.41
2010.12.03	53.01	
2011.01.25		28.08
2011.02.17	63.84	
2011.05.06		25.25
2011.05.17	45.20	
2011.05.27		18.97
2011.06.14	44.26	
2011.06.20		30.78
2011.07.07	62.83	
2011.07.25		32.65
2011.08.03	46.79	

Table 2: Continue

Stock code and γ value (Time)	WP value corresponding to $\max_{x \in I_k} f(x)$	WP value corresponding to $\min_{x \in I_k} f(x)$
2011.08.19		31.51
2011.08.26	48.02	
2011.09.06		36.51
2011.09.21	50.53	
2011.09.29		32.16
2011.10.13	42.22	
2011.10.21		24.46
002387,0.94		
2010.08.09	67.90	
2010.08.20		44.62
2010.09.08	63.10	
2010.10.18		30.85
2010.11.10	64.12	
2011.01.25		18.89
2011.02.14	58.26	
2011.03.31		23.12
2011.04.11	51.96	
2011.04.28		27.48
2011.05.03	38.59	
2011.05.30		21.79
2011.07.15	65.02	
2011.08.09		28.95
2011.09.14	63.83	

Table 3: WP value corresponding to $\max_{x \in I_k} f(x)$

WP	Values
Mean	71.18829
Standard error	1.435634
Median	72.65
Mode	#N/A
Standard deviation	8.493328
Variance	72.13662
Kurtosis	1.628164
Skewness	-1.05217
Range	36.79
Minimum	47.95
Maximum	84.74
Sum	2491.59
Observation number	35
Maximum (1)	84.74
Minimum (1)	47.95
Confidence coefficient (95.0%)	2.91756

function f(x). Table 5 helps to derive the corresponding Histogram 7 (Fig. 7). Table 6 is the corresponding statistical analysis table of WP, the minimum value of the decreasing waveform function f(x). Table 6 helps to derive the corresponding Histogram 8 (Fig. 8).

Increasing function: Security codes and values: 002353, 0.94°, 600111, 0.92°, 002176, 0.94°, 600160, 0.88°.

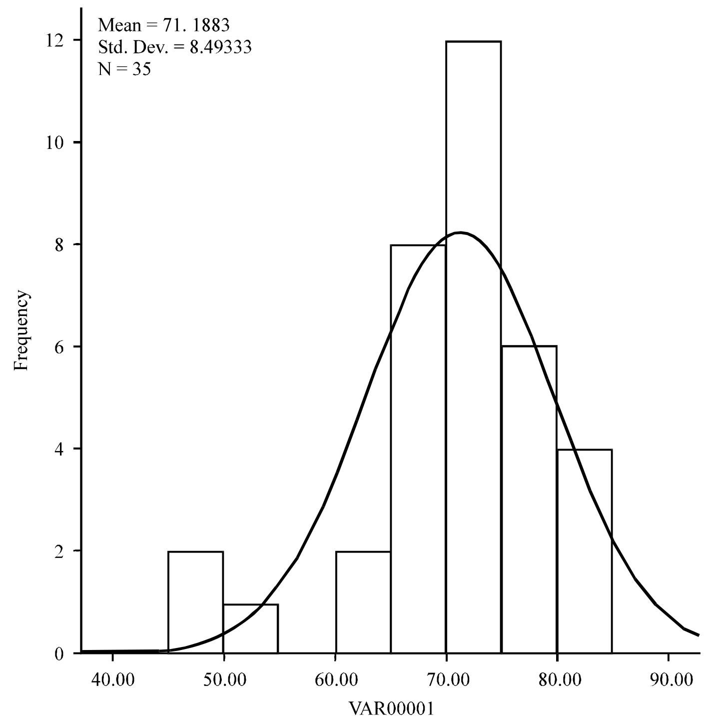

Fig. 5: Probability distribution of WP value when the increasing function reaches the maximum value

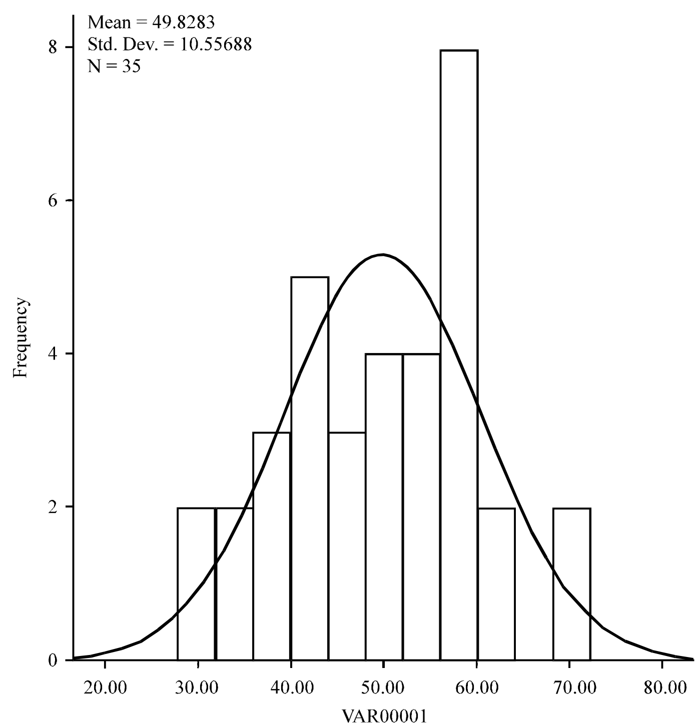

Fig. 6: Probability distribution of WP value when the increasing function reaches the minimum value

Table 4: WP value corresponding to $\min_{x \in I_k} f(x)$ (Statistical analysis)

WP	Values
Mean	49.82829
Standard error	1.784438
Median	50.96
Mode	#N/A
Standard deviation	10.55688
Variance	111.4476
Kurtosis	-0.44339
Skewness	-0.03824
Range	42.69
Minimum	28.94
Maximum	71.63
Sum	1743.99
Observation number	35
Maximum (1)	71.63
Minimum (1)	28.94
Confidence coefficient (95.0%)	3.626414

Table 5: WP value corresponding to $\max_{x \in I_k} f(x)$

WP	Values
Mean	57.00515
Standard error	1.542312
Median	58.3
Mode	#N/A
Standard deviation	8.859906
Variance	78.49793
Kurtosis	-0.81845
Skewness	-0.60345
Range	31.82
Minimum	38.59
Maximum	70.41
Sum	1881.17
Observation number	33
Maximum (1)	70.41
Minimum (1)	38.59
Confidence coefficient (95%)	3.141586

Decreasing function: Security codes and values: 002351, 0.96; 002362, 0.893; 002373, 0.94; 002379, 0.96; 002387, 0.94.

From the WP (Eq. 1) statistical analysis for the values increasing function or decreasing function extreme values of functions we know that WP's value range when the increasing function reaches the maximum value is (48,85) and when $70 \leq WP \leq 75$, the increasing function has the biggest possibility (34.28%) to hit the maximum value (Fig. 5). The WP's value range when the increasing function reaches the minimum value is (30, 70) and when $55 \leq WP \leq 60$, the increasing function has the biggest probability (22.86%) to hit the minimum value (Fig. 6). The WP's value range when the decreasing function reaches the maximum value is (40, 70) and when $60 \leq WP \leq 65$, the decreasing function has the biggest possibility (33.33%) to hit the maximum value (Fig. 7). WP's value range when the decreasing function reaches the minimum value is (14, 45) and when $25 \leq WP \leq 30$, the decreasing function has the biggest possibility (25.71%) to hit the minimum value (Fig. 8) (Wang and Huang, 2013a, b, e; Huang and Wang, 2013d; Wang and Xu, 2014).

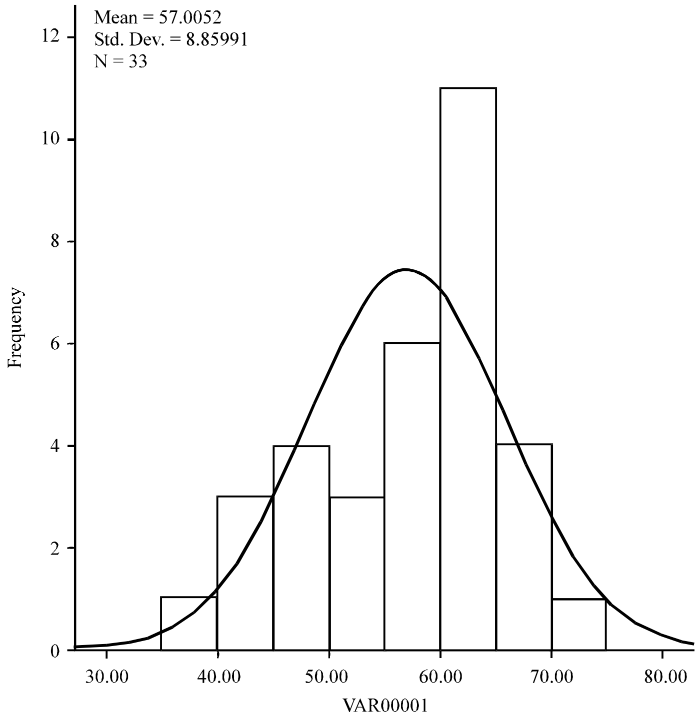

Fig. 7: Probability distribution of WP value when the decreasing function reaches the maximum value

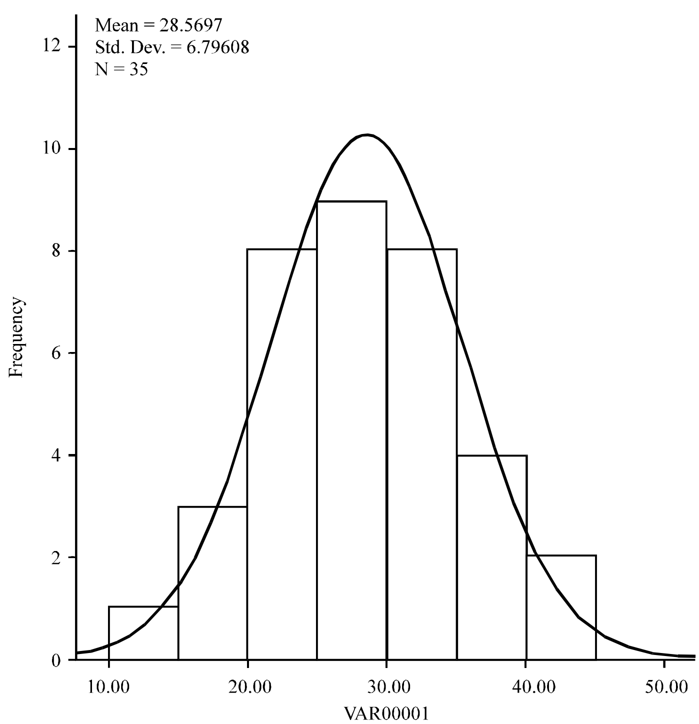

Fig. 8: Probability distribution of WP value when the decreasing function reaches the minimum value

Table 6: WP value corresponding to $\min_{x \in I_k} f(x)$

WP	Values
Mean	28.56971
Standard error	1.148748
Median	28.9
Mode	#N/A
Standard deviation	6.796084
Variance	46.18676
Kurtosis	0.522387
Skewness	0.383345
Range	31.08
Minimum	13.54
Maximum	44.62
Sum	999.94
Observation number	35
Maximum (1)	44.62
Minimum (1)	13.54
Confidence coefficient (95%)	2.334537

Table 7: Test results of each expert system on managerial targets

Parameters	Winning (%)	Annual return	Net profit margin	Annual transaction times
WP expert systems	87.57	75.70	31.54	6,837.60
BIAS expert systems	98.54	41.31	17.21	1977.60
KDJ expert systems	77.25	22.22	9.26	6,213.60
W&R expert systems	73.36	16.04	6.68	7658.40
MA expert systems	75.68	66.39	27.66	8436.00
MACD expert systems	71.94	58.07	24.19	8630.40
MTM expert systems	47.34	30.20	12.58	6065.00

DISCUSSION

Comparison of models: In fact, in K chart-based technical analysis, there are multiple expert systems. If we use winning percentage, annual return, net profit margin and annual transaction times (what the investors care about most) as the managerial targets, the rest results of each expert systems are set out in Table 7. Where, the test platform was Great Wisdom Securities Information Platform V5.99 and the test samples were daily price data of all A-share stocks of the Shenzhen securities market. The test time was from December 2012 to May 2013.

From Table 7 we can see that for what the investors care about most, the winning percentage, annual return and net profit margin, WP (Eq. 1) Expert System gives the optimal result (Wang and Huang, 2013c, d, 2014a, b; Huang and Wang, 2013a-c; Huang *et al*., 2014).

CONCLUSION

This study completes four parts, namely questioning, modeling, result verification and comparison of operating systems and thus redefines the new method of financial technical analysis-similar curve method. This study gives two original new definitions as well as the key source code visually achieved by the function curve. It is obtained that the probabilities for the increasing function to gain the maximum and minimum WP values (Eq. 1) are, respectively 34.28 and 22.86% and those for the decreasing function to gain the maximum and minimum WP values are, respectively 33.33 and 25.71%. The test results of the original WP expert system to the 4 management objectives, i.e., win rate, annual rate of return, net profit rate and annual number of transactions, are respectively 87.57, 75.70, 31.54 and 6,837.60. Compared with other 6 expert systems, WP expert system is the optimal. Due to similar methods of financial technical analysis, the similar curve method can be applied in all transactions. The subsequent studies will focus on the consistency of extreme values.

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