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Comparative Study of RSI Expert System Based on Dow Theory

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Abstract: Using statistical regression analytical method, with the help of stock information and transaction platform, based on the whole historical A-shares data in the stock market of both Shenzhen and Shanghai over 16 years and taking winning percentage, annual rate of return and gross profit rate as management objectives, empirically analyze the RSI expert system with the conclusion that these two stock markets are quite similar. The result proves that the index mutual verification principle of Dow theory is valid in China stock market.

Key words: Regression analysis, dow theory, RSI expert system, mutual verification principle

INTRODUCTION

In the current global financial transactions, there are two accepted mature methods: basic analytical approach and technical analysis. The application of technical indexes analysis and the expert system of security software are necessary to technical analysis. Wang *et al.* studied average line expert system MA and anti tendency expert system RSI (Huang and Wang, 2013a) and came to a conclusion that, expect for number of transactions, RSI expert system is better than MA expert system in terms of winning percentage, annual rate of return and gross profit margin. Wang *et al.* also investigated anti tendency expert system RSI, BIAS, KDJ and W&R (Wang and Huang, 2013; Huang and Wang, 2013b) and concluded that the test results of annual rate of return and gross profit rate for RSI expert system are the best but the test result of W&R is worst. The gross profit rate and annual rate of return for RSI are nearly five times better than W and R, whereas the winning percentage of BIAS expert system is the highest with 98.54% and the number of transactions for W and R is up to 7658.40 times. Therefore, we can know that RSI expert system is the best system whose test results are better than that for both other anti tendency expert systems and average line expert system (MA, MACD, MTM). (Huang and Wang, 2013c). studied the optimization problems of RSI expert system according to the historical data in the stock market of Shenzhen, China over 16 years and concluded that the annual rate of return and gross profit rate are at highest point if buy at 50 in bull market and the winning percentage is the highest if buy at 30. In addition, RSI transaction system has been optimized using these results and optimize source code has been given.

The third basic point of Dow theory (Hurst, 1977; Murphy, 1986), mutual verification principle points out that two kinds of indexes should authenticate mutually (Reja, 2008). That is to say, Shanghai securities composite index of Shanghai stock market and the comprehensive index of Shenzhen stock market should authenticate mutually. Therefore, whether the conclusion of RSI expert system studies are the same based on these two stock markets? Obviously, it is very necessary to have such kind of comparative study. Now, we invest the optimization problem of RSI expert system in Shanghai stock market based on the historical data in the stock market of Shenzhen, China over 16 years and compare with the problem of Shenzhen stock market(Li, 2011).

EMPIRICAL ANALYSIS OF RSI TRADING SYSTEM

Experiments and results: In The original formula given by Welles Wilder is as follows:

$$RSI = \frac{100 \times RS}{1 + RS} \quad (1)$$

or:

$$RSI = 100 - \frac{100}{1 + RS} \quad (2)$$

$$RS = \frac{\text{Average rise point in i days}}{\text{Average dropped point in i days}} (i = 1, 2, \cdots n) \quad (3)$$

Parameter N is determined by the trader and Welles Wilder took N = 14 (Wang, 2001, 2012; Wang and Fang,

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1981). In securities analysis trading software of Chinese mainland, it was taken at N = 6, 12, 24. In order to obtain the appropriate data, we conducted the simulation experiments as follows.

Experiment platform: Great Wisdom Securities Information Platform V5.98 version.

Experiment procedure: LC: = REF(CLOSE, L); WRSI: = SMA(MAX(CLOSE-LC, 0), N, 1)/SMA(ABS (CLOSE-LC),N,1)×100;ENTERLONG: CROSS(WRSI, LL); EXITLONG: CROSS(LH, WRSI).

Experiment parameters: To take a position of all funds by one time, to close all positions when meeting the sell condition, the transaction cost is taken as 0.5%, LL takes 20 (Wang, 2011) at the beginning, LH = 80 with the step length of 5. Experiment process, time and results (Schedule 1):

Test System Configuration

Test methods: technical indicator - RSI14
Test time:1996-3-1 - 2001-6-30 calculation of forced liquidation
Test stocks: total 940 stocks Initial investment: Yuan 40,000.00
Buy conditions:
Once established of one of the following groups:
1. Following conditions are established at the same time
1.1 Technical indicator: the index line RSI of RSI14 (14) pierced upward the 20.00 [daily line]
When the conditions are met: According to the mid-price: all funds are used to buy at the closing price
Once a continuous signal: No longer buy in.
Sell conditions: No sell conditions
Close-out conditions: (close-out according to the closing price)
Stock selection by indicators: Technical specifications: the index line RSI of RSI14 (14) pierced downward the 80.00 [daily line]
With the test on Shanghai Securities Market from March 1, 1996 to June 30, 2001 as the example, through the test by test system of Great Wisdom Securities Information Platform V5.98 version, the results are as follows.

System Test Report

Average number of trading cycles: 280.15
Average cycle of profitable transactions: 284.52
Average cycle of loss transactions: 244.77
Earnings coefficient: 0.95
Largest floating earnings: 47,609,844.00 Yuan
Largest floating loss: 0.00 Yuan
Difference between largest floating earning and loss: 47,609,844.00 Yuan
Total investment: 37,600,000.00 Yuan
Statistics of buy signal
(The statistics of all buy signal points, without considering the signal deletion caused by the capital and strategy during transaction testing)
Success rate: 89.07%
No. of signals: 439 Average annual number of signals: 83.62

Table 1: Test data in Shanghai securities market

LL	Winning rate	Annual rate of return	Net profit margin annual	On No.
20	88.94	5.06	26.14	82.26
25	90.68	10.20	52.68	141.29
30	90.33	16.62	85.88	202.06
35	89.43	20.28	104.78	241.74
40	88.23	22.16	114.51	264.77
45	87.20	25.05	129.43	288.77
50	86.63	26.84	138.69	312.77
55	85.82	25.58	132.15	323.42
60	85.39	24.76	127.92	333.87
65	85.50	23.40	120.89	340.45
70	85.36	19.85	102.56	347.61
75	87.54	13.67	70.61	355.74
80	76.35	2.49	12.87	353.61

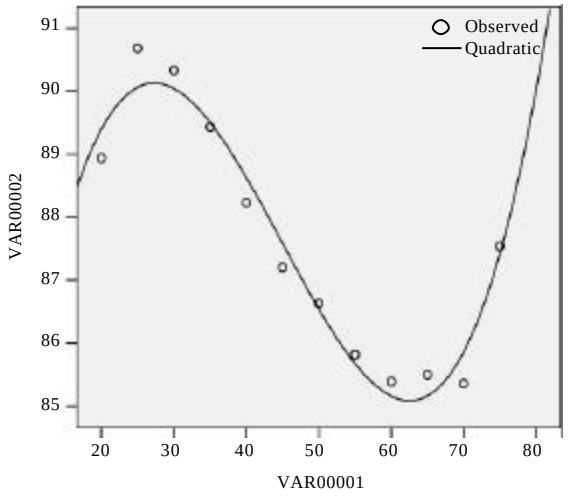

Fig. 1: Fitting curve of winning rate

Numerical analysis: SPSS software is used to conduct the regression analysis (Liu *et al*., 2012) for the above testdata in Shanghai Securities Market and the results are as follows.

The Table 2 shows that: R-squared (Sheng and Ye, 2011) R = 0.965, significance value sig = 0.000. Because the accuracy of coefficient b3 at cubic item is not enough, MATLAB software is used for re-fitting (cubic polynomial fitting), the fitting function and the function image is shown in Fig. 1.

The Table 3 shows that: R-squared R = 0.965, significance value sig = 0.000, fitting function and the function image is shown in Fig. 2.

The Table 4 shows that: R-squared R = 0.965, significance value sig = 0.000, fitting function $y = -185.5+12.764x-0.126x^2$ and the function image is shown in Fig. 3.

The Table 5 shows that: R-squared R = 0.998, significance value sig = 0.000, fitting function $y = -301.148+25.481x-0.346x^2+0.002x^3$ and the function image is shown in Fig. 4.

Table 2: 1996.03-2001.06 winning rate analysis

	Model summary					Parameter estimates			
Equation	R-square	F	df1	df2	Sig.	Constant	b1	b2	b3
Cubic	0.965	73.072	3	8	0.000	76.418	1.176	-0.031	0.000

Dependent variable: VAR00002, Independent variable: VAR00001

Table 3: 1996.03-2001.06 annual return rate analysis

	Model summary					Parameter estimates		
Equation	R Square	F	df1	df2	Sig.	Constant	b1	b2
Quadratic	0.965	138.671	2	10	0.000	-35.899	2.470	-0.024

Dependent variable: VAR00002, Independent variable: VAR00001

Table 4: 1996.03-2001.06 net profit analysis

	Model summary					Parameter estimates		
Equation	R Square	F	df1	df2	Sig.	Constant	b1	b2
Quadratic	0.965	138.835	2	10	0.000	-185.500	12.764	-0.126

Dependent variable: VAR00002, Independent variable: VAR00001

Table 5: 1996.03-2001.06 annual transaction number analysis

	Model summary					Parameter Estimates			
Equation	R Square	F	df1	df2	Sig.	Constant	b1	b2	b3
Cubic	0.998	1752.317	3	9	0.000	-301.148	25.481	-0.346	0.002

Dependent variable: VAR00002, Independent variable: VAR00001

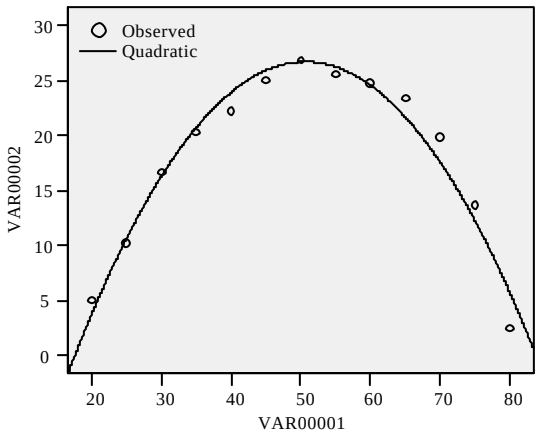

Fig. 2: Fitting curve of annual return rate

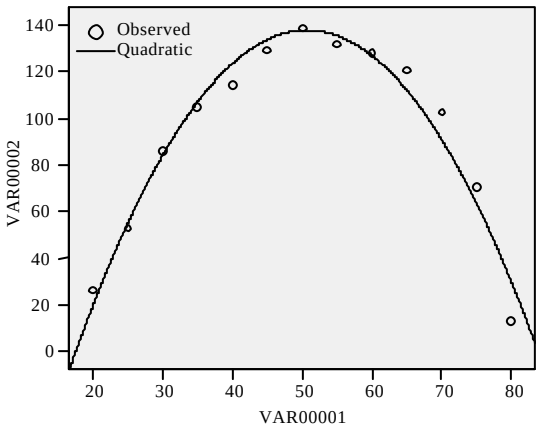

Fig. 3: Fitting curve of net profit analysis

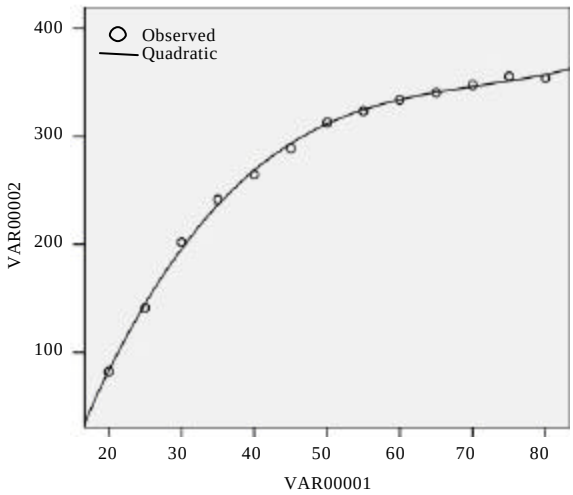

Fig. 4: Fitting curve of annual transaction No. analysis

For the fitting function of winning rate analysis $y = 77.34727+1.098118x-0.028971x^2+0.000214x^3$, we can obtain the stationary points $x_1 = 63.184$ and $x_2 = 27.068$. As shown in Fig. 3, the maximum point x = 27.068.

For the fitting function of annual return rate analysis $y = -35.899+2.47x-0.024x^2$, when $y' = 2.47-0.048x$ and $y'' = -0.048$, it obtained: $2.47-0.048x = 0$ and the maximum point x = 51.46.

Similarly, for the fitting function of net profit analysis, we obtained the maximum point x = 50.65.

As shown by the fitting function of annual transaction number analysis $y = -301.148+25.481x-0.346x^2+0.002x^3$ and its image Fig. 4, y is the monotonically increasing function of x.

Table 6: Fitted curve equations and Extreme value point

Time	Function	LL maximum point
		27.07
1996.03	$y = 77.34727 + 1.098118x - 0.028971x^2 + 0.000214x^3$ $y = -35.899 + 2.47x - 0.024x^2$	51.46
~	$y = -185.5 + 12.764x - 0.126x^2$	50.65
2001.06	$y = -301.148 + 25.481x - 0.346x^2 + 0.002x^3$	Monotonically increasing function
2001.07	$y = 43.493 - 1.251x + 0.017x^2$	36.79 (Minimum point)
~	$y = 1.523 - 0.582x + 0.007x^2$	41.57 (Minimum point)
2005.06	$y = 5.978 - 2.282x + 0.026x^2$	43.88 (Minimum point)
	$y = 251.332 - 4.185x + 0.240x^2 - 0.003x^3$	42.35
2005.07	$y = 82.9002 + 1.2512x - 0.0310x^2 + 0.0002x^3$	27.4983
~	$y = -2005.724 + 115.137x - 1.173x^2$	49.08
2007.09	$y = 152.015 - 55.376x + 2.810x^2 - 0.028x^3$	54.89
	$y = -1797.012 + 115.605x - 1.508x^2 + 0.007x^3$	Monotonically increasing function
2007.10	$y = 41.896 - 1.398x + 0.019x^2$	36.79 (Minimum point)
~	$y = 24.997 - 2.373x + 0.024x^2$	49.44 (Minimum point)
2008.12	$y = 29.1614 - 2.768x + 0.028x^2$	49.43 (Minimum point)
	$y = -1366.696 + 112.26x - 1.630x^2 + 0.006x^3$	46.24
2009.01	$y = 83.643 + 0.613x - 0.008x^2$	38.31
~	$y = -265.291 + 15.055x - 0.145x^2$	51.92
2009.12	$y = -243.188 + 13.801x - 0.133x^2$	51.88
	$y = -1038.922 + 25.439x + 1.386x^2 - 0.017x^3$	62.35
2010.01	$y = -27.305 + 3.269x - 0.083x^2 + 0.001x^3$	Monotonically increasing function
~	$y = 44.922 - 3.055x + 0.03x^2$	50.92 (Minimum point)
2010.06	$y = 18.724 - 1.273x + 0.012x^2$	53.04 (Minimum point)
	$y = -4867.703 + 348.607x - 5.174x^2 + 0.021x^3$	47.32
2010.07	$y = 71.966 + 0.905x - 0.014x^2$	32.32
~	$y = -92.508 + 6.274x - 0.066x^2$	47.53
2011.03	$y = -61.679 + 4.183x - 0.044x^2$	47.54
	$y = -3477.173 + 234.654x - 3.272x^2 + 0.013x^3$	51.93
2011.04	$y = 71.966 - 2.445x + 0.026x^2$	47.02 (Minimum point)
~	$y = 62.019 - 4.305x + 0.07x^2 - 0.000327x^3$	44.84 (Minimum point)
2012.09	$y = 87.84 - 6.098x + 0.099x^2 - 0.00046x^3$	44.76 (Minimum point)
	$y = -709.227 + 75.369x - 1.081x^2 + 0.004x^3$	47.26

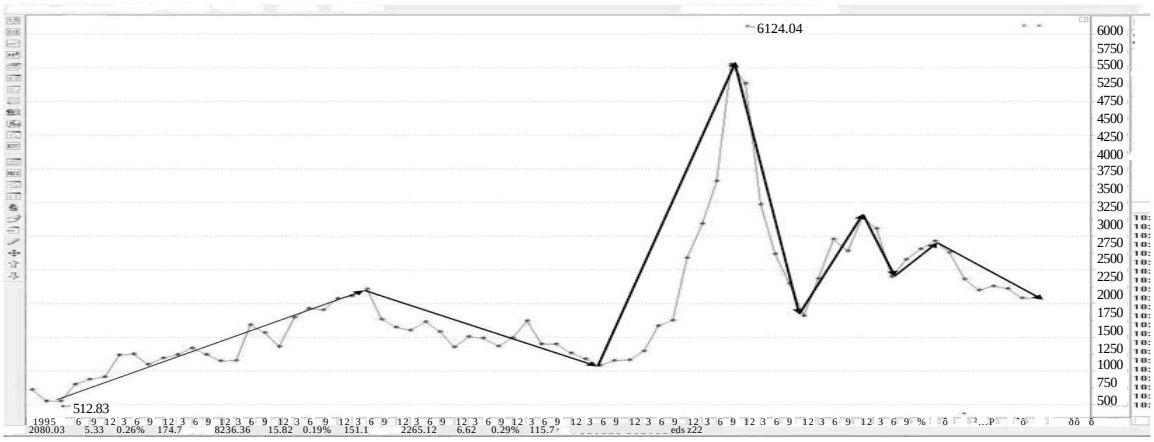

Fig. 5: Season chart of Shanghai composite index

According to above method, all calculated results are listed as follows, of which the functions are listed according to the order of winning rate analysis, annual return analysis, net profit analysis and the analysis of transaction number (Table 6).

Market analysis of mathematical results: As shown from the quarterly closing line of Shanghai Composite Index in Shanghai Securities Market (Fig. 5), the quarterly closing line of Shanghai Composite Index is a waveform increasing function. The market implication of mathematical results is analyzed below according to two situations of bull market (increasing function interval) and bear market (decreasing function interval).

As shown in the Table 7, in the bull market state, the average maximum point for winning rate is: 31.30; the

Table 7: Mathematical results in bull market

Time	Market rise (%)	Maximum point of winning rate	Maximum point of annual return rate	Maximum point of net profit margin
1996.03~2001.06	298.04	27.07	51.46	50.65
2005.07~2007.09	413.65	27.49	49.08	54.88
2009.01~2009.12	80.05	38.31	51.92	51.88
2010.07~2011.03	22.09	32.32	47.53	47.54

Table 8: Mathematical results in bear market

Time	Market rise (%)	Maximum point of winning rate	Maximum point of annual return rate	Maximum point of net profit margin
2001.07~2005.06	-51.26	36.79 (Minimum point)	41.57	43.88
2007.10~2008.12	-67.21	36.79 (Minimum point)	49.44	49.43
2010.01~2010.06	-26.82	Monotonically increasing fnnction	50.92	53.04
2011.04~2012.09	-28.75	47.02 (Minimum point)	44.84	44.76

average maximum point for annual rate of return is: 50.00; the average maximum point for net profit margin is: 51.23; the average maximum point for annual transaction number is: 57.14, or the function of annual transaction number is the monotonically increasing function. Its market implication is that, there is the largest winning rate (least lose) for buy stocks when the RSI pierced upward 31.30; the annual rate of return for buy stocks is the largest (the most profitable) when the RSI pierced upward 50.00; When RSI pierced upward 51.23, the annual net profit margin for buy stocks is the largest (fastest profit). When the RSI pierced upward 57.14 or RSI value is increasing, the success rate of transactions becomes larger. It means that, at this time the stock market is a strong market and the RSI value keeps always in the higher range.

As shown from the Table 8, the winning rate, the annual rate of return and the net profit margin have no maximum points and have only minimum points in the bear market state. The average minimum point for winning rate is: 40.20; the average minimum point for annual rate of return is: 46.69; the average minimum point for net profit margin is: 47.78; the average maximum point for annual transaction number is: 45.79.

With the time period from 2007.10-2008.12 as an example, the fitting function images for winning rate, annual rate of return and net profit margin are listed below (Fig. 6-9).

As shown in Fig. 6 when, the winning rate is the decreasing function of RSI, its market implication is that: The greater the RSI value, the fewer number of investment profitability; while, the winning rate is the increasing function of RSI and its market implication is that, the greater the RSI value, the more number of investment profitability.

As shown in Fig. 7 and 8: When, the annual rate of return and the net profit margin are the decreasing function of RSI and are negative, its market implication is that: The greater the RSI value, the smaller the annual investment rate of return and the net profit margin, i.e., the greater the loss. When, the annual rate of return and net

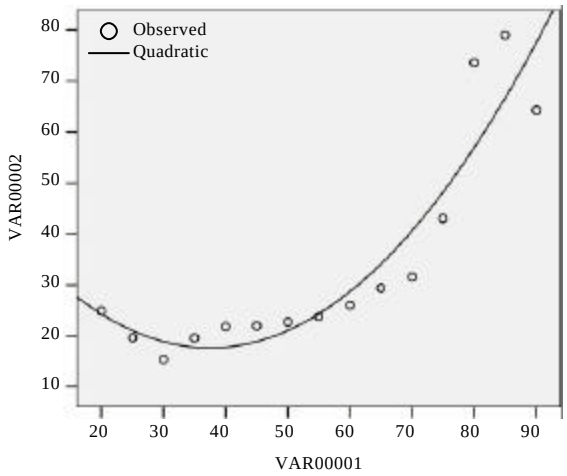

Fig. 6: fitting curve of winning rate

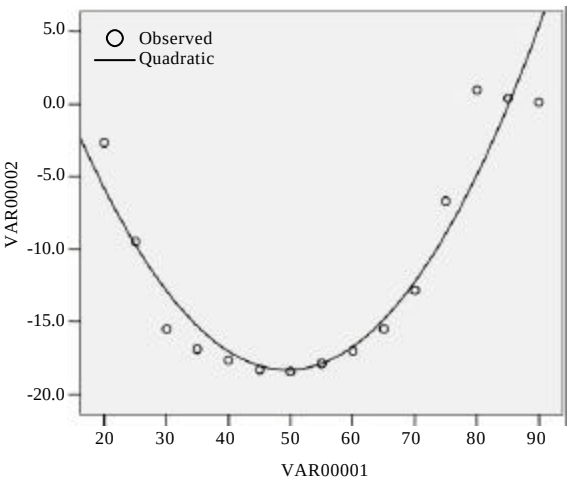

Fig. 7: Fitting curve of annual return rate

profit margin are the increasing function of RSI and are negative, its market implication is that: the greater the RSI value, the greater the annual investment rate of return and the net profit margin, i.e., the smaller the loss but still in a loss.

As shown in Fig. 9: Maximum point of annual transaction number is 46.24, its market implication is that: The number of transaction success is the largest. When, the annual transaction number is the decreasing function of RSI and its market implication is that: the greater the RSI value, the fewer number of transaction success.

In summary, from the perspective of investment profit, the RSI expert system can not guide the investors to profit in bear market.

Visualization results of RSI expert system (Li, 2012): As shown from the quarterly closing line of Shanghai Composite Index in Shanghai Securities Market (Fig. 5), the quarterly closing line of Shanghai Composite Index is a waveform increasing function. The market implication of mathematical results is analyzed below according to two situations of bull market (increasing function interval) and bear market (decreasing function interval).

Optimization of source code:

```
LC: = REF(CLOSE, 1);
WRSI: = SMA(MAX(CLOSE-LC, 0), N, 1)/SMA (ABS(CLOSE-LC),
N, 1)×100;
ENTERLONG :CROSS(WRSI, LL);
EXITLONG:CROSS (LH, WRSI).
```

The following Fig. 10-11, respectively the image of the same stock before and after optimizing the RSI

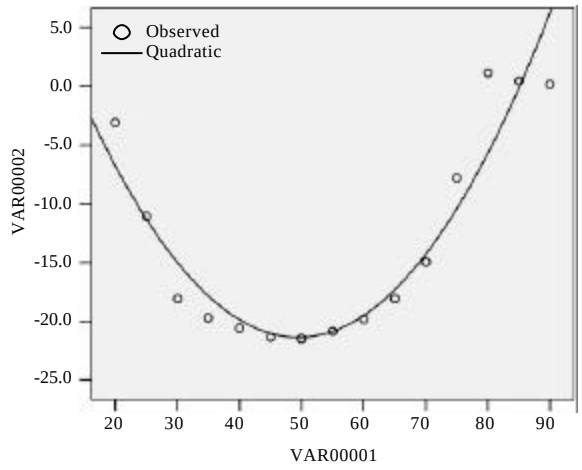

Fig. 8: Fitting curve of net profit analysis

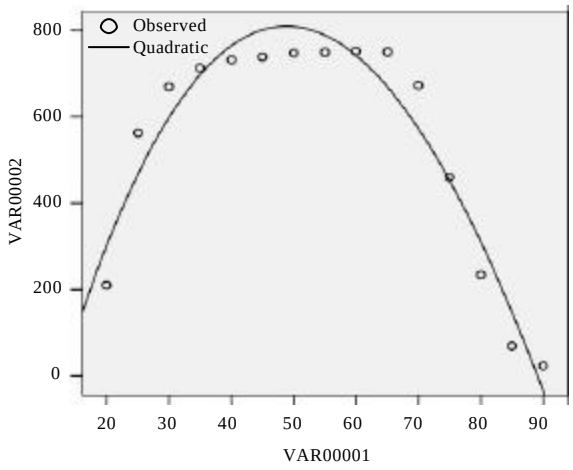

Fig. 9: Fitting curve of annual transaction number analysis

Fig. 10: RSI non-optimal the figure

Fig. 11: RSI Optimize the figure

indicator and the earnings result in Fig. 11 is obviously better than in Fig. 10.

CONCLUSION

Based on the whole historical A-shares data in the stock market of both Shenzhen and Shanghai over 16 years (from March, 1996 to September, 2012), this article empirically analyzes the RSI expert system. In terms of annual rate of return and gross profit rate, the RSI extreme value of these two management objectives for Shenzhen and Shanghai stock market is 0.2485 and 3.0325, respectively, whereas the RSI extreme value of winning percentage is 8.6526. This result illustrates that, under the three management objective above, these two stock markets are quite similar. This result also proves that the Dow theory is applicable in China stock market.

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