Does Change of Shanghai Composite Index Associate with the Stock?

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Abstract

Using Shanghai Composite index as an example, this paper solves the association problem of stock and index using monthly data from 2011 to 2015. To find the association has two problems. The first problem is that probability statistical methods are required huge data to solve large sample multiple data uncertainties. The other problem is that the volume of stock data is so large that it affects our ability to use it. To solve two problems, we constructed a database to reduce the size of stock data and used with that technical theory of gray system developed by Deng that can provide a framework to measure the association with stock and index. These findings have implications for investors that have enough reference to make investment decision.

Keywords: Shanghai Composite index, gray system.

1. Introduction

Investors seek to avoid irrational and blind investment behavior by adopting an optimal investment strategy. They have attempted to use various instruments to identify the pattern of changes in the stock market, predict future trends in share prices, and improve the timing of buying and selling. Investors have a difficult time doing this because of the complexity of the stock market. So Lee and Jo (1999) showed that the timing of buying/selling stock is based on determining the best time to buy and sell stocks given the constant fluctuation of stock prices.

It is difficult to predict stock prices because the volume of data is too huge to influence the ability of using information (Fayyad et al., 1996 and Widom, 1995). Multiyear trend analysis of the stock price thus still presents a problem due to the vast amount of data involved. It is, therefore, important to devise efficient methods to analysis and predict stock prices. For this reason, we constructed a data mart (Demarest, 1994), a relational database, to clean and reduce the size of the stock data so only the useful data is downloaded into the data mart (Liu & Setiono, 1996).

They showed that there are many studies which address prediction of stock price that have generally employed the time series analysis techniques and multiple regression models. But they only consider quantitative factors like technical indexes.

The grey theory that was first proposed by avoids the inherent defects of conventional statistic methods and only requires a limited amount of data to estimate the behavior of unknown systems (Deng 1982 and 1989a,b). In this paper, we use the theory to solve the change of associated with the stock and Shanghai Composite index.

2. Mathematics Model

Deng proposed grey system theory in 1989. The main function of grey relational grade is to do the measurement between two discrete sequences. The grey relational grade is the most important topic in grey system theory. The whole analysis steps are shown below：.

2.1 Factor space

Assume $\{P(X)\}$ is theme, Q is a relationship, and $\{P(X);Q\}$ have (1) existence of factor; (2) accountability of factor; (3) expansion of factor and (4) factor of independent, then, $\{P(X);Q\}$ is called factor space.

2.2 Comparison

For sequence is

$$x_i = (x_1(k),\cdots,x_i(k)) \in X; \quad (1)$$

where: $k = 1,2,3,\cdots,n \in N$, $i = 0,1,2,\cdots, m \in I$, X is Universal set.

If Eq. (1) satisfies: (1) non-dimension; (2) scaling and (3) polarization three conditions, then x_i is called the comparison of sequence.

2.3 Grey relational space

If a space satisfy the conditions of factor space and comparison, then it is called grey relational spce,and written as $\{P(X);\Gamma\}$, where $\{P(X)\}$ is the theme, and Γ is the measure.

2.4 Four axioms

If they exists a function $\gamma(x_i,x_j)\in\Gamma$ satisfy normality; duality symmetric; wholeness and closeness four axioms, then $\gamma(x_i,x_j)$ is called grey relational grade.

Based on Eq. (1), we can write the sequences, as shown in Eq..

$$\begin{aligned} x_0 &= (x_0(1),x_0(2),\cdots,x_0(k)) \\ x_1 &= (x_1(1),x_1(2),\cdots,x_1(k)) \\ x_2 &= (x_2(1),x_2(2),\cdots,x_2(k)) \\ &\vdots \\ x_m &= (x_m(1),x_m(2),\cdots,x_m(k)) \end{aligned} \quad (2)$$

where $i = 0,1,2,\cdots,m$, $k = 1,2,3,\cdots,n \in N$

2.5 Deng's Formula

Deng based on the four axioms to create the grey relational grade, and the Eq. is shown below.

2.5.1 Grey relational grade formula

$$\gamma(x_i(k), x_j(k)) = \frac{\Delta \min. + \xi\Delta \max.}{\Delta_{0i}(k) + \xi\Delta \max.} \quad (3)$$

where: i =1,2,3,…,m, k =1,2,3,…,n, $j \in I$

(1) x_0 : Reference sequence

(2) x_i: Inspected sequences

(3) $\Delta_{0i} = \left|x_0(k) - x_i(k)\right|$;

The norm between x_0 and x_i

(4) $\Delta_{\min.} = \underset{j \in i}{\overset{\min.\min.}{\forall}} \; \forall k \; \left| x_0(k) - x_j(k) \right|$

(5) $\Delta_{\max.} = \underset{j \in i}{\overset{\max.\max.}{\forall}} \; \forall k \; \left| x_0(k) - x_j(k) \right|$

(6) ξ: Distinguishing coefficient,

$\xi \in [0,1]$ (Usually takes 0.5)

2.5.2 Grey relational grade

Takes the mean of grey relational coefficient

$$\gamma(x_i, x_j) = \frac{1}{n} \sum_{k=1}^{n} \gamma(x_i(k), x_j(k)) \qquad (4)$$

2.5.3Grey relational rank ordinal

After the grey relational grade is calculated, according the value, we can rank the sequence, and this procedure is called grey relational rank. For reference sequences x_0, and inspected sequences are x_i, if $\gamma(x_0, x_i) \geq \gamma(x_0, x_j)$ then we found that under the reference sequence x_0, the grey relational rank of x_i is greater than grey relational rank of x_j.

2.5.4 Cardinal Grey Relational Grade

Because Deng's grey relational grade is ordinal type, hence, in our paper, the cardinal grey relational grade is presented in the paper. The Hsia's cardinal grey relational grade is using in the paper (Wen, 2004).

$$\Gamma_{0i} = \Gamma(x_0, x_i) = \frac{\Delta_{\max.} - \overline{\Delta}_{0i}}{\Delta_{\max.} - \Delta_{\min.}}, \quad \overline{\Delta}_{0i} = \left\{ \frac{1}{n} \sum_{k=1}^{n} \Delta_{0i}(k) \right\} \qquad (5)$$

In Eq. (2), if each sequence $x_i(k)$ can be the reference sequence, then, it called globalization grey relational grade, then, Eq.(5) can be rewritten as

$$\Gamma_{ij} = \Gamma(x_i, x_j) = \frac{\Delta_{\max.} - \overline{\Delta}_{ij}}{\Delta_{\max.} - \Delta_{\min.}}, \quad \overline{\Delta}_{ij} = \left\{ \frac{1}{n} \sum_{k=1}^{n} \Delta_{ij}(k) \right\} \qquad (6)$$

2.5.5 Globalization Grey Relational Grade

After all of grey relational grade is calculated, the grey relational grade matrix can be established, then, use the eigenvector method to find the weighting for each factor. The whole steps are illustrated below.

1. Constructing the relative weighting matrix $[R]_{m \times m}$, which is called "grey relational matrix".
2. Finding the eigen value for the relative weighting matrix $AR = \lambda R$
3. Using eigenvector method to find the weighting for each target $P^{-1}RP = diag\{\lambda_1, \lambda_2, \lambda_3, \ldots \lambda_n\}$
4. The maximum $\lambda_{\max}$ corresponding eigenvector are the weighting value for whole sequences.

$$R_{m \times m} = \begin{bmatrix} \Gamma_{11} & \Gamma_{12} & \cdots & \Gamma_{1m} \\ \Gamma_{21} & \Gamma_{22} & \cdots & \Gamma_{2m} \\ \vdots & \vdots & \ddots & \Gamma_{11} \\ \Gamma_{m1} & \Gamma_{m2} & \cdots & \Gamma_{mm} \end{bmatrix} \qquad (7)$$

3. Data

3.1 Sample Construction

The samples of 50 securities are constructed. The securities are selected at Shanghai Stock Exchange 180 index constituents from the Shanghai Stock Exchange Corporation (SSE). These securities comprising 50 of the most liquid, the largest stocks and representing nearly 55% of the Shanghai market. They are the most influential groups of leading enterprises in the market situation, concentrate in the traditional industries of financial, energy, raw materials and industrial.

The SSE 180 Index selected that Shanghai Stock Exchange listed companies in the total market value and the amount of turnover of the top 180 stocks. These companies are the most representative large blue-chip stock indexes in the Shanghai stock market, accounting for 73% of the market value, accounting for 46% of the transaction volume, released in July 2002. They have many advantages that include the strong core competitiveness, large-scale assets, good business performance and wide product brands. The base period of the Shanghai 50 Index began on January 2, 2004, and the quarterly audits of constituents were performed in June and December of each year. If the market performance of constituent stocks is abnormal and the numbers of committee are deemed unsuitable for use as samples, the stock will be deleted.

Constituents were required to fulfill three core auditing criteria:

The first criterion was no more than 10% per adjustment.

The second criterion was the adjustment of the sample. It set the buffer and the top 40 new samples prioritized to entry it , the top 60 older samples was reserved.

The third criterion is the factors that affect the eligibility of constituents. It includes long-term stock suspension, financial losses, mergers and acquisitions, the separation of a number of companies, to suspend listing or delisting and bankruptcy and other factors.

Data between January 2006 and December 2015 were used as test samples. Applying the three criteria listed above, we eliminated from our study any stocks that were replaced by reserve-list stocks and any that had incomplete data for the study period. We choose the maximum number of samples that was the period between January 2011 and December 2015. The actual sample structure was comprised of 38 constituents, and the list of companies is presented in Table 1.

It was removed twelve companies, including : Baogang Group (600010) 、SIPG (600018) 、BESTV (600637) 、Avic Power Science (600893)、Guotal Junan (601211)、NCI(601336)、Power China (601669) 、CRRC (601766) 、 China Communications Construction (601800) 、 Founder Securities (601901) 、 CLP Group(601985) 、CSIC (601989).

We used the closing price on the last transaction day of every month to measure correlation.

Table 1: List of Shanghai Composite 50 Index Constituents Fitting the Sample Structure

Time Period: 2011 – 2015

Stock Code	Company Name	Order	Stock Code	Company Name	Order
600000	SPD Bank	1	600999	CMS	20
600015	Huaxia Bank	2	601006	Daqin Railway	21
600016	CMBC	3	601088	China Shenhua	22
600028	Sinopec	4	601166	Industrial Bank	23
600030	Citic Securities	5	601169	Beljing Bank	24
600036	CMB	6	601186	China Railway Construction	25
600048	Poly	7	601288	Agricultural Bank of China	26
600050	China Unicom	8	601318	Ping An	27
600104	Saic Motor	9	601328	Bank of Communications	28
600109	Sinolink Securities	10	601390	China Railway	29
600111	China Northern Rare Earth	11	601398	ICBC	30
600150	CSSC	12	601601	CPIC	31
600518	KangMei	13	601628	China Life	32
600519	Kweichow Moutal	14	601668	China State Construction	33
600585	CONCH	15	601688	HuaTai Securities	34
600795	Guodian Power	16	601818	China Everbright Bank	35
600837	Haitong	17	601857	CNPC	36
600887	Yili	18	601988	Bank of China	37
600958	Orient Securities	19	601998	China Cttic Bank	38

3.2 Data sampling

In this paper, all the data was collected from a stockbroker's mainframe in Shanghai stock market recorded every day. The trading hours in Shanghai stock market is from 9:30am to 11:30am and 13:00pm to 15:00pm on weekdays.

To simplify data processing, constituents of the SSE 50 Index were extracted from the set of 1079 listed companies (through the end of 2015), and 12 company stocks with fluctuations were removed, leaving 38 constituents used to measure correlation with the Shanghai Composite index. Data generated between January 2011 and December 2015 were used as test samples. The closing price on the last transaction day of each month was used as data to measure correlation.

The nature of grey prediction system is the result of uncertainty caused by a limited amount of data. Only a small amount of data is needed to resolve the uncertainty caused by limited data and small samples.

Accordingly, the closing prices of the last transaction day of each month for both the Shanghai Composite index and the 38 constituents were used as data for relational testing. Monthly data from January 2011 to December 2015 were used as test samples (each batch consisted of 60 data points).

4. Empirical Results

4.1 Calculating the mean values of relational coefficient between the Shanghai Composite index and individual shares

The data of the test sample were processed according to the following procedure to calculate the mean values of relational coefficients between the Shanghai Composite index and individual shares.

First, we identified the reference sequence and the comparative sequence. The reference sequence A_0 and comparative sequence A_i were identified from the research subjects. The reference sequence is a combination of the ideal target values of each contributing factor, and the comparative sequence is composed of the performance values of each proposal. In the current study, the Shanghai Composite index was set as the reference sequence and the 38 constituents were set as the comparative sequences.

Second, we standardized the numerical values of the collected sequences. There are three methods of standardization in grey relational analysis: larger-the-better, smaller-the-better, and nominal-the-best.

The most frequently applied method, larger-the-better, is described as follows: the larger the target numerical value, the better; for example, the larger the profits, the better.

$$X_{ij}^{*} = -\frac{x_{ij}-\min_i x_{ij}}{\max_i x_{ij}-\min_i x_{ij}} \quad (8)$$

Where $\max_i \ x_{ij}$ the maximum is numerical value for item j; $\min_i \ x_{ij}$ is the minimum numerical value of item j.

The smaller-the-better can be described as follows: the smaller the target value, the better; for example, the less pollution, the better.

$$X_{ij}^{*} = -\frac{\max_i x_{ij}-x_{ij}}{\max_i x_{ij}-\min_i x_{ij}} \quad (9)$$

The nominal-the-best method is described as follows: setting the target value as a specific value between the maximum and minimum value, denoted by $x_{obj.}$

$$X_{ij}^{*} = -\frac{|x_{ij}-x_{obj}|}{\max_i x_{ij}-x_{obj}} \quad (10)$$

Where $\max_i \ x_{ij} \ \geq \ x_{ij} \ \geq \min_i \ x_{ij}$

To simplify data calculation, the closing prices of the Shanghai Composite index and individual stocks on January 31, 2011 were defined as the denominator for the Shanghai Composite index and the 60 test samples of individual stocks. The percentages of the other 59 test samples were calculated, and they were ordered in sequence by month. The Shanghai Composite index of the reference sequence was placed on the first row, and individual stocks of other comparative sequences were ranked from the second row to the 39th row, completing the standardization of numerical values.

The third step was to calculate the grey relational distance Δ_{oij}. Δ_{oij} can be described as the distance between each numerical value post-standardization and the reference numerical value post-standardization.

$\Delta_{oij} = |x^*_{oj} - x^*_{ij}|$ (11)

x^*_{ij} represents the reference numerical value after normalization, x^*_{oj} represents numerical values after normalization.

Fourth, the grey relational coefficient γ_{oij} was calculated. γ_{oij} can be described as follows: ζ is the distinguishing coefficient, which aims to control the size of the grey relational coefficient to facilitate judgment, and 0.5 is generally used as the criteria.

$$\gamma_{oij} = \frac{\Delta \min + \zeta \Delta \max}{\Delta + \zeta \Delta \max} \quad (12)$$

$$\Delta \max = \max_i \max_i \Delta_{oij} \qquad \Delta \min = \min_i \min_i \Delta_{oij} \qquad \zeta \in [0.1]$$

Fifth, we calculated the grey relational grade Γ_{oi}.For each proposal, the grey relational coefficient was multiplied by the weighting of each assessment criterion, and the weighted average was the grey relational grade. This can be regarded as the score of each proposal: the higher the score, the more important it is, or the better the performance.

Sixth, we addressed the grey relational rank. An important proposal was chosen based on the grey relational grade, and the decision-making process was compared with the computed the grey relational grade $\Gamma_{oi;}$ the greater the value of $\Gamma_{oi,}$ the more important it is or the better the performance.

Subsequent to the calculations from steps three to six of standardized data, the results of analyses were obtained, as shown in Table 2. In the table, the values are arranged according to the value of the gray relational degree Γ_{oi}. The largest and ranked first stock is code 601328 companies.

Table 2: Results of Grey Relational Analysis

Stock	the Mean Values of Relational Coefficient	Sequence	Stock	the Mean Values of Relational Coefficient	Sequence
601328	0.9594	1	600999	0.8924	20
601006	0.9574	2	600050	0.8821	21
601998	0.954	3	600519	0.8812	22
601988	0.9501	4	600048	0.8702	23
601601	0.9445	5	600028	0.8655	24
600104	0.9422	6	600030	0.8637	25
601818	0.9408	7	600518	0.8591	26
600000	0.9392	8	600109	0.8587	27
600036	0.9322	9	601088	0.8516	28
601628	0.9322	10	600958	0.8425	29
600015	0.9309	11	601186	0.8332	30
600795	0.924	12	600887	0.8272	31
601318	0.9227	13	600585	0.8212	32
601857	0.922	14	600837	0.82	33
601398	0.9147	15	601390	0.7951	34
601169	0.9125	16	601166	0.7909	35
601688	0.8984	17	600111	0.7809	36
601288	0.8982	18	600150	0.7375	37
601668	0.8962	19	600016	0.7167	38

4.2 Verifying the correlation between the Shanghai Composite index and individual stocks

After the numerical value standardization and multiple calculations of the Shanghai Composite index and the 38 constituents, we yielded the mean values of relational coefficients between each test sample and the Shanghai Composite index. The larger the numerical value, the stronger the relationship between the test sample and the Shanghai Composite index.

To better understand the implications behind the ranking of relational coefficient mean values, the market capitalization proportion ranking of Shanghai Composite index constituents released by Shanghai Composite index was included for cross-comparison with the relational coefficient mean value sequence. The modified analytical results can be found in Table 3. Guotai Junan Securities to provide information on the proportion of market value of constituent stocks in January 28, 2015.

It is clearly shown in Table 3 that Ping An (601318), which had a weighted proportion of 9.71% in the Shanghai stock market, ranked 13th on the relational coefficient sequence. Citic Securities (600030), ranking the second in the weighted proportion, had a rank of 25th in the relational coefficient sequence. The three most important companies in the industrial sector ranked 21th (Sinopec), 22th (China Unicom), and 10th (ICBC) on the weighted proportion. Their corresponding ranks in the relational coefficient sequence were 24th, 21th, and 15th, respectively. One surprising result was that Bank of Communications, which ranked first in the relational coefficient sequence, ranked 8th in the weighted proportion sequence. Our results deviated substantially from the rules of thumb used by many investors.

Stock investors are most interested in predicting future trends in stocks prices, and in improving the timing of buying and selling. The ability to determine the optimal timing of buying and selling stocks could help investors earn exceptional rewards. Consequently, investors have used various instruments to predict the movements of the Shanghai Composite index, in an attempt to search for the pattern of price changes in the stock market. They have also analyzed the characteristics of fluctuations in stock prices, and the cycle of increasing and decreasing prices based on this pattern. These instruments have enabled investors to adopt optimal investment strategies when facing a volatile stock market, and to prevent blind and irrational investment behavior.

Investors have also frequently assessed the risks of entering the market by observing the relative positions of the Shanghai Composite index, in conjunction with observations about the stock price trends of specific constituents that serve as indicators for bull and bear market directions. In the Shanghaiese stock market, the most frequently selected constituents for observation are leading companies in various industries, such as the aforementioned Ping An (601318), Citic Securities (600030), Sinopec (600028), China Unicom(600050), ICBC (601398). However, this type of observation list does not offer clear guidance on the direction or movements of the Shanghai Composite index.

In the next section, we will determine whether the stock price trend of Bank of Communications, which ranked first in the relational coefficient sequence, can be used as an important indicator for observing future trends in the Shanghai Composite index.

First, the graphs of stock price trends for the Shanghai Composite index and Bank of Communications were presented as closing price trend lines, which is a form of technical analysis. The monthly trend lines from January 2011 to December 2015 were used. The line in stock price was marked with a bold black line, forming the comparison charts in Figure 1.

Second, on the Shanghai Composite index and Bank of Communications stock price charts was marked, and the date of each turning point was recorded. Shanghai Composite index had 26 turning points, while Bank of Communications had 24. After eliminating short-term fluctuational turning points, there were 20 significant turning points.

Third, after summarizing the dates of all turning points, we generated a statistical table in which the turning points (peaks and troughs) of the Shanghai Composite index and Bank of Communications took place on the same month, as seen in Table 4. Among the 20 time-points of bull and bear market transitions, Shanghai Composite index and Bank of Communications shared 16 turning points that were on the same month, with a matching rate of 80%; as a result, Bank of Communications can be regarded as a coincident indicator of the Shanghai Composite index.

Table 3: Constituents in Shanghai Index, Proportion of Market Capitalization and Relational Coefficient Sequence

Stock	Stock Rank of Weighted Value	Rank of Relational Coefficient	Market Capitalization as a Proportion of Shanghai Index
601318	1	13	9.71%
600030	2	25	6.36%
600016	3	38	5.96%
600036	4	9	5.68%
600000	5	8	4.37%
601166	6	35	4.03%
600837	7	33	3.55%
601328	8	1	3.22%
601601	9	5	2.62%
601398	10	15	2.57%
601668	11	19	2.23%
600519	12	22	2.18%
600887	13	31	2.08%
601628	14	10	1.94%
601006	15	2	1.87%
601169	16	16	1.69%
600104	17	6	1.65%
601857	18	14	1.48%
601818	19	7	1.44%
601390	20	34	1.31%
600028	21	24	1.21%
600050	22	21	1.17%
601088	23	28	1.15%
600015	24	11	1.09%
600585	25	32	1.07%
601988	26	4	1.06%
600999	27	20	1.05%
601186	28	30	1.04%
601998	29	3	0. 61%

Figure 1: The Closing Price Correlation Graphs between Shanghai Composite index and Bank of Communications over a 5-year Period

Time Period: 2011 – 2015

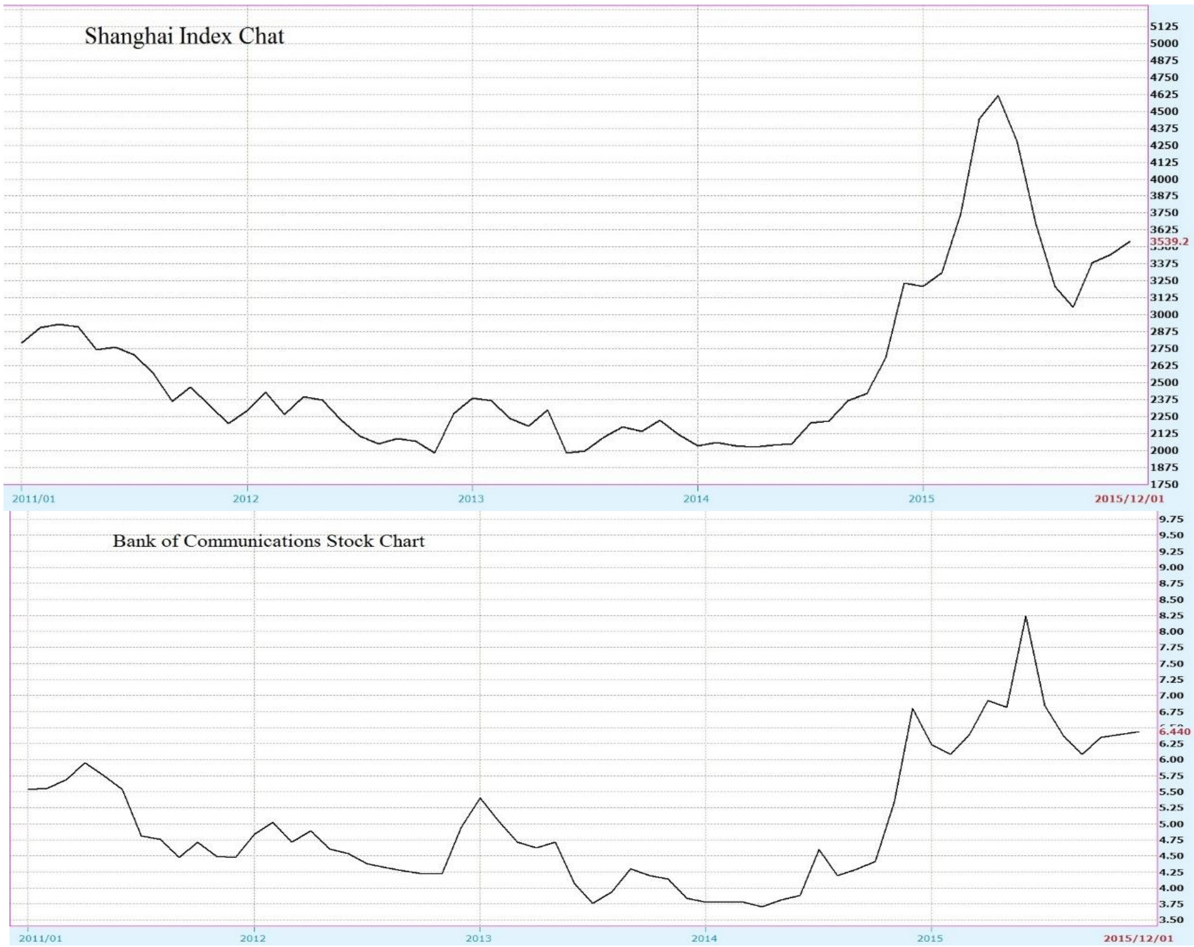

Table 4: Timing of Turning Points (Peak and Troughs) for Shanghai Composite index and Bank of Communications

Time Period: 2011 – 2015

Turning Points	Time	Frequency	Turning Points	Time	Frequency
Low	2005/8/31	1	High	2009/9/30	21
High	2005/9/30	2	Low	2009/12/31	22
Low	2005/10/31	3	Low	2010/2/26	23
High	2005/12/30	4	High	2011/1/28	24
High	2006/12/29	5	Low	2011/2/25	25
Low	2007/1/31	6	Low	2011/9/30	26
Low	2007/4/30	7	High	2011/10/31	27
High	2007/7/31	8	Low	2011/11/30	28
Low	2007/8/31	9	High	2012/2/29	29
High	2007/10/31	10	Low	2012/7/31	30
High	2008/4/30	11	High	2012/9/28	31
Turning Points	Time	Frequency	Turning Points	Time	Frequency
Low	2008/7/31	12	Low	2012/10/31	32
High	2008/8/29	13	High	2013/5/31	33
Low	2008/11/28	14	Low	2013/6/28	34
High	2008/12/31	15	High	2013/7/31	35
Low	2009/1/21	16	Low	2013/8/30	36
High	2009/5/27	17	High	2013/12/31	37
Low	2009/6/30	18	Low	2014/4/30	38
High	2009/7/31	19	High	2014/7/31	39
Low	2009/8/31	20	Low	2014/9/30	40

5. *Conclusion*

The following conclusions were reached in this article:

The weighting value of constituents in Shanghai Composite index was not positively correlated with the relational coefficient sequence.

The stock most strongly correlated with Shanghai Composite index was Bank of Communications, and among the 20 turning points in the 5-year period of sample observation, 16 turning points in the closing price trend lines occurred on the same month, resulting in a matching rate of 80%. For this reason, Bank of Communications can be regarded as a coincident indicator of Shanghai Composite index.

Investors frequently observe the dynamics of large-scale weighted stocks when determining the trends of the Shanghai Composite index for the operations of related financial commodities. However, our results deviated from the more heavily weighted individual stocks, which are more familiar to investors. Consequently, our results can serve as another focus of observation for investors, and as an important guide for investment decision-making.

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