

The Index and Stock Price Synchronicity: Evidence from Taiwan

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Abstract. Research on stock synchronization has always been a topic of concern to scholars and investors. In the past, the focus was mainly on equity concentration, foreign shareholding, audit quality, and other issues, not including indexes. This article uses the monthly data of the Taiwan Stock Exchange Capital Weighted Stock Index (TAIEX) to solve the problem of the index and stock synchronization. And use the technical theory of the gray system to solve the small sample and uncertain problem. The discovery of the synchronization between these indexes and stock prices may provide investors with sufficient reference to make investment decisions.

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) [1] 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 volumes of data are too huge to influence the ability to use information (Fayyad et al., 1996 and Widom, 1995)[2][3]. A multi-year 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 for the analysis and predict stock prices. For this reason, we constructed a data mart (Demarest, 1994)[4], 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)[5].

They showed that many studies address the prediction of the stock price that has 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)[6][7].

In this paper, we use his theory to solve the change associated with the stock and index. The current research on stock synchronization covers the following topics: equity concentration, foreign shareholding, audit quality, system development, trade secret law, trust, analyst coverage, but does not include indexes (Chan and Hameed (2006), Gul, Kim et al. (2010), Hasan, Song et al. (2014), Kim, Su et al. (2020) and Qiu, Yu et al. (2019)[8][9][10][11][12].

2 Data and methods

2.1 Data for association problem within grey system theory

The constituent stocks of the FTSE Taiwan 50 Index of the Taiwan Stock Exchange account for nearly 70% of the market capitalization of the Taiwan market and are the highest blue-chip stocks. The benchmark period of the Taiwan 50 Index began on April 30, 2002. Quarterly audits of constituent stocks are conducted in March, June, September, and December each year. The core audit criteria are market value, free float, and liquidity. This article takes these 50 securities as the research sample which is the most representative for Taiwan's securities market.

For the completeness and correctness of the information, this article applies the above audit standards to collect data between January 2003 and December 2018 as test samples. Any stocks with incomplete data during the study period and stocks replaced by stocks on the reserve list are eliminated. The final sample structure is composed of 43 constituent stocks. The data uses the

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closing price of the first trading day of each month to measure the synchronization of stocks.

2.2 research methods

Many researchers have conducted much of the research to measure the change of index associate with the stock.

According to the methodology used by researchers, previous studies can be divided into three streams of research: one stream of research using statistical methods and the other streams of research using the fuzzy stock prediction system and grey theory. The comparison of the three research methods is shown in Table 1.

This research uses gray theory to solve the problem of stock price synchronization.

Table 1 Difference of Probability Statistics, Fuzzy Theory, Gray Theory

Comparison Of Projects And Differences	Probability Statistics	Fuzzy Theory	Gray Theory
1.Essential Connotation	Large Sample and Uncertain	Uncertainty of Cognition	Small Sample and Uncertain
2.Mathematical Basis	Cantor Set	Fuzzy Set	Hazy Set
3.Mathematical Operation	Statistical Methods	Take the Boundary Value	Generating Method
4.How Much Data	Multiple Data State	Empirical Data Status	Less Data State
5.Data distribution	Typical Distribution	The Distribution of Functions	Arbitrary Distribution
6.The Goal Of Completion	The Statistical Law of History	Cognitive Expression	The Law of Reality

3 RESEARCH MAPPING RESULTS

3.1 Calculate the average value of the relationship coefficient, from the index and constituent stocks

According to the technical theory of the gray system, this paper uses six steps to calculate the average value of the correlation coefficient between the index and the constituent stocks.

First, the reference sequence A_0 and the comparison sequence A_i must be determined. The combination of ideal target values for each influencing factor is set as the reference order, and the composition of each suggested performance value is set as the comparison order. In this article, the reference sequence is set as an index, and the comparison sequence is 43 constituent stocks.

Second, in order to simplify the calculation of the data, this paper standardized the values of the collected series. The denominator is defined as the closing price of the index and 216 constituent stocks on January 2, 2003. And sort by month, calculate the percentage of other 215 test samples. Place the index of the reference sequence in the first row, and rank individual stocks in other comparison sequences from the second row to the 44th row to complete the numerical standardization work.

The third step is the calculation of the gray relationship distance Δ_{oij} .

Fourth, calculate the gray correlation coefficient γ_{oij} .

Fifth, we calculated the grey relational grade Γ_{oi} .

Sixth, we addressed the grey relational rank. After calculating the standard data from step 3 to step 6, the analysis results in Table 2 are obtained.

Table 2 Results of Grey Relational Analysis

Stock	the Mean Values of Relational Coefficient	Sequence	Stock	the Mean Values of Relational Coefficient	Sequence
1303	0.9979	1	2885	0.9855	23
1301	0.9971	2	2408	0.9854	24
2412	0.9951	3	2303	0.9848	25
1326	0.9943	4	2882	0.984	26
1402	0.9932	5	2892	0.984	26
2105	0.9925	6	2880	0.983	28
2002	0.9923	7	2890	0.9829	29
1102	0.9922	8	2884	0.9828	30
4904	0.9916	9	2409	0.9824	31
2823	0.9913	10	2883	0.9822	32
6505	0.9902	11	2308	0.981	33

1101	0.99	12	2891	0.9808	34
2881	0.9898	13	2887	0.9792	35
2801	0.9886	14	2912	0.9791	36
2317	0.9882	15	3045	0.9772	37
2382	0.9881	16	2357	0.9731	38
2886	0.9881	16	1216	0.9687	39
2395	0.9879	18	2354	0.9604	40
2301	0.9876	19	2474	0.9563	41
2454	0.9875	20	2327	0.9441	42
2330	0.9873	21	3008	0.9026	43
9904	0.9871	22			

3.2 Synchronization verification between the index and constituent stocks

To solve the problem of synchronization verification between the index and the constituent stocks, multiple calculations and numerical standardization must be carried out for the index and the 43 constituent stocks to calculate the average value of the relationship coefficient

between each sample and the index. Finding the sample with the largest value means the stronger the relationship with exponential synchronization.

What is the meaning behind the ranking of the average correlation coefficient? This article cross-compared it with the market capitalization ratio rankings of TAIEX constituent stocks, and you can understand the importance of the correlation coefficient average series.

The analysis results after cross-comparison are shown in Table 3.

Table 3 Constituents in TWSE TAIEX, Proportion of Market Capitalization and Relational Coefficient Sequence

Stock	Ranking of Stock Weight Value	Ranking of Relational Coefficient	Market Capitalization as a Proportion of TAIEX
2330	1	21	19.298%
2317	2	15	3.3413%
6505	3	11	3.2779%
2412	4	3	2.7297%
1301	5	2	2.2697%
1303	6	1	1.9412%
1326	7	4	1.8799%
2882	8	26	1.6822%
3008	9	43	1.6103%
2454	10	20	1.5523%
1216	11	39	1.4633%
2881	12	13	1.4611%
3045	13	37	1.3098%
2886	14	16	1.3086%
2891	15	34	1.2962%
2308	16	33	1.274%
2002	17	7	1.2225%
2912	18	36	0.9728%
2884	19	30	0.8768%
2892	20	26	0.876%
4904	24	9	0.7945%
2880	25	28	0.7495%
1101	26	12	0.7325%

2382	27	16	0.7265%
2885	29	23	0.6787%
2801	30	14	0.6387%
2408	31	24	0.6133%
2395	32	18	0.5747%
1402	33	5	0.5584%
2474	34	41	0.5338%
2303	35	25	0.5267%
2357	37	38	0.5158%
1102	39	8	0.4977%
2887	40	35	0.4648%
2890	41	29	0.458%
2883	42	32	0.4413%
2105	44	6	0.4048%
9904	48	22	0.3533%
2327	49	42	0.3511%
2823	50	10	0.3454%
2301	52	19	0.3331%
2409	56	31	0.2787%
2354	57	40	0.2779%

Table 3 reveals the sequence of constituent stocks, market capitalization ratios, and relationship coefficients. This article ranks 43 samples in order. Tsmc ranks first in stock weight, and its market capitalization accounts for 19.298% of TAIEX, but it ranks 21st in the relationship coefficient sequence. Hon, which ranks second in the weighted ratio, ranks 15th in the relationship coefficient sequence. For investors in many foreign institutions, or when the MSCI index is adjusted quarterly, the ranking of stock weights has always been one of the most important reference indicators. However, if the futures and spot transactions are paired according to this, there will be a phenomenon that performance is not synchronized or the effect of hedging is not obvious. Because the ranking of the relationship coefficient series is related to the synchronization with the index.

The ranking of stock weights generally represents the ranking of their importance in the market, but their stock price trends are not synchronized with the index. This result is confusing for many investors. In addition to this phenomenon in the top two stocks above, it also occurs in many heavyweight weight samples. For example, the stock champion Largan Precision ranks inversely in the relationship coefficient sequence. Formosa Plastics, the most important in the plastics industry, has a corresponding rank of 2nd in the correlation coefficient sequence. Cathay and Fubon rank the top two in financial stocks, ranking 26th and 13th. Nan-Ya Plastics ranks sixth in the weighted ratio series but ranks first in the correlation coefficient series. Although this result is not strange or deviates from the rules of thumb used by investors, Nan-Ya Plastics is not the focus of attention in the market, after all, therefore, such research results and findings are still helpful to clarify the problem of synchronization between the index and the stock price.

There are many investment tools in the financial market, and futures and stocks are the key financial tools that attract the most investors to participate. In order to

obtain the best investment performance, investors are most interested in the topic of improving trading timing and predicting the future trend of stock prices. Through proper observation of some indicators to predict the stock price trend, and the ability to grasp the best timing of buying and selling stocks, under the blessing of the two can help investors obtain special returns. In order to find out the cycle of price rise and fall, if you can find appropriate observation indicators is one of the best methods. For example, after finding the stocks with the highest synchrony with the index, there are two strategies: First, if you observe the trend of individual stocks, if you find that there has been a turning point, you can switch to the futures market to buy and sell the index; the second is that there is a turning point in the market index, you can make a profit by making long or shorting individual stocks (or options). By observing the indicators of synchronization, investors can adopt the best investment strategy in the face of a turbulent stock market and avoid blind and irrational investment behavior.

After confirming Nan-Ya Plastics, which ranks first in the relationship coefficient series, this article will verify the evidence of its synchronization in the historical trajectory of the stock market to confirm whether it can be used as an important indicator to observe the future trend of TAIEX.

First, the stock price trend chart of TAIEX and Nan-Ya Plastics is presented through a form of technical analysis (price line). It is a line connecting all closing prices in the monthly trend line from January 2003 to December 2018.

Second, the stock price trend chart of the index and individual stocks is marked, and the date of each turning point is recorded in detail. After statistics, it is found that TAIEX has 97 turning points, while Nan-Ya Plastics has 86 turning points. After deducting the meaningless turning points of short-term volatility, 66 important turning points have been confirmed in the 16-year trend.

Finally, compare the dates of all turning points and indicate the number of peak-to-valley turning points of the index and individual stocks on the same day. In the 66 time points that have gone through long and short movements, the two overlapped 43 turning points, and the match rate reached 65.15%; therefore, Nan-Ya Plastics can be regarded as a synchronization indicator of TAIEX. The advantage of the grey correlation study is finding consistency indicators. Therefore, by observing Nan-Ya Plastics (sample), this paper can infer the trend of the TAIEX (population).

3.3 Other evidence of association research

In order to avoid the bias of the data caused by sampling, in addition to the data during the above sample period, this study increased the sampling of the three sample periods under the factor that the number of samples could be increased and respectively calculated the sequence of the gray correlation coefficient. This shows that the gray correlation coefficient of South Asia Plastics ranks first in all the sampling intervals. This evidence shows that there is no sampling bias in the results of this study.

4 CONCLUSION

This paper provides five major contributions to our understanding of how the index is associated with the stocks. First, there is no positive correlation between the correlation coefficient sequence and the weight value of the constituent stocks. Secondly, the company with the highest synchronization with TAIEX is Nan-Ya Plastics; it can be regarded as a synchronization indicator of TAIEX. Third, through multiple sample period verifications, the association between Nan-Ya Plastics and TAIEX remains foremost. Fourth, this result is unchanged in the verification of the statistical method-correlation coefficient. Finally, the stock with the highest correlation with the index is ranked eighth, and the result doesn't substantially differ from the rule of thumb used by many investors. Although this result is not strange or deviates from the rules of thumb used by investors, Nan-Ya Plastics is not the focus of attention in the market, after all, therefore, such research results and findings are still helpful to clarify the problem of synchronization between the index and the stock price.

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