Using Hierarchical Correlation in Macro-Economic Market for Taiwan Stock Market Analysis

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Abstract

It is important for investors to make proper and appropriate investments in stock markets. Macro-economic or other technical indicators are commonly used by investors to project the stock market. Based on the previous researches, there is a considerable degree of volatility between the macro economy and stock prices. The macro economy has a certain degree of predictive power. In addition, geographical location of the country is one of the most important factors that affect the stock market linkage in various countries. The study uses the macro-economic variables to explore the three-tier hierarchical associations of local, regional and global areas. The association rules are extracted to reveal the hierarchical relations among Taiwan stocks, macro economies in Taiwan, Japan, China and the United States. The outcome shows the hierarchical rules as the sound references to help investors while investing in the stock market.

***Keywords*：** Stock Market, Macro economy, Technical indicator analysis, Association rule

1. Introduction

The capital market plays an important role in the economic development of the country. The enterprise capital needed by an enterprise can be raised in the market by promoting the market economy through the issuance of securities such as stocks or bonds. The stock market can be described as the window of a country's economy. In addition, the trading of stocks can facilitate the circulation of capital and be used as the major part of raising funds for the enterprise in the capital markets. Shih (2004) pointed out that the macro-economic performance in Taiwan has the lead effect on Taiwan's stock price returns, and noted that the growth and decline of the total economic variables have a better chance of grasping the trend of Taiwan stocks. Therefore, this study is divided into two main research topics. First of all, the research tends to explore the correlation between the stock market and the macro-economic variables in Taiwan, expanding to regional countries, then to global countries. Second, the association rules of correlations will be observed. This paper explores whether the use of association rules is more relevant and accurate than previous literatures which used different methods but the same research target. The purposes of this study are listed as follows：

i. Using historical data to analyze the ups and downs of Taiwan's macro-economic variables and the stock indices.
ii. In the context of global interaction, the three-tier concept of specific regions (Taiwan), regions (Japan, China) and the global (United States) will be used to explore the interconnections of the macro-economies among these countries.

iii. Whether or not the user monetizes this model while investing using the association rule model.

2. Literature Review

2.1Macroeconomy

General economic analyzes the rules of economic operation using such general statistical concepts as national income, investment and consumption of the economy. In the stock price and return, strategies are basically divided into fundamental, technical, chips and message surface analysis. Fundamental factors are the root causes of stock price changes. It assumes that the stock itself has its own value, which will change with the macro-economic variables. They are treated as potential factors which controls the whole market price in the long-term trend. Aggarwa(1981)explored the relationship between the changes in exchange rates of the macro-economic variables and the volatility of the New York Stock Exchange and the S&P 500 in the United States. That confirms the positive correlation between changes in the short-term exchange rate and the stock price index. Dhakal et al.(1993)explored the causal relationship between money supply and stock price showing that the money supply will directly affect the stock price and will indirectly affect the stock price through channels such as interest rates and inflation rates. Thus the stock price is one of the leading variables in the macro-economic situation.

2.2Associated factors

The stock price will be changed due to external factors or internal factors. Those factors have complex inter-relationships. The external factors mostly come from the macro environment, such as economic conditions, market supply and demand, and government policies. These factors will affect the risk of enterprises, and further lead to the stock price change. Cifterand Ozun (2007) used the EGARCH model to explore the effect of the volatility effect of the advanced countries stock market on the stock price rate of return in emerging countries. The study confirmed the dynamic relationship between emerging market economy and international markets. Cheng and Kai-Yuan (2009) used factor analysis to analyze the linkage of the global stock markets under the financial crisis. It was found that the geographical differences of countries are one of the common factors that affect the stock market linkage in different countries. According to the foregoing researches on the stock market linkage, the international stock markets are inter-related, especially the influence of the U.S. stock market is the largest. In addition, the geographical location of the country is one of the most important factors that affects the stock market linkage in various countries. Therefore, this study distinguishes three hierarchicallayers of relations forlocal region, neighboring regions and global regions to explore the degree of interaction and their relevance among the international stock markets.

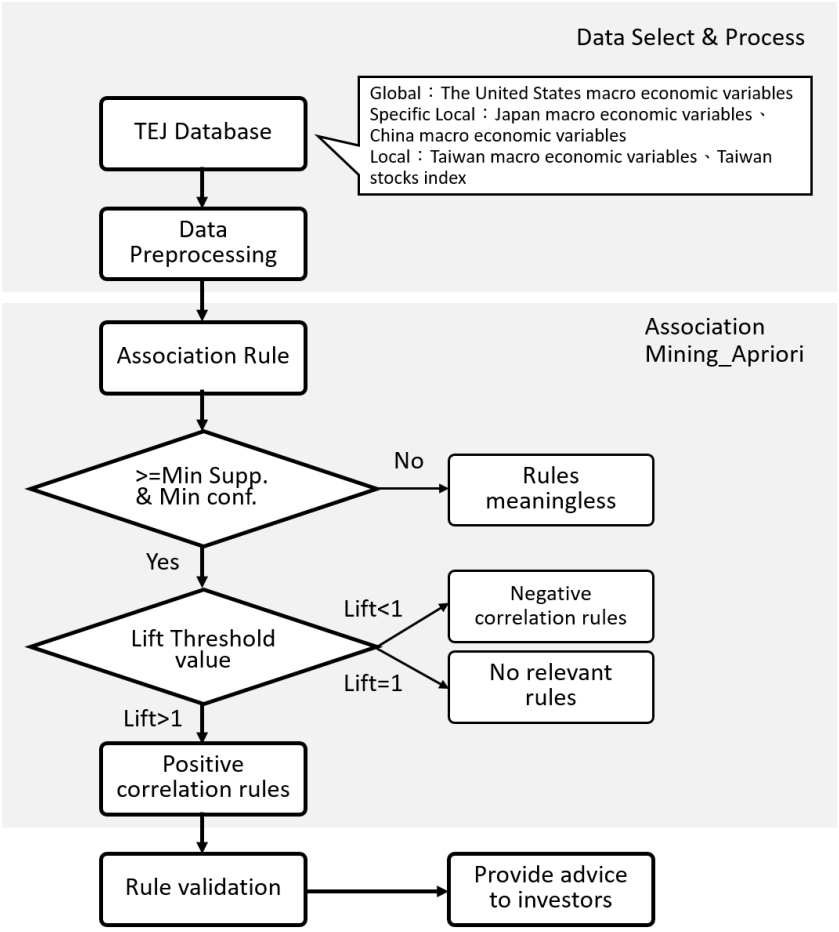
2.3Technical Indicator Analysis

In recent years, due to the growth of information technology and the Internet, the daily amount of information generated has soared. How to extract implicit information from these huge amounts of data into valuable economic knowledge to help policy makers make better decisions are taken more and more seriously. At present, data mining technology is also used as a popular application of knowledge extraction in DSS. According to the practice and related research, the semi-strong market still belongs to the current stock market, which means that there is a certain degree of correlation between the past public information and the stock price in the future. Lin and Hui-Wen (2006) used the Apriori algorithm to explore the correlation between the 19 stocks in Taiwan's centralized market and the weighted stock price index. Li and Chia-Cheng (2009) also used association rules analysis to explore the correlation between the stock prices of listed OTC companies that produce notebooks and memory in Taiwan's electronics stocks. In the study, the gray correlation used to verify the consistency of association rules accuracy rates from 88.89% to 100%. In conclusion, the linkages among different country stocks and indicators of the macro economy are relevant. Therefore, this study uses the association rules to explore the correlation between the macro-economic variables of various countries and Taiwan.

3. Research methods

3.1System model

Figure 1：Research architecture diagram



In this study, we proposed a visual interactive system that extracts association rules from macro-economic variables. The main structure of this study is shown in Fig. 1.The system consists of two modules： Data collection &processing module and association rule module. In the data collection section, this study uses data from Taiwan Economic Times (TEJ) database to collect: (1) the stock index of various stocks in Taiwan, (2) the macro-economic variables of Taiwan, China, Japan and the United States. Preprocessing is conducted before system applies Apriori algorithm analysis for association rule discovery. Then, a numerical analysis of model provides the results for experts to assess and verify its accuracy to meet the current market trends. Finally, the investment decision-making advice will be generated in the end of the process.

3.2Data Description

This study uses data from Taiwan Economic Times (TEJ) on the macro-economic variables of various countries and various stock indices in Taiwan, collected from January 2000 to March 2017 for a total of 17 years since the macro national economy mostly in a month long period. Therefore, this study uses monthly data for analysis. Total of 203 rows of data for each macro-economic variable or the stocks are collected and processed. According to previous studies, we know that fluctuations in the international macro-economic variables will affect each other. This study aims to explore the impact of local, regional and global countries whereas Taiwan as the local target, China and Japan as the targets of regional countries, and the United States as the global-effect target. The total number of listed companies in Taiwan's Stock Exchange is 874 with a total market capitalization of 27.64 trillion dollars. However, this study focuses on various types of stock market instead of individual874 companies. After the data is collected, the preprocessing is applied to convert the numerical data to ordinal data by comparing the current value to the previous one. The data thus will be covert to 'up', 'down' and 'moderate' to indicate the trends of the specific time shown on Table 1.

Table 1：Data preprocessing

Date	US		Japan		Taiwan		Taiwan stock	
	m1	unemploymentrate	export	consumer confidence index	economic monitoring indicator comprehensive score	unemployment rate	cement industry category	textile fibers
2016/12	up	up	up	up	up	down	down	**up**
2016/11	up	down	up	down	up	**down**	down	down
2016/10	moderate	down	down	down	up	down	up	down

3.2 Hierarchical Association rules

To define the association rules, this study assumes that I = {i1, i2, ..., in} is a set of projects for all the macro-economic variables and stock indices, X and Y represent different sets of data items in the data set, there will be two items in the representation of the association rules, namely the preceding and the following items, which are represented by $X \Rightarrow Y$, $X \subset I$, $Y \subset I$ and $X \cap Y = \varphi$, representing the appearance of X and the appearance of Y as well. Afterwards, two parameters, support and confidence as shown in formula 1, are set to determine whether this association rule is meaningful. The support indicates the frequency of the occurrence of the general economy and the stocks in the dataset, expressed in the form of Sup (X) ; while the confidence level indicates that when the total project X is established, the probability of another general project Y being established is expressed in the form of Conf ($X \rightarrow Y$).

$$Sup(X) = \frac{frq(X)}{N}$$

$$Conf(X \rightarrow Y) = \frac{Sup(X \cap Y)}{Sup(X)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

In addition to the above two criteria, a correlation analysis is considered in order to reduce errors, namely lift analysis as shown in formula(2) :

$$Lift = \frac{Conf(X \rightarrow Y)}{Sup(Y)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

When the Lift is> 1, it means that the preceding term X has a positive correlation with the latter term Y, and the rule has practicability. When the Lift = 1, it is expressed as an independent event, and the result is similar to the method of obtaining random numbers. When the Lift is less than 1, it means negative correlation, and the result is worse than the random number. Therefore, when using association rules to conduct prospecting, it is necessary to set the degree of support and confidence according to the situation and pay attention to the fact that the value of Lift needs> 1, so that the rules of exploration are practical and meaningful. In this study, we used numerical analysis and semi-structured interview with experts to verify the accuracy of the data. In the numerical analysis section, we verify the correctness of the information of T period by the data of each T-1 period in the past and discuss the strength of the correlation. Finally, we predict the trend of T+1 period in the T period.

4. Experiment data and results

Data pre-process is one of the most important factors in data mining. The null values or missing values will affect the accuracy of the experiment results. According to previous researches, macro-economy variables such as the judgment score of prosperity measures, trade balance, money supply definition, and interest rate are selected as the experiment parameters. Table2 shows the original data of partial indices.

Table 2：Original Data of Partial Indices

	USA GNP	USA foreign exchange reserves	USA M1	USA M2	Dow Jones industrial, New York, USA Average	USA NASDAQ index
2016/12	19,112.4	114,671	3,381	13,277	19,762.60	4,863.62
2016/11		115,675	3,324	13,167	19,123.58	4,810.81
2016/10		119,119	3,327	13,059	18,142.42	4,801.27

According to the growth rate and the range, table2 then was converted to Table3.

In the data consolidating processing, this research attempts to explore whether the global floating will affect the changes in the Asian region and the domestic stocks. If global prosperity changes affect the next Asian region, if the rules are established, users can predict the trend of changes in stocks for the next quarter.

Table 3：Preprocessed Data Fragment

	2016/12	2016/11	2016/10	2016/09	2016/08
USA GNP	up	up	up	up	up
USA M1	up	down	up	down	up

This research first explores whether the Asia macro-economic will affect the Taiwan stock market or not. According to the Statistics Department of the Executive Yuan in 2015, Taiwan's import and export countries in Asia is manly in Japan and China. Therefore, this research selected 30macro-economicindices from Japan and 35 from China. Table 4 shows the top three rules for Asia and Taiwan macro-economic indices.

Table 4：Association rules for Asia and Taiwan

Rule	Lhs	Rhs	Support		Confidence	Lift
R1	China M0=up		Taiwan M2 daily average =up	0.5196078	0.8412698	1.065957
R2	Japan M2=up	China GDP=up	Taiwan M2 daily average =up	0.5294118	0.8372093	1.060812
R3	Japan M2=up		Taiwan M2 daily average =up	0.5539216	0.8370370	1.060594

Based on the findings, multi-level association rules show the positive correlation between Asia macro-economic indices and Taiwan stock market. This research uses TOP-DOWN method from the top down. Asia market is linked to the Taiwan market and stocks to explore meaningful rules. Next, global macro-economic indices are examined. In TAITRA's Global Information Network, the data shows that the United States is the largest economy in the world in 2015, accounting for about one fifth of the global economy. On Taiwan's import and export trade rankings, the United States is one of the major trading nations.

Table 5：Association rules for Asia and USA

Rule	Lhs	Rhs	Support	Confidence	Lift
R1	USA average person GDP=up	China GDP=up	0.8275862	1.0000000	1.057292
R2	New York, United States, Temple 500 stock price=up	China GDP=up	0.5714286	0.9666667	1.022049
R3	USA Russell=up	China GDP=up	0.5665025	0.9663866	1.021752

Based on the above observation, the performance of the US market can affect China's economy. Changes in US stock prices, import and export trade, money supply and national income will affect the China GDP and China M2. Taiwan also will be linked and affected by the changes in stocks. Table 5 shows the top three rules for Asia and U.S.A macro-economic indices.

5. Conclusion

This research proposed a three-tier hierarchical rule extraction using macro-economic indices. Although the ups and downs in stock are still difficult to predict, this study manages to assist investors in decisions making. This research uses hierarchical association rules to find the correlations among different levels of macro-economics and the stocks. According to research problems and purpose, the study draws the following conclusions : The hierarchical association rules for macro-economic indices are observed. The global market changes do affect the regional markets and Taiwanese stocks. Using the global macro-economic indices as the indictors to predict the trends of local markets is possible. In the future, this study can be combined with technical or chip strategies. The hierarchical analysis can be done by other research methods such as neural networks, decision trees, genetic algorithms and other data exploration approach to have more accurate predictions.

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