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Data mining investigation of co-movements on the Taiwan and China stock markets for future investment portfolio

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ABSTRACT

On June 29, 2010, Taiwan signed an Economic Cooperation Framework Agreement (ECFA) with China as a major step to open markets between Taiwan and China. Thus, the ECFA will contribute by creating a closer relationship between China and Taiwan through economic and market interactions. Co-movements of the world's national financial market indexes are a popular research topic in the finance literature. Some studies examine the co-movements and the benefits of international financial market portfolio diversification/integration and economic performance. Thus, this study investigates the co-movement in the Taiwan and China (Hong Kong) stock markets under the ECFA using a data mining approach, including association rules and clustering analysis. Thirty categories of stock indexes are implemented as decision variables to observe the behavior of stock index associations during the periods of ECFA implementation. Patterns, rules, and clusters of data mining results are discussed for future stock market investment portfolio.

1. Introduction

With the increasing significance of international flows of goods, services and capital, co-movements of economic variables in different countries is becoming increasingly evident. The extent to which globalization causes domestic economies to move along with economies in the rest of the world or in their particular region, is a major concern for policy-makers. Thus, it is believed by many that regional trade integration and regional free trade agreements (RFTAs) are beneficial to a nation's economy (Edwards & Ginn, 2011; Kearney & Muckley, 2007). In the case of Taiwan and China, due to the nature of the political relationship across the Taiwan Straits, the R.O.C. Taiwan has been excluded from the rising trend of ASEAN economic integration, and thus is facing the risk of marginalization. However, since R.O.C. Taiwan President, Ma Ying-jeou took office in May 2008, cross-strait relationships have experienced their most rapid improvement in decades. On April 26, 2009, at the third round of cross-strait talks in Nanjing, Taipei and Beijing inked three new agreements. Such initiatives are crucial to normalize cross-strait economic ties. More importantly, Taiwan recognizes the need to establish more institutionalized cooperation platforms with its neighbors. On June 29, 2010, Taiwan signed an Economic Cooperation Framework Agreement (ECFA) with China as a major step in this direction. For Taiwan, the ECFA may promote greater market opportunities and the possibility of signing Free Trade Agreements (FATs) with other ASEAN countries. For China, the ECFA may contribute in eliminating economic imbalances caused by the rapid economic progress since China's reform and open-up policy in 1978. Thus, the ECFA will contribute by creating a closer relationship between China and Taiwan through economic and market interactions, thus establishing mutual understanding and trust, the basis of peace across the Straits.

July 29, 2011, the Ministry of Economic Affairs (MOEA) expressed satisfaction in the results of the early harvest program in the Economic Cooperation Framework Agreement (ECFA) with mainland China. Taiwan's gross export value to mainland China amounted to US$61.56 billion over the first six months this year, with tariff exemptions and reductions of US$53.71 million. On the other hand, Taiwan's import value from mainland China, during the same period, grossed US$21.92 billion, saving the Chinese about US$9.43 million on tariffs. It is also noteworthy that the American Chamber of Commerce (AmCham) in Taipei announced that nearly half of Taiwan's 2010 GDP growth came from its trade with China. Taiwan has become reliant on economic and trade relationships with China, which drove 47% of Taiwan's economic growth in 2010. Therefore, there is a co-movement relationship between the Straits not only on trade exchange, but also on industry and financial markets under the ECFA.

On the other hand, co-movements of the world's national financial market indexes are a popular research topic in the finance literature (Meric, Ratner, & Meric, 2008; Chow, Liu, and Niu, 2011; Graham, Kiviaho, & Nikkinen, 2012; Liao, Chu, & You, 2011). Some studies examine the co-movements and the benefits of interna-

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tional financial market portfolio diversification/integration and economic performance (Liljeblom, Löflund, & Krokfors, 1997; Meric et al., 2001; Chu, 2002; Aslanidis, Osborn, & Sensier, 2010; Beine & Candelon, 2010; Madaleno & Pinho, 2012). In addition, the Asian financial crisis has stimulated a great deal of interest in how economic shocks are transmitted across different countries (Arestis, Caporale, Cipollini, & Spagnolo, 2005; Brown, Rhee, & Zhang, 2008; Chang, 2002; Jang & Sul, 2002). The international stock market is one of the most popular forms of investment due to the expectations of high profit. However, higher expected profit also implies higher risk. Thus, numerous studies have proposed different analysis methods to assist investors in analysis and decision-making. In addition, many individual investors, stockbrokers, and financial analysts attempt to predict stock market price activities and their potential development. This mass behavior runs counter to the counsel of the many academic studies, which contend that the prediction of international stock market development is ineffective. This point of view is codified in what is referred to as the efficient markets hypothesis (Fama, 1991; Haugen, 1997). In particular, Forbes and Rigobon (1999) and Rigobon (1999), in their studies of international stock market co-movements, discovered no significant changes in the international transmission mechanism of shocks during the financial crises, but found it puzzling why the degree of co-movement is so high at all times. Thus, the international financial capital market efficiency becomes an interesting issue for research on international financial market co-movements.

In addition, there are three degrees of international financial capital market efficiency. The first degree is the strong form of the efficient market hypothesis, which states that all information that is knowable is immediately factored into the market's price for security. If this is true, then all price predictors are definitely wasting their time, even if they have access to private information. The second degree is the semi-strong form of the efficient market hypothesis, in which all public information is considered to possess private information, which can be used for profit. The third degree is the weak form, which holds only that any information gained from examining a security's past trading history is reflected in price. Indeed, past trading history is public information, implying that the weak form is a specialization of the semi-strong form, which itself is a specialization of the strong form of the efficient market hypothesis. Thus, integration of co-movement and portfolio analysis in financial market, in terms of investment and risk management, has become a critical research issue (Alexakis, Niarchos, Patra, & Poshakwale, 2005; Bohl, Brzeszczyński, & Wilfling, 2009; Boyer & Zheng, 2009; Liao, Chu, & Teng, 2011; Oh & Parwada, 2007).

Due to the different degrees of international financial capital market efficiency, academic researchers investigate the efficient market hypothesis by exploring unknown and valuable knowledge from historical data, using techniques such as data mining. Enke and Thawornwong (2005) introduced an information gaining technique used in machine learning for data mining to evaluate the predictive relationships of numerous financial and economic variables. Neural network models for the estimation and classification of levels are then examined for their ability to provide an effective forecast of future values. Boginski, Butenko, and Pardalos (2006) proposed a network representation of stock market data referred to as a market graph. This graph is constructed by calculating cross correlations between pairs of stocks based on opening price data over a certain period of time. Chun and Park (2005) proposed a learning technique to extract new case vectors using Dynamic Adaptive Ensemble CBR (DAE CBR). The main idea of DAE CBR originates from finding combinations of parameters and updating and applying an optimal CBR model to an application or domain area. These concepts are investigated against the backdrop of a practical application involving the prediction of a stock market index. In addition, Rapach and Wohar (2006) analyzed in-sample and out-of-sample tests of stock return predictability to better understand the nature of the empirical evidence in return predictability. Their study found that certain financial variables display significant in-sample and out-of sample predictive ability with respect to stock returns. Overall, most studies consider stock market analysis as a time series problem, and there have been few studies using stock market efficiency to explore the possible cause-and-effect relationships among different stock categories or the influence of outside factors (Liao, Ho, & Lin, 2008).

Thus, this study investigates the co-movement in the Taiwan and China (Hong Kong) stock markets under the ECFA using a data mining approach, including association rules and cluster analysis. Specifically, this study investigates the following research issues: (1) the study of the relationships among Taiwan, China and Hong Kong stock market indexes by association rules to find a similar trend in transaction data, and also to identify any co-movement of market performance; (2) the use association rules to understand the co-movement between stock market indexes and their categorical stock indexes in Taiwan, China and Hong Kong stock market; (3) according to the findings, this study puts forward recommendations for investment portfolios and management as a follow-up reference. The rest of this study is organized as follows. In Section 2, we present the background of the Taiwan and China (Hong Kong) stock markets. Section 3 describes the methodology, including the research framework, data sources, and database design. Section 4 presents the data mining approach, association rules, Cluster analysis (K-means), and data mining tool – SPSS Clementine - and discusses research findings. Section 5 illustrates the data mining results. Finally, Section 6 presents a brief conclusion and discussion.

2. Taiwan and China (Hong Kong) stock market

2.1. Taiwan stock market

The TSEC, Taiwan Stock Exchange Corporation, maintains stock price indices to allow investors to conveniently grasp both overall market movement and the performances of different industrial sectors. These indices may be grouped into market value indices and price average indices. The former are similar to the Standard and Poor's Index, which is weighted by the number of outstanding shares, and the latter are similar to the Dow Jones Industrial Average and the Nikkei Stock Average. The Taiwan Stock Exchange Capitalization Weighted Stock Index ("TAIEX") is the most widely quoted of all TSEC indices. The base year value as of 1966 was set at 100. TAIEX is adjusted in the event of new listings, de-listings and new share offerings to offset the influence on TAIEX owing to non-trading activities. TAIEX covers all listed stocks, excluding preferred stocks, full-delivery stocks and newly listed stocks that have been listed for less than one calendar month. The other market value indices are calculated and adjusted similarly to that of the TAIEX, but with different groupings of stocks included for calculation. Out of the TAIEX Component Stocks, the non-Finance Sub-Index, Non-Electronics Sub-Index, and Non-Finance Non-Electronics Sub-Index include stocks not in the financial sector, not in the electronics sector, and not in either sector. Similarly, the Industrial Sub-Indices are calculated for different industrial sectors. In 1986, eight Industrial Sub-Indices were introduced, i.e., Cement/Glass/Ceramics, Textiles, Foods, Plastics/Chemicals/Rubber, Electric Machinery/Electric Appliance/Cable/Electronics, Paper/Pulp, Construction, and Finance. In 1995, the TSEC introduced an additional 14 Industrial Sub-Indices, i.e. Cement, Plastics, Electric machinery, Electric appliance/cable, Automobile, Chemicals, Glass/ceramics, Iron/steel, Rubber, Electronics, Transportation, Tourism, Retail and Others. This expansion was intended to give a broader perspective of industrial performance and a more comprehensive