



## Mining the hedge and arbitrage of the Taiwan foreign exchange market

Shu-hsien Liao\*, Shao-ling Lu, Yung-wei Lai

Department of Management Sciences, Tamkang University, No. 151, Yingjuan Rd., Danshuei Jen, Taipei 251, Taiwan, ROC

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### ABSTRACT

The foreign exchange market is one of the biggest markets in the global financial capital market. With current trends toward financial capital globalization, it is becoming more important to understand the hedge and arbitrage of foreign exchange markets. Thus, this study implements association rules as a data mining approach to explore the associations among 19 different pairs of foreign exchange rates. Transaction data, such as foreign exchange rates, were collected to construct a database; the Apriori algorithm was then used to generate the association rules. By doing so, this study proposes several possible portfolio alternatives in the Taiwan foreign exchange market, including foreign exchange hedge and arbitrage under different circumstances.

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### 1. Introduction

According to the 2009 survey of the Bank for International Settlements (BIS), the average daily turnover of the global foreign exchange market is \$4.3 trillion. According to the Central Bank of the Republic of China (Taiwan), the average daily turnover of the foreign exchange market in Taiwan is \$29.23 billion. The foreign exchange market has the largest trading volume of any single market in the world. Operating 24-h, the international financial market has a pivotal position. The influence of the Asian financial crisis in 1997 on the international financial market shows that a large number of withdrawals of international capital can enable a single country, or can even be a serious threat to a region as a whole. In financial and market globalization, with trends toward liberalization, traders, investors, speculators, bankers and other participants in the foreign exchange market make repeated daily transactions, such as arbitrage and hedging actions, so as to activate countries' stock markets and capital flows. Through globalization in finance and trade, all countries and firms are increasing their dependence on foreign trade. This kind of trade relationship leads to a dependent response in the foreign exchange market. Thus, integration of hedging, arbitrage, and portfolio analysis in financial capital markets in terms of investment and risk management study has become a critical research issue (Ghosh, Ghosh, & Bhatnagar, 2010; Montana, Triantafyllopoulos, & Tsagaris, 2009).

In addition, there are three degrees of 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.

Due to the different degrees of 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 level estimation and classification 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, which 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, which extracts new case vectors using Dynamic Adaptive Ensemble CBR (DAE CBR). The main idea of DAE CBR is based on 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) implemented an analysis of in-sample and out-of-sample

\* Corresponding author.

E-mail address: [michael@mail.tku.edu.tw](mailto:michael@mail.tku.edu.tw) (S.-h. Liao).

tests of stock return predictability in an effort to better understand the nature of the empirical evidence in return predictability. Their study finds 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 have used 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). On the other hand, Montana et al. proposed a concept of statistical arbitrage, an investment strategy that exploits patterns detected in financial data streams. They demonstrate that flexible least squares (FLS) are algebraically equivalent to the well-known Kalman filter equations, and take advantage of this equivalence to gain a better understanding of FLS and suggest a more efficient algorithm. Their study presented promising experimental results obtained from a FLS-based algorithmic trading system for the S&P 500 Futures Index are reported (Montana et al., 2009).

Accordingly, this study investigates the research issues related to the hedging and arbitrage of the Taiwan exchange market. They issues discussed here include: (1) from the October 1, 2008 to September 30, 2009 transactions in the Taiwan foreign exchange market were predominately in NT dollars. The foreign currency exchange rate between the 19 files changed due to their relevance and mutual influence. We go on to explore the various types of foreign currency, examining whether the ups and downs are linked or whether the order of interaction, that is, the relationship between the ups and downs is relevant. We also assess the influence of the rising effect losing streaks on compensatory growth. (2) To explore the links with the mining out of the actual foreign exchange rules and make a comparative analysis of market trends. (3) To examine how each of the ups and downs of the currency linked relationship between the arbitrage and hedging of operations are applied to the proposed business and corporate investment to avoid exchange rate risk and profit objectives. The rest of this study is organized as follows. In Section 2, we present the background of foreign exchange market management and the stock market in Taiwan. Section 3 describes the methodology, including the research framework, data sources, and database design. Section 4 presents the data mining approach, association rules, and data mining tool – SPSS Clementine, and discusses research findings. Section 5 illustrates the data mining results and Section 6 describes research findings and managerial implications. Finally, Section 7 presents a brief conclusion.

## 2. Taiwan financial capital market

### 2.1. Taiwan foreign exchange market

Prior to February 1979, management of foreign exchange in the Republic of China was characterized by a central clearing and settlement system. Following the establishment of the Taipei Foreign Exchange Market in February 1979, a flexible exchange rate system was formally implemented. Since then, the NT dollar exchange rate has been determined by the market. However, when seasonal or irregular factors disrupt the market, the Central Bank of China (CBC) will step in to maintain an orderly foreign exchange market. However, the CBC has continued to promote financial liberalization and internationalization. The management of capital movements is market based. In general, capital can flow freely in and out of Taiwan. The CBC's management philosophy of its foreign exchange reserves centers around liquidity, security, and profitability. The foreign exchange reserves have also been used to promote economic development and industrial upgrading.

On the other hand, as the domestic financial market has opened up further to foreigners after Taiwan's entrance in the World Trade

Organization (WTO), the volume of capital flowing in and out of the country and the number of market participants has significantly increased. The depth and scope of Taiwan's foreign exchange market will be broadened as a result, and the market scale will rise as well. Also, in response to mounting foreign exchange transactions, new financial products related to foreign exchange will be further diversified. In particular, associated hedge instruments will rapidly increase. Moreover, regulations governing trading procedures will conform to international practices. The Central Bank of China will also emphasize discipline of financial institutions and allow the NT dollar exchange rates to reflect underlying economic fundamentals (<http://www.cbc.gov.tw/np.asp?ctNode=444&mp=2>).

### 2.2. Foreign exchange market arbitrage

Arbitrage is motivated by profit considerations rather than avoiding risk behavior. Means to transfer funds from countries with lower interest rates and high interest rate countries makes up the difference between the interest of incomes received from foreign exchange transactions. When a country is lacking capital, this will be reflected in interest rates and money will be funded by the state of low interest rates due to the lack of funds transferred to high interest rate countries, making funds play a more effectively role. Fung and Isberg (1992) found that in the money market, US dollar rates in Europe (overseas markets) and the US dollar interest rate (home market) entail a causal association (co-movement) between the opposite, thus, proving to be the same in regard to different exchange-traded financial assets and providing the existence of arbitrage opportunities.

### 2.3. Corporate hedging

Whether engaged in international import and export, the buying or selling of goods by traders produces foreign owned subsidiaries or multinational companies trading risk. In the end of the fiscal year, the conversion of assets and liabilities of the parent country causes currency risks to arise from the conversion. Therefore, investment or international trade in response to changes in national real exchange rate can lead to economic risk. On the basis of expected future cash during a certain amount of foreign exchange, to prevent existing or expected exchange rate fluctuations resulting in loss, people may apply the use of derivatives as part of risk aversion (partial hedge), or all risk-aversion (fully hedge).

## 3. Research design

### 3.1. Research framework

The research framework of this study is shown in Fig. 1. It involves collecting 19 foreign exchange rates. According to the collected information, a database system is built to effectively store and inquire about a huge number of transactions. In accordance with the database system, we further use association rule technology to explore a possible investment portfolio.

### 3.2. Data source

On June 15, 1990, the Central Bank of the Republic of China released amendments of eight years of "bank foreign exchange business management measures." The Taiwan foreign exchange market provides foreign exchange and foreign exchange cash transactions in the major foreign exchange banks. Exchange transactions include: USD, HKD, EUR, GBP, AUD, CAD, SGD, CHF, JPY, ZAR, DKK, SEK, NZR, THB, PHP, IDR, INR, KRW, MYR, and CNY. These indices

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