Chapter 5
Constructing Structural Equation Model Rule–Based Fuzzy System with Genetic Algorithm

EnDer Su
National Kaohsiung First University of Science and Technology, Taiwan

Thomas W. Knowles
Illinois Institute of Technology, USA

Yu-Gin Fen
National Kaohsiung First University of Science and Technology, Taiwan

ABSTRACT

The present study uses the structural equation model (SEM) to analyze the correlations between various economic indices pertaining to latent variables, such as the New Taiwan Dollar (NTD) value, the United States Dollar (USD) value, and USD index. In addition, a risk factor of volatility of currency returns is considered to develop a risk-controllable fuzzy inference system. The rational and linguistic knowledge-based fuzzy rules are established based on the SEM model and then optimized using the genetic algorithm. The empirical results reveal that the fuzzy logic trading system using the SEM indeed outperforms the buy-and-hold strategy. Moreover, when considering the risk factor of currency volatility, the performance appears significantly better. Remarkably, the trading strategy is apparently affected when the USD value or the volatility of currency returns shifts into either a higher or lower state.

1. INTRODUCTION

The onset of financial liberalization, internationalization, and new financial technology and innovation among countries has resulted in global capital flowing more rapidly and massively in currency markets. In this context, currency exchange rates also become more volatile, unpredictable, and uncontrollable. In fact, the changes in the exchange rate reflect the relative activities of the economy between countries despite brief currency speculations. This condition implies that, to manage properly the risk and uncertainty of exchange rates, the interactive factors of the economy that actually result in the changes in the exchange rate should be examined. Once the trend or volatility of the exchange rate is well managed and supervised, international traders, financial institutes, and currency investors would find it advantageous to create effective and correct hedges, as well as to formulate investment strategies.

However, the exchange rates are determined by the demand and supply in the currency market, and sometimes the central banks will intervene for the market's own benefit (Neely, 2005). In a liberalized market, a number of factors will reduce the demand for certain currencies, resulting in the depreciation of the value of such currency. Therefore, what factors will give rise to changes in demand and supply, i.e., market volatility? What factors should be managed to prevent the risk for exchange rate changes?

Economists have continuously proposed a number of exchange rate determination models and theories from various perspectives to determine the factors affecting exchange rates. Moffet and Karlsen (1994) found that the most important factors are inflation, interest rate, international balance of payments, and government fiscal policy, among others. However, a number of studies report that money supply and demand are the most important factors determining equilibrium exchange rates (Eichengreen et al., 2006), further arguing that monetary policy is the most influential tool in determining exchange rates (Bilson, 1981; Frenkle, 1981). A portfolio balance model (Branson et al., 1977; Branson and Henderson, 1985) assumes that domestic and foreign bonds are not interchangeable and that the portfolios held by investors affect the determination of exchange rates. Studies on foreign exchange risk began appearing in the 1970s. Among the best known is the regression analysis by Alder and Dumas (1984). Over the last two decades, several studies have employed Alder and Dumas as the basis for their determination of foreign exchange risk models (Williamson, 2001; Bodnar et al., 2002; Koedijk et al., 2002; Bodnar and Wong, 2003; Doidge et al., 2006).

However, referring to the factors or approaches found in only one or two specific references lacks comprehensiveness. On the other hand, judging the effect of these factors on the change in exchange rates is extremely deterministic. Thus, the current paper combines the theories on balance of payments, purchasing power parity, and flexible price monetary approaches to construct a knowledge-based system. Subsequently, the studied factors comprise money supply (M2), consumer pricing index (CPI), gross domestic production (GDP), rediscount rate, and stock price index as the five major observable variables to construct the structural equation model (SEM). Although the SEM includes theoretical constructs, it also handles measurement errors using maximum likelihood estimation (MLE) to estimate the parameters (Anderson and Gerbing, 1988).

In the present paper, three latent (i.e. unobservable) variables are used, which are the value of the United States Dollar (USD), the value of the New Taiwan Dollar (NTD), and the USD index in SEM. The relationships between the three latent factors are very useful in building the knowledge-based system (Jöreskog, 1973). The volatilities of USD to TWD are also considered important in determining the exchange rate changes. Therefore, four factors are used as the input variables, with the change in exchange rates being the output variable for the fuzzy model. The knowledge-based system created

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