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Non-linear, hybrid exchange rate modeling and trading profitability in the foreign exchange market

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Abstract

A neuro-fuzzy decision-making technology is designed and implemented to obtain the optimal daily currency trading rule. It is found that a non-linear, artificial neural network exchange rate microstructure (hybrid) model combined with a fuzzy logic controller generates a set of trading strategies that earn a higher rate of return compared to the simple buy-and-hold strategy. After accounting for realistic transaction costs, the gains from utilizing a dynamic, neuro-fuzzy model are still present.

JEL Classification: F31; G14; C45; C52; C53

Keywords: Market microstructure; Artificial neural networks; Fuzzy logic

1. Introduction

Advanced modeling techniques such as artificial neural networks (ANN), fuzzy logic controllers (FLC), and genetic algorithms (GA) have a vast array of applications in finance and economics. Moreover, by combining these techniques,

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more complex problems can be addressed. This paper combines two of the most popular concepts: ANN and FLC.

There has been a growing literature on FLCs and their use in financial economics. Many of these examples, such as ones for portfolio management and stock market trading, can be found in Deboeck (1994). Further, Bojadziev (1997) uses FLC for evaluating a client's risk tolerance level based on his/her annual income and total net worth. Peray (1999) determines an opportunity for equity fund investments using well-established technical indicators (e.g., the gap from the moving average) and market fundamentals (GDP, inflation rate, interest rate, etc.). Also, fuzzy logic can be used to explain non-linearities in interest rates (Ju et al., 1997). In Japan, fuzzy logic is used in a foreign exchange trading system to forecast the Japan/U.S. exchange rate. This system uses fuzzy logic rules to make inferences based on economic news that may affect the currency market (Yuize, 1991). Tseng et al. (2001) integrate fuzzy and ARIMA models to forecast the Taiwan/U.S. exchange rate and Tay and Linn (2001) model agent's reasoning process in an artificial stock market with fuzzy logic. Recently, using a fuzzy logic (technical trading) pattern-recognition model, Zhou and Dong (2004) find significant abnormal returns in a large sample of AMEX, NASDAQ and NYSE stocks.

This paper develops an original and novel approach to generating trading strategies in the foreign exchange (FX) market based on forecasts from an ANN hybrid exchange rate model.[1] Fuzzy reasoning is combined with ANN-generated one-day-ahead Canada/U.S. exchange rate forecasts into a dynamic neuro-fuzzy (NF) model. This enables one to investigate the evolution of NF-defined strategies over different periods in 1990s.

In recent literature that tackles the problem of generating trading strategies, either the efficacy of technical analysis is tested (Osler, 2000; Lo et al., 2000; Brock et al., 1992; Levich and Thomas, 1993; Gençay, 1998) or the search for improved technical trading models is conducted (Allen and Karjalainen, 1999). The approach applied in this work departs from recent research in this area in that the strategies contain macroeconomic and microstructure effects processed by the ANN. In addition to this, a fuzzy logic approach is employed to obtain a smoother decision surface. Previous studies were able to generate only discrete buy or sell trading signals while this papers' trading strategies are more continuous.

There are several characteristics that distinguish the NF trading rules developed in this paper from technical trading rules. First, the searching space is different. For technical trading rules the searching space consists only of past prices, while for NF trading rules the searching space contains fundamental variables, such as interest rate differential, and market order flow variables. Second, the question of which trading rules are important is subtly different. Instead of checking whether *specific* rules work, this paper sheds light on whether an *optimized* ANN combined with FLC can be used to generate a single trading strategy. Third, fuzzy logic is employed in this paper to link the forecasting value to a decision space. One advantage of fuzzy

[1]In this context, 'hybrid' refers to a model that uses both fundamental and market microstructure variables (see Lyons and Evans, 2002; Goldberg and Tenorio, 1997; Osler, 1998).