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Stochastic and genetic neural network combinations in trading and hybrid time-varying leverage effects

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ABSTRACT

The motivation of this paper is 3-fold. Firstly, we apply a Multi-Layer Perceptron (MLP), a Recurrent Neural Network (RNN) and a Psi-Sigma Network (PSN) architecture in a forecasting and trading exercise on the EUR/USD, EUR/GBP and EUR/CHF exchange rates and explore the utility of Kalman Filter, Genetic Programming (GP) and Support Vector Regression (SVR) algorithms as forecasting combination techniques. Secondly, we introduce a hybrid leverage factor based on volatility forecasts and market shocks and study if its application improves the trading performance of our models. Thirdly, we introduce a specialized loss function for Neural Networks (NNs) in financial applications. In terms of our results, the PSN from the individual forecasts and the SVR from our forecast combination techniques outperform their benchmarks in statistical accuracy and trading efficiency. We also note that our trading strategy is successful, as it increased the trading performance of most of our models, while our NNs loss function seems promising.

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1. Introduction

The term of Neural Network (NN) originates from the biological neuron connections of the human brain. Artificial NNs are computation models that embody data-adaptive learning and clustering abilities, deriving from parallel processing procedures (Kröse and Smagt, 1996). NNs are considered a relatively new technology in Finance, but with high potential and an increasing number of applications (Lam, 2004; Bahrammirzaee, 2010). However, their practical limitations and contradictory empirical evidence have led to skepticism on whether they can outperform existing traditional models. NNs are similar to any advanced statistical model. They are optimized in an in-sample period and applied for prediction in an out-of-sample period. The difference of NNs with statistical models is on their adaptive nature. NNs can take many different forms and have as inputs any potential explanatory variable. Therefore they are capable of exploring different forms of non-linearity and theoretically provide a superior performance than statistical–econometrical models. Non-linearity is not possible to be measured in statistical terms and therefore models such as NNs have the advantage in problems where the exact nature of the series under study is unknown. Skeptics point out the NNs' lack of formal theoretical background and see them as a black box (Vellido et al., 1999; Paliwal and Kumar, 2009). However, financial series and especially exchange rates are dominated by factors (e.g. behavioral factors, politics, . . .) that time-series analysis and statistics are unable to capture in a single model. Based on this, it can be argued that a time-series statistical model that will capture the pattern of exchange rates in the long-run is impossible. Statistical theory and mathematics will never be able to explain such a complex relationship.

The Adaptive Market Hypothesis (AMH) argues that financial markets follow an evolutionary process. Profitable trading strategies exist at any time but their strength and robustness is diminishing over time (Lo, 2004). Heuristics such as NNs, Genetic Programming (GP) and Support Vector Regression (SVR) try to imitate biological functions and create mathematical relationships. According to the AMH they seem a perfect fit for our study and should outperform the classic statistical/technical models that dominate the relevant literature.

In this paper we examine the performance of a Multi-Layer Perceptron (MLP), a Recurrent Neural Network (RNN) and a Psi-Sigma Network (PSN) architecture in forecasting and trading the Euro/Dollar (EUR/USD), Euro/British Pound (EUR/GBP) and Euro/Swiss Franc (EUR/CHF) exchange rates. Then, we explore the utility of Kalman Filter, Genetic Programming (GP) and Support Vector Regression (SVR) algorithms as forecasting combination techniques. As benchmarks for our NNs we use a Random Walk model (RW), an Autoregressive Moving Average model (ARMA) and a Smooth Transition Autoregressive Model (STAR). Our forecast combination techniques are then benchmarked by a Simple Average and a Least Absolute Shrinkage and Selection Operator (LASSO). Our forecasts are evaluated in terms of statistical accuracy and trading efficiency. All three exchange rates are highly liquid and well known for their high volatility in our days. Therefore, they are perfect series for a forecasting exercise with nonlinear models.

The rationale of the paper is multiple. We explore if nonlinear models such as NNs are able to outperform traditional models such as RW, ARMA and STAR. The STAR model will act as statistical nonlinear benchmark while the comparison of our results with a RW model will add to the ongoing debate if financial forecasting models can outperform a RW.[1] In this forecasting competition we do not include structural macroeconomic models as presented by Flannery and Protopapadakis (2002), Andersen et al. (2003), Pearce and Solakoglu (2007), Evans and Speight (2010), and recently Bacchetta and Wincoop (2013). The main reason for that choice is the unavailability of daily data of relevant macroeconomic indicators. Comparing our models with benchmarks generated by lower frequency data would make the forecasting competition unfair and unequal. This study will also check if statistical models like the LASSO and the Kalman Filter can combine our forecasts successfully and provide a superior trading performance. Their results will be benchmarked against those generated by two advanced nonlinear techniques, a SVR and a GP model. SVR and GP algorithms have provided promising

[1] We also explored several autoregressive, moving averages and exponential smoothing models. Their statistical and trading performance was worse than those of ARMA for all exchange rates and periods considered.