UNIVERSITY OF COLOMBO, SRI LANKA

Dynamic Environment Based Clustering and Hybrid Forecasting (DEC-HyF) Model: An Application to EUR/USD Exchange Rate

A thesis submitted for the Degree of Doctor of Philosophy

H. A. Pathberiya

Faculty of Science

University of Colombo

April 2018

Abstract

Some characteristics, such as non-linear dependencies and heterogeneity in variance, make the modeling of financial time series, a complex task. Financial systems turn out to be more complex with the effects of diversified events occurring at different time lags. Such effects cause non-static environments. Consequently, the accuracy of forecasts derived from conventional Time Series Models, will be diminished. Under such circumstances, conventional time series models fail to achieve the expected accuracy and inapplicability of these models arise.

This thesis is focused on formulating a novel approach for developing a dynamic forecasting model, with the perspective of incorporating dynamic environmental conditions. The study claims that the accuracy can be improved by utilizing only the most appropriate subset from the time series. Such subset is supposed to reflect effects from environmental conditions similar to that of the forecasting time point.

In order to capture contrasting effects of dynamic environmental conditions, an improved two-step clustering algorithm is proposed. The first step is designed to cluster dynamic environments, based on the attributes representing reactions of the time series. In the second step, the time series is clustered by assigning cluster numbers of dynamic environments attached to respective time points. Moreover, the novel algorithm is capable in eliminating the effect of noise objects on clustering result.

Finally, cluster-wise hybridized models are formulated by integrating time series mode decomposition and feature extraction through a feed forward neural network (DEC-HyF model). Intension of mode decomposition is motivated by the evident diversity in the volatility process. Sensitivity of time series, towards some sets of dynamic environments even within the same clusters, leads to extract such features and incorporate those in the model. Hybrid modeling concept is introduced to enable the model to capture diverse characteristics witnessed in financial time series.

Results observed from the Forex trading application, reveled a significant contribution of clustering procedure in comparison to the models which disregards clustering. Final result confirms, that the integration proposed by means of DEC-HyF model outperforms the other tested integration schemes, specifically, clustering-decomposition (EMD-ANN) and clustering-decomposition-volatility estimation (EMD-GARCH-ANN). Moreover, the proposed expert system for Forex trading, based on the DEC-HyF model emphasized 76% of opportunities with positive aggregated profits over the forecasting period.