# PREDICTIVE ANALYTICS FOR CRUDE OIL PRICE USING RNN-LSTM NEURAL NETWORK

**Author:Mohd Hafizul Afifi Abdullah, Lei Liu, Ahmad Naqib Zaidi**

Due to the market's extreme complexity, chaos, and dynamic nature as well as stakeholder perception, forecasting the price of crude oil is regarded as a significant challenge. Every minute, the price of crude oil fluctuates, and millions of shares are traded. News, the difference between supply and demand, labour costs, the amount of remaining resources, as well as stakeholder perception, all have an impact on market prices for commodities like crude oil. As a result, different technical analysis indicators have been used in order to forecast the price of crude oil in the future. In recent years, many researchers have used machine learning techniques to address this issue.. This study showed how to use RNN-LSTM networks along with other technical analysis indicators to forecast the price of crude oil using historical data. The goal of this study is to validate the ability of a prediction model based on an RNN-LSTM network to forecast the price of crude oil in the future. To determine whether the network can improve the accuracy of crude oil price prediction in comparison to other approaches, the developed model is trained and evaluated against accuracy matrices. The model's outcome demonstrates the RNN-LSTM algorithm's potential for predicting changes in the price of crude oil

# AN AI-AGENT-BASED TRAPEZOIDAL FUZZY ENSEMBLE FORECASTING MODEL FOR CRUDE OIL PRICE PREDICTION

**Author : Lean Yu, Shouyang Wang, Bo Wen, Kin Keung Lai**

In this study, a trapezoidal fuzzy ensemble forecasting model based on ai agents is suggested for predicting crude oil prices. a few single ai models are initially e mployed as predictors for the prediction of the price of crude oil in the proposed ensemble model. following that, some fuzzy prediction representations are crea ted from these individual prediction results generated by the individual ai-based predictors.
these fuzzified representations are then combined to create an aggregated fuzzy prediction, or fuzzy consensus. the final prediction result is the aggregated predi ction defuzzified into a crisp value. two common crude oil price prediction expe riments are presented for testing purposes.

In this section, an AI-agent-based trapezoidal fuzzy ensemble forecasting model is proposed for time series prediction. The basic idea of the proposed model is to make full use of ensemble members' knowledge to make a more accurate prediction over any single AI predictors. Generally, the proposed model consists of four different steps: single AI-based predictor creation; fuzzification of single AI prediction; fuzzy prediction ensemble; aggregated prediction defuzzification

# UNDERSTANDING CRUDE OIL PRICES

**Author's: James D. Hamilton NBER.**

This article describes some of the key features of the oil market and then discusses the pricing of oil, highlighting the important role of the futures market. It also notes some related issues for the oil market. Topics discussed include the role of commodity speculation, OPEC, and resource depletion. This is true in terms of both production and financial market activity. In terms of statistical regularities, the paper notes that changes in the real price of oil have historically tended to be permanent, difficult to predict, and governed by very different regimes at different points in time. From the perspective of economic theory, we review three separate restrictions on the time path of crude oil prices that should all hold in equilibrium. The first of these arises from storage arbitrage, the second from financial futures contracts, and the third from the factthat oil is a depletable resource. We also discuss the role of commodity futures speculation.In terms of the determinants of demand, we note that the price elasticity of demand is challenging to measure but appears to be quite low and to have decreased in the most recent data. Income elasticity is easier to estimate, and is near unity for countries in an early stage of development but substantially less than one in recent U.S. data. We also relate the challenge of depletion to the past and possible future geographic distribution of production.Our overall conclusion is that the low price-elasticity of short-run demand and supply,the vulnerability of supplies to disruptions, and the peak in U.S. oil production account for the broad behavior of oil prices over 1970-1997. Although the traditional economic theory of exhaustible resources does not fit in an obvious way into this historical account, the profound change in demand coming from the newly industrialized countries and recognition of the finiteness of this resource offers a plausible explanation for more recent developments. In other words, the scarcity rent may have been negligible for previous generations but may now be becoming relevant Yet its pricing is relatively complex. Unquestionably the three key features in any account are the low price elasticity of demand, the strong growth in demand from China, the Middle East, and other newly indus-trialized economies, and the failure of global production to increase. These facts explain the initial strong pressure on prices that may have triggered commodity speculation in the price of petroleum

# A MULTI-RECURRENT NETWORK FOR CRUDE OIL PRICE PREDICTION

**Author: Oluwatamilore Orojo, Jonathan Tepper, T.M. Mcginnity**

Crude oil is fundamental for global growth and stability. The factors influencing crude oil prices and more generally, the oil market, are well known to be dynamic, volatile and evolving. Subsequently, crude oil prediction is a complex and notoriously difficult task. In this paper, we evaluate the Multi-recurrent Network (MRN), a simple yet powerful recurrent neural network, for oil price forecasting at various forecast horizons. Although similar models, such as Long Short-Term Memory (LSTM) networks, have shown some success in this domain, the MRN is a comparatively simplified neural network model which exhibits complex state-based memories that are both flexible and rigid. We evaluate the MRN against the standard Feedforward Multilayered Perceptron (FFMLP) and the Simple Recurrent Network (SRN) in addition to the current state-ofthe-art LSTM for specifically modelling the shocks in oil prices caused by the financial crisis. The in-sample data consists of key indicator variables sampled across the pre-financial crisis period (July 1969 to September 2003) and the out-sample data used to evaluate the models, is before, during and beyond the crisis (October 2003 to March 2015). We show that such simple sluggish state-based models are superior to the FFMLP, SRN and LSTM models. Furthermore, the MRN appears to have discovered important latent features embedded within the input signal five years prior to the 2008 financial crisis. This suggests that the indicator variables could provide Central Banks and governments with early warning indicators of impending financial perturbations which we consider an invaluable finding and worthy of further exploration

# CRUDE OIL PRICE PREDICTION USING DEEP LEARNING

**Author : Y. Jeevan Nagendra Kumar, Partapu Preetham, P. Kiran Varma, P. Rohith, P. Dilip Kumar**

The price of crude oil significantly affects the global economy.
Since a few years ago, the price of crude oil has fluctuated more than that of any other commodity. It is difficult to predict the price of crude oil because it is hig hly volatile and dependent on a number of outside factors. Recurrent neural net work-based Long Short-
Term Memory (LSTM) has demonstrated improved performance in predicting h ighly volatile prices. The significant crude oil price is assessed and modelled usi ng this model.
The useful data from the WTI unrefined petroleum markets is used to evaluate t he proposed model's performance.
The exploratory results demonstrate that the proposed model increases the expe cted level of result precision.

LSTM is the most widely used type of RNN. LSTM is mainly used for the sequence prediction problem. RNN has encountered two significant problems, i.e., vanishing gradients and exploding gradients. These two major problems are solved using LSTM. The main reason is the structure of LSTM, which helps to overcome these problems.

# A NOVEL HYBRID APPROACH WITH A DECOMPOSITION METHOD AND THE RVFL MODEL FOR CRUDE OIL PRICE PREDICTION

**Author : Chengyuan Zhang, Fuxin Jiang , Shouyang Wang, Wei Shang**

Volatility of international crude oil prices is influenced by various external factors on different time scales. User search data (USD) which reflects investor attentions has been widely researched and proved to be associated with crude oil price change at different frequency bands. In this paper, a novel hybrid approach that utilizes bivariate empirical mode decomposition (BEMD) with user search data and machine learning is developed for crude oil price forecasting. First, BEMD is adopted to simultaneously decomposed the crude oil price data and USD into a finite set of components. Second, each component is modelled and predicted by random vector functional link (RVFL) network and the corresponding final results are obtained via an ensemble model. Third, Brent crude oil spot price is used to test the proposed approach empirically. Forecasting results are analyzed with various evaluation criteria and verified robustness. Results show that the proposed approach statistically outperforms traditional forecasting machine learning techniques and similar counterparts (with USD or EMD-based method) in terms of prediction accuracy.

# MORPHOLOGICAL COMPONENT ANALYSIS BASED HYBRID APPROACH FOR PREDICTION OF CRUDE OIL PRICE

**Author : Kaijian He, Kin Keung Lai, Jerome Yen**

Because of the difficult process involved in creating the data, crude oil price prediction continues to be a difficult problem. Recent empirical evidence suggests that the combination of data characteristics in the time scale domain is another crucial data feature to be included in the modelling process, in addition to the long-perceived problem with nonlinear data features. In this paper, a brand-new hybrid methodology based on morphological component analysis is proposed for simulating the multiscale heterogeneous data generation process. Empirical research on the benchmark crude oil market demonstrates the proposed algorithm's notable performance improvement over competing models. The separation of the underlying distinct data features and the determination of appropriate model specifications for them are credited with the proposed model's superior performance. In the meantime, the suggested methodology provides offers additional insights into the underlying data generating process and their economic viability

# INTELLIGENT CRUDE OIL PRICE FORECASTER

**Author: Fares Hedayati, Ardalan Tebyanian**

We offer two ensemble regression algorithms that use features taken from the U.S. Energy Administration and a few international news agencies to forecast the daily price of crude oil. A collection of homogeneous regressors with different parameters, such as linear regression models with various ridge regularisation parameters, make up an ensemble regression model. The individual regressor with the lowest mean square error over recent data is chosen by the first ensemble method, called "recent leader." The second model, referred to as a "exponentially weighted ensemble," combines individual regressors in a linear manner with weights of constituent models decrementing exponentially with mean square error over previous predictions. Linear regression, support vector regression, decision trees, and Gaussian processes were used to test these two methods. The most effective model was an exponentially weighted ensemble with support vector regression.

# Analysis and forecasting of crude oil price based on the variable selection-LSTM integrated mode

**Author's: Quanying Lu, Shaolong Sun, Hongbo Duan, Shouyang Wang.**

Memory Network (LSTM) is developed for crude oil price forecasting. Then six different forecasting techniques, random walk (RW), autoregressive integrated moving average models (ARMA), elman neural Networks (ENN), ELM Neural Networks (EL), walvet neural networks (WNN) and generalised regression neural network Models (GRNN) were used to forecast the price. sFinally, we Utilizing root mean squared error, compare and contrast the various outcomes. Therefore, systematic analysis of the characteristics of complex international oil markets and accurate capture of the new trend in international oil prices are critical. However, as the linkage between the markets, the uncertainty of the world economy and energy, the influence factors of oil price have become complex. It is difficult to point out which factors have the dominant effect on the oil price. How to forecast crude oil prices in a new and effective method is one problem that academics and practitioners are very concerned about all the time. Directional symmetry, mean absolute percentage error (MAPE), and RMSE (DS). Our According to empirical findings, the variable selection-LSTM technique performs better than baseline techniques for forecasting precision at both the level and direction. The statistical test results show that the prediction of 1 step in advance in-sample and 1 step in advance in out of sample. Compared with the prediction performance of the three variable extraction methods, the directional prediction accuracy and horizontal prediction accuracy of the BMALSTM integrated model are the best, followed by Spike and Slab-LASSO-LSTM and GLMNET-LSTM. This indicates that the variable selection-based machine learning integrated research framework proposed in this chapter significantly improves the forecasting performance of oil prices. In future research, we may introduce more independent variables with the help of internet search data, test our framework performance. Moreover, investor sentiment can be quantified in this process. In addition, different variable selection methods can be introduced more

# LEARNING PART-BASED DICTIONARIES BY NMF FOR CRUDE OIL MARKET PREDICTION

**Author : Caiyang Xu, Xueyan Mei**

Since the crude oil market has an influence on the world economy, it is crucial to create some reliable methods for predicting the price and volatility of crude oil. The purpose of this paper is to forecast the trend of the future price of crude oil using ten features that may have an impact on its price. Artificial neural networks, support vector machines, and logistic regression, which are classifiers trained from the training data and used to make predictions for the new data, are currently the most widely used and reliable machine learning-based prediction methods. The performance of To predict the trend of the future price of crude oil, a support vector machine (SVM) is trained on data encoded by words from a dictionary. The study demonstrates the usefulness of the suggested framework for forecasting the crude oil marketthe classifier training, however, also depends on how the data are represented.