NEURO – GENETIC MODEL FOR THE PROJECTION OF CRUDE OIL PRICE CAPABLE OF HANDLING OF UNCERTAINTY

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ABSTRACT

Some events occur sometimes without any warning, such as war, revolution, financial crises, terrorist attacks, political conflicts, false news, natural disasters, earthquakes, and extreme weather conditions. These types of events which we termed as uncertain events, when related to crude oil have significant effects on the price and will contribute to oil price volatility. Volatility in crude oil market has direct and indirect negative effects on the global economy and inflicts suffering on communities across the globe. The effects of crude oil volatility have no geographical boundary as there is no restriction to a specific country or region of the world. The purpose of the research is to propose a model that can predict the price of crude oil in the real world scenario. This study presents an alternative model based on Neural Network and Genetic Algorithm (Neuro-Genetic) for the projection of crude oil price while considering the impact of uncertainties. The difference between the crude oil price projected by the Neuro-Genetic model and the actual price was not statistically significant. The results obtained by the Neuro-Genetic model performs significantly better than the backpropagation neural network and support vector machine in both accuracy and CPU processing time. The model was able to learn patterns from volatile crude oil price datasets during the 1991 Gulf War, the 1997 Asian financial crisis, the 2002 Venezuelan unrest, the second Gulf War of 2003, and the 2007 global financial recession. The retraining applied in the modeling process possibly allow the Neuro-Genetic model to learn and capture new data patterns during the uncertain events. Thus, the model can effectively be applied as an alternative mechanism by policy makers in the formulation of policies related to energy demand and supply, bio-fuel, fuel subsidy, global food price subsidy, the stock market as well as national planning and budget. Intergovernmental organizations such as the Organization of Petroleum Exporting Countries (OPEC) can use our proposed model to serve as a guide for the

formulation of policies related to international crude oil price. The model has the potential for realistic, practical application in the real world.

ABSTRAK

Beberapa peristiwa berlaku kadang-kadang tanpa sebarang amaran , seperti peperangan, revolusi , krisis kewangan , serangan pengganas , konflik politik , berita palsu , bencana alam , gempa bumi , dan keadaan cuaca yang melampau . Jenis-jenis acara yang kita digelar sebagai peristiwa yang tidak menentu , apabila berkaitan dengan minyak mentah mempunyai kesan yang besar ke atas harga dan akan menyumbang kepada harga minyak turun naik . Turun naik dalam pasaran minyak mentah mempunyai kesan negatif secara langsung dan tidak langsung kepada ekonomi global dan ditimpakan penderitaan pada masyarakat di seluruh dunia. Kesan turun naik minyak mentah tidak mempunyai sempadan geografi kerana tidak ada sekatan kepada negara tertentu atau rantau di dunia. Tujuan kajian ini adalah untuk mencadangkan satu model yang boleh meramalkan harga minyak mentah dalam senario dunia sebenar . Kajian ini membentangkan satu model alternatif berdasarkan Neural Network dan Algoritma Genetik (Neuro - genetik) untuk unjuran harga minyak mentah manakala mengingati kesan ketidakpastian . Harga minyak mentah diunjurkan oleh model Neuro - Genetik dan harga sebenar didapati secara statistik sama . Keputusan yang diperolehi oleh model Neuro - genetik yang melakukan lebih baik daripada itu rangkaian neural rambatan balik dan sokongan mesin vektor dalam ketepatan dan masa pemprosesan CPU . Model ini dapat mempelajari corak dari set data harga minyak mentah yang tidak menentu semasa Perang Teluk 1991, 1997 krisis kewangan Asia 2002 rusuhan Venezuela , Perang Teluk kedua 2003 , dan 2007 kemelesetan kewangan global . Latihan semula yang digunakan dalam proses pemodelan mungkin membenarkan model Neuro - genetik untuk mempelajari dan menguasai corak data baru dalam acara yang tidak menentu . Oleh itu , model yang boleh berkesan digunakan sebagai mekanisme alternatif oleh pembuat dasar dalam penggubalan dasar-dasar yang berkaitan

dengan permintaan dan bekalan tenaga , bio - bahan api , subsidi bahan api , global subsidi harga makanan , pasaran saham dan juga perancangan negara dan bajet . Pertubuhan antara kerajaan seperti Pertubuhan Negara-negara Pengeksport Petroleum (OPEC) boleh menggunakan model yang dicadangkan kami untuk berkhidmat sebagai panduan untuk menggubal dasar yang berkaitan dengan harga minyak mentah antarabangsa . Model ini mempunyai potensi untuk aplikasi praktikal realistik dalam dunia sebenar .

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List of Abbreviations

ac	Percentage of accuracy
AI	Artificial Intelligence
AIT	Artificial Intelligent Techniques
ANFIS	Adaptive Neuro Fuzzy Inference Systems
ANN	Artificial Neural Network
ANN-Q	ANN–Quantitative
ANOVA	One-way Analysis of Variance
ARIMA	Autoregressive Integrated Moving Average
B	Batch weight/bias learning rules
BFG	BFGS Quasi-Newton
BR	Bayesian Regulation
CL	Crude oil
Daqling	Daqing oil field
DOAJ	Direct Open Access Journals
EIAUSDE	Energy Information Administration of the US Department of Energy
EMD–ARIMA–ALNN	ARIMA, empirical mode decomposition–feed forward ANNs– adaptive linear NNs

EMD–ARIMA–Averaging	Empirical Mode Decomposition- Autoregressive Integrates Moving Average
EMD–FNN–ALNN	Empirical Mode Decomposition FFNN Adaptive Linear ANN
EMD–FNN–ALNN	Empirical Mode Decomposition-Based ANN Ensemble Learning Pattern
ENN	Elman Neural Networks
FNN	Fuzzy Neural Network
FOB	Freight on Board
FR	Fuzzy regression
GA	Genetic Algorithm
GARCH	Autoregressive Conditional Heteroskedasticity
GDP	Gross Domestic Product
GDX	Gradient Descent BEP
ROPF	Regular Oil Price Fluctuation
GMDHNN	Group Method of Data Handling ANN
GP	Genetic Programming
GPMGA	Generalize Pattern Matching based on Genetic Algorithms
GRNN	Generalized Regression ANN

HIS	Hybrid intelligent systems
hn	Hidden layer nodes
HO	Heating oil
HTW-MBPNN	Harr a Trous Wavelet multilayer back- propagation ANN
HU	Gasoline
HWT	Haar Wavelet Transform
HWTBPNN	Haar Wavelet Transform backpropagation ANN
IIS	Individual Intelligent System
IMF	International Monetary Fund
KLT	Karhunen-Loève Transform
KLTBNN	Karhunen-Loève Transform backpropagation neural network
LM	Levenberg–Marquardt
LMBP	Levenberg – Marquardt backpropagation
LRM	Linear Regression Model
LSSVM	Least-Square-Support Vectors
MAE	Mean Absolute Error
MAPE	Mean Absolute Percentage Error
MLFFNN	Multilayer FFNN
MLNN	Multi-layer backpropagation ANN
MLRM	Multiple Linear Regression Model

MPE	Mean Percentage Errors
MSE	Mean Square Error
NESWM	Hybrid of NN, expert system, and web mining
NG	Natural gas
NM	Normalized Method
NMSE	Normalized Mean Square Error
NOPECCP	Non OPEC crude oil production
NYMEX	New York Mercantile Exchange
OECD	Organization for Economic Co – operation and Development
OECDCOC	OECD crude oil consumption
OECDES	OECD crude oil ending stocks
OPEC	Organization of Petroleum Exporting Countries
OPECCP	OPEC crude oil production
PCA	Principal Component Analysis
PMRS	Pattern Modeling and Recognition System
PN	Propane
R	Regression
RBFNN	Radial Basis Function ANN
rBPNN	Correlation BPNN
RM	Raw Method
RMSE	Root Mean Square Error

RNN	Recurrent ANN
RW	Random Walk
SHCI	Shanghai Composite Index
ARIMA	Autoregressive Integrates Moving Average
FNN	Feed-forward ANNs
SINOPEC	Stock Price of China's largest oil company: China Petroleum & Chemical Corporation
STEO	Short Term Energy Outlook
SVM	Support Vector Machine
SZCI	Shenzhen Compositional Index
SZPI	Shenzhen Petrochemical Index
TE	The trial and error (TE)
TEBPNN	Trial and error backpropagation neural network
USCOI	US crude oil imports
USCOP	US crude oil production
USCOS	US crude oil supplied
USCOSR	US crude oil stocks at refineries
USESTG	US gasoline ending stocks
WBNNK	Wavelet Boltzmann cooperative ANNs and kernel density estimation
WCOP	World crude oil production
WDNEVaR	Wave Decomposition Network Value at Risk
WDVaR	Wavelet Decomposition Value at Risk

W-LSSVM	Wavelet and least-square-support vectors
WRBFNN	Wavelet transform and RBFNN
WTI	West Texas Intermediate