

**SOFT COMPUTING APPROACHES TO STOCK FORECASTING: A SURVEY****Ifebanjo Temitope M\*, Ogunleye Olawole M, Abiodun Theresa Nkechi, Adebisi Ayodele A.**

\* Department of Computer and Information Science, Covenant University (Nigeria)

**DOI:****KEYWORDS:** Soft computing techniques, Stock price prediction, Stock Index.**ABSTRACT**

Soft computing techniques has been effectively applied in business, engineering, medical domain to solve problems in the past decade. However, this paper focuses on censoring the application of soft computing techniques for stock market prediction in the last decade (2010 - todate). Over a hundred published articles on stock price prediction were reviewed. The survey is done by grouping these published articles into: the stock market surveyed, input variable choices, summary of modelling technique applied, comparative studies, and summary of performance measures. This survey aptly shows that soft computing techniques are widely used and it has demonstrated widely acceptability to accurately use for predicting stock price and stock index behavior worldwide.

**INTRODUCTION**

The inherent desire of man to see the future since the beginning of time is exemplified in the desire of stock market investors' quest to accurately as possible predict the future prices of stock for profit and make better informed investment decisions. The main aim of stock market predictions is usually to achieve accurate prediction of the future prices/indices of the stock market, doing so with the least possible amount of data, with the most uncomplicated model possible (Atlasakis, 2009).

Armed initially in the early days of stock market forecasting with the statistical methods of autoregressive conditional heteroscedasticity (ARCH) model (Engle's, 1982), generalized ARCH (GARCH) model (Bollerslev's 1986), Box and Jenkins's (1976) autoregressive moving average (ARMA) model, and the autoregressive integrated moving average model (ARIMA) amongst others.

However, the various factors such as high dimensionality of the data, inherent chaotic and volatile nature of the market, politics and even natural disasters makes the prediction of stock prices an arduous and complicated task; leading to the advent of soft computing techniques in the 90s, which has made available a plethora of soft computing methods that has attempted and successfully predicted the future prices, movement or index of the stock markets all over the world.

This work examines over 110 published works that used soft computing techniques in the last seven years (2010 - todate) to forecast stock prices or stock indexes. The first table lists the respective stock markets authors have used and cited in their works. The second table lists input variables (independent variables) to the stock market model. The third table summarizes specific methodologies and model parameters used in each paper to forecast stock markets. The fourth table demonstrates modeling benchmarks of each author's specific approach, as well as any comparisons/discussions made against other techniques; such techniques include artificial neural networks (ANNs), linear and multi-linear regression (LR, MLR), ARMA and ARIMA models, genetic algorithms (GAs), random walk (RW), buy and hold (B & H) strategy, and/or other models. The last table summarizes performance measures used to evaluate each surveyed model (Atlasakis et al., 2009). The rest of this paper is structured as follows: Section 2, presents the survey stock market. In Section 3, presents the input variables used in the models. Section 4, shows the different modeling techniques/ models used in survey articles.. Section 5 reveals how the authors benchmarked their models with other models. Section 6, the performance measures in each articles surveyed and Section 7 concludes the paper.

**SURVEYED STOCK MARKET FROM WHERE AUTHORS OBTAINED DATASETS**

From Table 1, it was observed from the random collection of journals used for this survey, studies carried out on the Asian stock markets took the forefront. Surveys carried out on the Indian stock market leads the pack Dase and Pawar(2010), Kunwar and Ashutosh (2010), Nitin et al. (2010), charkravaty and Dash (2012), Sujata et al. (2012), Sureshkumar and Elango (2012), Santosh et al. (2013), Choudhurg et al. (2014), Rajashree and Pradiptakishore(2014), Narendra and Eswara (2014), Subhabrata et al. (2014), Babita et al. (2014), Anish and Majhi(2015), .Narendra and Eswara (2015), Jyoti and Jitendra (2015), Anbalayan and Mheswari (2015), Preethi et al. (2015), and Rajashree and Pradiptakishore (2016).

Followed closely on the Asian market is the Chinese stock exchange with the works of: Zhe and Jue(2010), Qinghua wen et al., (2010), Yixin and Zhang (2010), Li-Ping et al.,(2011), Lie and Qung(2011), Chong and Olivia(2011), Kang and Sun (2011), Jian-Zhou et al., (2011), Wei shen et al. (2011), Wensheng et al. (2012), Luo and chen(2013), Chuangxia et al.,(2013), Wen et al., (2014), Donglin et al., (2014), ZheGao et al, (2014), Yudie du et al. (2014), Huanhuan et al. (2014), Chunpeng and Liyun (2015), Yong Hu et al. (2016). Still from the Asian market, from the Taiwan Stock Exchange are: Chie\_jie lu (2010),Chih\_fong and Yu-cieh (2010), Chun-I et al, (2010), Ching-Hsue et al, (2010), Cheng a et al. (2010), Liang-Ying a,b et al. (2011), Tsung-Jung et al.,(2011), Feng and Choub(2011), Chih-Ming Hsu(2011), Olivia and Sheng (2011), Chin-Yuan et al.,(2011), Chang-Fan (2011), Shie-jue et al.,(2012),Liang-Ying(2013), Wen Fenghua et al.,(2014),Kao-Yi and Gwo-Hshung (2015 and 2016).

The African markets are represented in the survey by the Nigerian stock exchange has these works selected Akintola et al.,(2011), Adebisi et al., (2011, 2012), Ajao and Wemambu (2012), Adebisi (2012), Neenwi et al., (2012), Adetunji et al., (2013), Olayiwola and Basira(2013), Neenwi et al. (2013), Abubakar and Adeboye(2013, 2014), Godknows and olusanya(2014), Ayodele et al.,(2014), Adebisi et al., (2014), Huanhuan et al., (2014), Acheme David et al., (2014) and from Gabon is the work of Andrea Nemeli et al., (2015).

The American Markets also featured Johan et al.,(2010), Pei-Chann and Chang(2011), Ju-Jie et al.,(2011), Erkam et al.,(2011), Mighel and pedro(2011), Chih-Fong et al.,(2011), Yinkak (2011), David Enke et al., (2011), Ju-Jie et al.,(2012), Sureshkumar and Elango (2012), petr and filippo (2013), Yuling Lin et al., (2013), and Michael et al., (2015).

The European Markets represented includes the works of Y. Wu et al., (2010) and Chan and Franklin (2011), of the Australian Stock Market, Enric et al.,(2014), of the Belgium market, works from German, Japan, Romania, Switzerland, United Kingdom (Maik et al.,(2012), James and Mark(2012)), and Turkey were also reviewed.

**Table 1: List of surveyed stock markets**

<b>Stock Market</b>	<b>Article</b>
Ahmedabab stock market	Jay et al (2013)
Asia stock market	Wensheng et al. (2012)
Australia stock market	Y. Wu et al. (2010) and Chan et al. (2011).
Bangladesh stock market	Muhammad et al. (2010), Mustain et al. (2015),
Belgium stock market	Enric et al. (2014)
China stock market	Zheet al. (2010), Qinghua wen et al. (2010), Yixin and Zhang (2010), Li-Ping et al. (2011), Lie and Qung( 2011), Chong and Olivia(2011), Kang and Sun (2011), Jian-Zhou et al. (2011), Wei shen et al. (2011), Wensheng et al. (2012), Luo and chen(2013), Chuangxia et al. (2013), Wen et al. (2014), Donglin et al. (2014), ZheGao et al. (2014), Yudie du et al. (2014), Huanhuan et al. (2014), Chunpeng et al. (2015), Yong Hu et al. (2016)
Egypt stock market	Osman et al. (2014)
Gabon index market	Andrea et al. (2015)



Germany stock market	Michael et al. (2013)
Greece stock market	Atsalaki et al. (2011)
Hawaii stock market	Michael et al. (2012)
Hong Kong stock market	Senthamarai et al. (2010) and Chan et al. (2011).
India stock market	Dase et al. (2010), Kunwar et al. (2010), Nitin et al. (2010), charkravaty and Dash (2012), Sujata et al. (2012), Sureshkumar et al. (2012), Santosh et al. (2013), Choudhurg et al. (2014), Rajashree et al. (2014), Narendra et al. (2014), Subhabrata et al. (2014), Babita et al. (2014), Anish et al. (2015), Narendra et al. (2015), Jyoti et al. (2015), Anbalayan et al. (2015), Preethi et al. (2015), and Rajashree et al (2016).
Iran stock market	Esmail et al. (2010), Shahrokh et al. (2012), Asadi et al. (2012), Ahmad et al. (2013), Frookh et al., (2013), Reza et al. (2015), Mohammad (2015)
Japan stock market	Shangkun et al. (2011)
London stock market	Maik et al. (2012), James and Mark(2012),
Malaysia stock market	Azadeh et al. (2010), and Shu and Shok(2014).
Morocco stock Market	Salim Lahmiri(2014),
New York stock market	Daniel et al. (2010),
Nigeria stock market	Akintola et al.(2011), Adebisi et al. (2011, 2012), Ajao et al. (2012), Neenwi et al. (2012), Adetunji et al. (2013), Olayiwola et al. (2013), Neenwi et al. (2013), Abubakar et al. (2013, 2014), Godknows et al. (2014), Adebisi e et al. (2014), Ayodele et al. (2014), Huanhuan et al. (2014), Acheme et al. (2014),
Romania stock market	Catalina-Lucia(2015).
Singapore index	Adam et al, (2015),
South Korea Market	Park and Shin(2013),
Switzerland stock market	Maik et al. (2010), Angeva (2015),
Taiwan stock market	Chie_jie lu (2010), Chih-fong et al. (2010), Chun-I et al. (2010), Ching-Hsue et al. (2010), Cheng et al. (2010), Liang-Ying et al. (2011), Tsung-Jung et al. (2011), Feng et al. (2011), Chih-Ming (2011), Olivia and Sheng (2011), Chin-Yuan et al. (2011), Chang-Fan (2011), Shie-jue et al. (2012), Liang-Ying (2013), Wen Fenghua et al. (2014), Kao-Yi and Gwo-Hshung (2015 and 2016).
Thanjavur stock market	Preethi and santhi(2012).
Toronto stock market	Jeffrey et al. (2010), Callen (2010),
Turkey stock market	Malek and Derya(2010), Yakup et al. (2011), Sakir et al. (2015), Nerandra et al. (2015),
USA stock market	Johan et al. (2010), Pei-Chann and Chang(2011), Ju-Jie et al. (2011), Erkam et al. (2011), Mighel and pedro (2011), Chih-Fong et al. (2011), Yinkak (2011), David et al. (2011), Ju-Jie et al. (2012), Sureshkumar and Elango (2012), petr and filippo (2013), Yuling Lin et al. (2013), and Michael et al. (2015).
Vietman Index Stock	Duc-Hien and MAnh-Thanh(2014),
Wiley stock market	Esmail et al. (2012)

## INPUT VARIABLES

Table 2 represents the differing input variables the used by the authors in the various articles. It is observed that most work surveyed used technical indicators for the stock forecasting, fewer works used the fundamental indicators. Adebisi et al (2011) is an exception with a hybrid of 21 input variables, combining fundamental and



## Global Journal of Engineering Science and Research Management

technical data as inputs. The average number of variables (often technical data) used in the surveyed works ranges between four and nine.

Worthy of note are the works of Nitin et al 2010 who used the prices of daily open, high, low and close of SENSEX, BSE IT, BSE Oil & Gas, BSE 100 and S& P CNX Nifty. Johan et al, 2010 combined 9,853,498 tweets posted by approximately 2.7M users + DJIA closing-values from Yahoo! Finance to forecast stock price index, Şakir et al., 2015 also used gold price, oil price, interest rate, consumer price index (CPI), exchange rate, money supply and BIST volume to predict the BIST 100.

**Table 2: Input variables used in different articles**

Article	Input Variables
Adebiyi et al. 2011	21 input variables, including Technical analysis variables (Two Opening price, daily high price, daily low price, closing price and trading volume), fundamental variables (Price per annual earning, return on asset of trading, return on equity, management quality, investors confident, inflation rate, political factor and government policy) and experts' opinion variables
Adebiyi et al. 2012	Seven Technical indicators, Six Fundamental Indicators, and five Experts view (Total 18).
Adebiyi et al. 2014	Historical daily stock prices (open price, low price, high price, close price, and volume traded).
Abubakar et al. 2013	NSE All Share index (NSE_ASI), NGN/USD exchange rate (NGN_USD), NSE Market Capitalization (NSE_MCAP), Volume (VOL_CLOSING), Value (VAL_CLOSING).
Abubakar et al. 2014	NSE All Share index (NSE_ASI), NGN/USD exchange rate (NGN_USD) 9, NSE Market Capitalization (NSE_MCAP), Volume (VOL_CLOSING), Value (VAL_CLOSING)
Acheme et al. 2014	The Moving Average Convergence/Divergence (MACD), Relative Strength Index (RSI), Stochastic Oscillator (SO) and On-Balance Volume (OBV).
Adetunji et al. 2013	Stock moving average convergence/divergence, stock stochastic oscillator, closing momentum, stock relative strength index, stock on-balance volume, and the 5 and 10 days closing moving average.
Ahmad et al. 2013	NASDAQ (Intel, National Bank shares and Microsoft daily closed (last stock price.)
Ajao et al. 2012	Daily data on Standard and Poor (S&P) index
Akintola et al. 2011	Closing price, Highest price, Lowest price, Volume.
Anbalaga et al. 2011	Technical Indicators (Simple Moving Average (SMA), Exponential Moving Average (EMA), Moving Average Convergence Divergence (MACD) and Relative Strength Index (RSI))
Anish et al. 2015	Ten indices from DJI & S&P500



## Global Journal of Engineering Science and Research Management

Anjeza 2015	Investor sentiment and four macro indicators (real GDP growth, CPI inflation, unemployment rate and term spread)
Asadi et al. 2012	Technical index
Atsalakis et al. 2011	Closing prices, opening prices,.
Azadeh et al. 2010	Historical market prices and technical analysis
Babita et al. 2014	Eight Technical indicators
Narendra et al 2014	Sunspot data, electricity price data, and stock market data,
Narendra et al. 2015	Ten data set from Indian NSE
Catalina-Lucia et al. 2015	opening, closing, highest and lowest price respectively of SNP stock from Bucharest Stock Exchange,
Cheng et al. 2010	Technical analysis
Chan 2011	Financial Report text (2000 financial reports with 28,000 sentences)
Chih-Fong et al. 2010	Fundamental indexes (Financial and macroeconomic variables).
Chih-Fong et al. 2011	Taiwan Economic Journal (TEJ) Data set.
Chih-Ming Hsu 2011	Technical and fundamental indices
Charkravarty 2012	The Standard's & Poor's 500 (S&P 500), the Bombay stock exchange (BSE) and Dow Jones industrial average (DJIA).
Chi-Jie Lu 2010	Forecasting variables
Ching-Hsue et al. 2010	Technical Analysis
Chin-Yuan et al. 2011	Taiwan Capitalization Weighted Stock Index.
Chin-Yuan et al. 2011	Technical indices(Moving Average(MA), Bias(BIAS), Relative strength index(RSI), Nine days stochastic lines (KD), Moving average convergence and divergence(MACD).
Chong 2011	72,221 micro blog postings for 1909 stock tickers and 3874 distinct authors
Choudhury et al. 2014	Top 102 stocks of the NSE stock market (India)
Chun-I et al. 2010	Taiwan Stock Indices
Daniel et al. 2010	Las Vegas sports betting markets, Trade Sports (now In trade), and Hollywood Stock Exchange (HSX).
David et al. 2011	The closing of the Shenzhen Integrated Index (SZII) and opening of the Dow Jones Industrial Average Index (DJIAI)
Donglin et al. 2014	The daily data including ASPI, All Share Total Return Index (ASTRI), Market Price Earnings Ratio (PER), and Market Price to Book Value (PBV) of the Colombo Stock Exchange
Duc-Hien et al. 2014	Stock market index (opening price, high price, low price, closing price).
Enric et al. 2014	Training Quote data, Training new data, and test plan
Erkam et al. 2011	Technical analysis and fundamental analysis (bond yields, bond prices, contact volumes etc.)



Esmaeil et al. 2010	Technical index
Esmaeil et al. 2012	Stock index opening or closing price, as well as the daily highest and lowest values,
Feng et al. 2011	Two primary technical index
Frookh et al. 2013	NASDAQ historical quotes, namely Intel, National Bank shares and Microsoft daily closed (last) stock price.
Godknows et al 2014	technical analysis indicator
Hemanth et al. 2012	Closing data from Bombay Stock Exchange Sensex
Javad et al. 2015	Tehran Stock Exchange (Book Value, net EPS, forecasted EPS, ROE, ROA, P/E, Percentage of dividends, ratio of dividend to price, the Beta, CFO, operating profit (loss), profit in cash, dividend growth, rating liquidity, firm size, ratio of book value to market value, ratio of market value to book value, total equity at the end of fiscal year, net assets, annual stock returns).
Jay et al. 2013	Closing value of S&P CNX Nifty 50 Index
Jian-Zhou et al. 2011	.....
Johan et al. 2010	9,853,498 tweets posted by approximately 2.7M users + DJIA closing-values from Yahoo! Finance.
Ju-jie et al. 2012	The closing of the Shenzhen Integrated Index (SZII) and opening of the Dow Jones Industrial Average Index (DJIAI)
Kao-Yi et al. 2015	17 financial ratios
Kao-Yin, et al. 2014	17 financial ratios
Kunwar, et al. 2010	NIFTY data (Indian NSE)
Lei et al. 2011	Shangai Composite Index
Liang-Ying 2013	Two technical indicators
Liang-Ying et al. 2011	Technical analysis
Li-Ping et al. 2011	Kernel Principal Component Analysis (KPCA)
Luo et al. 2013	20 shares from Shanghai Stock
Melek, 2010	six macroeconomic variables and three indices
Michael et al. 2012	.....
Michael et al. 2013	.....
Michel et al. 2015	.....
Miguel, 2011	Standard & Poor's (S&P) 500 index
Muhammad, 2010	The textual message base and corresponding exogenous feedback
Mustain et al. 2015	Six macroeconomic variables and three indices
Nitin et al. 2010	Prices of daily open, high, low and close of SENSEX, BSE IT, BSE Oil & Gas, BSE 100 and S& P CNX Nifty.



## Global Journal of Engineering Science and Research Management

Olayiwola, 2013	Stock prices of Nigerian breweries from 2008 to 2012
Osman et al. 2014	Two input variables
Park, 2013	The stock prices of LG Chem and KIA Motors, WTI intermediate oil price, other external factors, etc.
Preethi, 2012	Open, High, Low, Close values of the daily shares are input.
Qinghua et al. 2010	Closing price and technical indicators
Rajashree et al 2016	Open, low, high and closing stock index prices from (S&P500) and Bombay Sensex
Reza et al. 2015	Six macro-economic variables and three indices
Neenwi et al. 2013	Technical data from Banks On The Nigerian Stock Exchange
Olatunji et al. 2013	Closing price of the stock
Şakir et al. 2015	Gold price, oil price, interest rate, consumer price index (CPI), exchange rate, money supply and BIST volume
Salim 2014	Obtained approximation(Low frequency), detailed component (high frequency)
Senthamarai et al. 2010	High, Low, Close values of the daily share
Shahrokh et al. 2012	Technical index
Shangkun et al. 2011	News text data and time series data
Shie-Jue et al. 2012	Closing prices of the previous day
Shu, 2014	Annual stock market capitalization, gross domestic product, inflation rate, interest rate, and exchange rate volatility
Suanu et al. 2012	Stock index and its corresponding index futures, technical indicators(RSI, MACD, Trend, Momentum)
Subhabrata et al. 2014	Financial return on investments and movement of market indicators.
Sujata et al. 2012	7 samples from the respective datasets and three technical indicators.
Sureshkumar et al. 2012	TCS Company's previous close, open price, high, price, low price and close price
Tsung et al. 2011	Candidate input features.
Wei Shen et al. 2011	BIAS6, OBV and PSY12
Wen et al. 2014	Predictive value for each component
Wensheng et al. 2012	Independent Components (ICs)
Y. Wu et al. 2010	Sales to total assets, lagged stock return (lagEx-Return) and volatility variables (lagSIGMA)
Yakup et al. 2011	Ten technical indicators
Yixin,Zhang2010	Technical indicators (Moving average (MA), Random indicator (KDJ), Moving Average Convergence/Divergence (MACD), Relative Strength Index (RSI), On Balance Volume (OBV), BIAS, Increase scope).
Yong Hu a et al. 2016	Fundamental analysis, technical analysis
Yudie Du et la. 2014	3 input nodes



Yuling LIN et al. 2013	Selected subset of financial indexes
ZheGao et al. 2014	Sets of predictors and super predictors

## MODELLING TECHNIQUES/MODELS

Table 3 provide the analysis of the modelling techniques used in the surveyed journals, it shows that most of the data samples used in the surveyed paper were pre-processed before they were inputted into the prediction model, the table 3 revealed that over 50% of the journals pre-processed their data while some did not show if the data used for the prediction were pre-processed or not. This shows that data pre-processing plays an important role in stock prediction. The input data size varies greatly in the surveyed papers; ranging from 6343 data samples in the work of Abubakar et al., 2014, and as low as 228 inputted data sample size in the work of Melek et al, 2010. In all cases, the whole of the data samples are divided into training, testing and checking/validation data. Also, the surveyed papers reveals that the dominance of Artificial Neural Networks (ANN) model for stock price prediction stand out, and followed by it variant Adaptive Neuro-Fuzzy Inference System as presented in the table below.

*Table 3: Summary of modelling techniques*

Article	Data Preprocessing	Sample size	Model used	Network Layers	Membership functions	Validity Set	Training Method
Adebiyi et al. 2012	(0,1)	1781	FFNN	18:26:01	sigmoid		Back propagation Alg.
Adebiyi, et al. 2011	(0,1)	3000	BPN	21:26:01	sigmoid	21	FNN
Abubakar et al. 2013	Yes	570 days	SMO	_____	_____	163	SVM
Abubakar et al. 2014	Yes	6343	FFNN	4:02:01	_____	399	EBP
Acheme et al. 2014	No	D: 2months	Fuzzy	_____	Gauss, triangular	_____	FLC
Ahmad et al. 2013	(0,1)	640	hybrid ANN, ANFIS	_____	_____	160	FNN
Adetunji et al. 2013	(-1,1)	D:~2 years	ANN	9:05:01	Sigmoid, hyperbolic, tangent	Yes	ANN,BN
Ajao et al. 2012	No	D: 4years	ARCH	_____	_____	Yes	Myriad
Akintola et al. 2011	(0-1)	D: 15months	FFNN	4/4/4/1	Step, Sigmoid	25%	BPN
Anbalagan 2015	No	623513	FM	_____	DSS	20%	BSE
Anjeza 2015	No	32 months	PTR	_____	_____	_____	LSM
Anish 2015	Yes	3168	FFLANN	_____	sigmoid, gauss	500	RecursiveLeastSquare
Asadi et al. 2012	No	620	ANN	2/4/4/1	sigmoid, Tanh	500	PELMNN
Atsalakis et al. 2011	No	2060	ANFIS	_____	Bell, gauss, gauss2, triangular, trapezoidal	60	WASP





Ayodele et al. 2014	No	5680	ANN	10:17:01	triangdm	5000	LSM
Azadeh et al. 2010	No	—	—	—	—	—	—
Babita et al. 2014	No	500	hyb.BFNN,NGS A-II	—	Guass	144	LSM
Narendra et al. 2014	Yes	744	hyb. ANN, ARIMA	4:02:01	sigmoid	20	MAE, MSE
Narendra et al. 2015	Yes	500	hyb. ARIMA, GARCH	—	Gaussian	50	ANN
Catalina-Lucia 2015	No	6000	ANN	—	—	200	MSE
Chan et al. 2011	Yes	28,000 Sentences	Hidden Markov Model (HMM)	—	Viterbi Algorithm	2000 Reports	ML
Cheng et al. 2010	Yes	D:1 year	ANNs	—	triangular	2 months	NN
Charkravarty et al. 2012	(0,1)	800	FLANN	7:2:4:4:1	Guassian	600	ANN
Chih-Fong et al. 2011	No	210	MLP	1:01:01	—	72	NN
Chih-Fong et al. 2010	Yes	D:1 year	BPNN	6:12:18	—	—	ANN
Chih-Ming Hsu 2011	No	3540	hyb. SOMNN,GP	4:01:01	Guassian	—	GP
Chi-Jie Lu 2010	Yes	781	BPNN	3:04:03	Guassian	235	ICA
Ching-Hsue et al. 2010	Yes	D: 6 years	ANN	—	—	—	AI
Chin-Yuan et al. 2011	No	D: 36 months	FNN	2:01:01	—	3 months	PSO, RLS
Chin-Yuan Chang 2011	Yes	D:3 year	ANN	—	Sigmoid	7 months	LSM
Chong et al. 2011	Yes	3 months	Sensitivity Analysis	—	—	—	—
Choudhury et al. 2014	No	102	SVM	—	—	—	SOM
Chuangxia et al. 2013	No	58751	HAR-CJ-M	—	—	1199	ARV
Chun-I et al. 2010	No	D: ~1 year	NNGBM	—	—	—	LSM
Daniel et al. 2010	No	—	BJNN	—	—	—	—



## Global Journal of Engineering Science and Research Management

Dase et al. 2010	No	_____	ANN	___	_____	___	NN
DOnglin et al. 2014	Yes	D:2 years	BPNN	3:03:03	_____	20%	MAPE
David et al. 2011	No	216	hyb. ESM, ARIMA, BPNN	12:09:12	_____	48	BPNN
Duc-Hien et al. 2014	No	2409	ANFIS	_____	Gaussian	200	Fuzzy
Enric et al. 2014	Yes	36 months	SVM	_____	_____	12 months	EMP
Erkam et al. 2011	No	43194.05	hyb. ANN, RNN	_____	_____	16889.1	DAN2
Esmail et al. 2012	Yes	503	hyb. FMAS	1:3:2:4	Gaussian	91	SOM-Clustering
Esmail et al. 2010	No	400	Fuzzy logic, ANNs	___	Triangular	71	CGFS
Frookh et al. 2013	Yes	800	SVR	_____	_____	160	FNN
Godknows et al. 2014	Yes	D:16 years	ANN, ARIMA	_____	_____	1 year	EMP
Hemanth et al. 2012	Yes	Daily	ANFIS	4:2:2:2:1	_____	10 days	Neuro Fuzzy
Javad et al. 2015	No	2047	ANN	4:05:01	_____	15%	EMH
Jay et al. 2013	Yes	3000	ANN	1:10:10	_____	540	NN
Jian-Zhou et al. 2011	Yes	204	BPNN	_____	_____	20%	WDBP
Johan et al. 2010	No	D:~10 months	Sentiment Analysis	_____	_____	20 days	Fuzzy NN
Ju-Jie et al. 2011	No	216	hyb.ESM, ARIMA, BPNN	12:09:12	_____	48	GA
Agrawal et al. 2013	Yes	D: 4 years	NN	_____	___	30	Hybrid
Kao-Yi et al. 2015	No	124	ANNs	_____	_____	50	ANP
Kao-Yin et al. 2014	No	75	ANN	_____	_____	20	ANP, DEMATEL
KAo-Yin et al. 2016	No	512	FLANN	___	Gaussian	171	Fuzzy NN
Kunwar et al. 2010	Yes	500	NNs	_____	_____	100	MAPE, MSE, RMSE
Lei-Qiang2011	Yes HLP	24 groups	ANN	_____	_____	4 groups	HLP
Liang-Ying 2013	No	D: 12 months	ANFIS	4:2:2:2:1	BELL	2 Months	FIS
Liang-Ying et al. 2011	Yes	D: 12 months	ANFIS	4:2:2:2:1	Gauss	2 months	LSM



Li-Ping et al. 2011	(1, -1)	D: 6 years	SVM	_____	_____	1 year	KPCA
Luo et al. 2012	No	D:~1 year	PLR and weighted SVM	_____	_____	10%	NN Toolbox in Matlab R2007b
Melek et al. 2010	No	228	ANFIS	6:9:9:9:1	gbell, gauss	106	RMS
Michael et al. 2012	No	Daily	ANN	_____	_____	_____	SVM
Michael et al. 2013	No	3478	SVMs	_____	_____	50%	BNS, Chi <sub>2</sub>
Michel et al. 2015	No	81%	NN	_____	_____	15%	Ensemble
Miguel et al. 2011	No	D: 60 months	MSE	_____	_____	_____	SOP
Muhammad et al. 2010	No	D:30 days	_____	_____	_____	7 days	_____
Mustain et al. 2015	No	500	ANN, ANFIS	1:3:3:1	Sigmoid	30	_____
Nitin et al. 2010	Yes	1218	ANN, ARIMA	5:05:01	_____	30	BP Alg.
Olayiwola et al. 2013	No	141.49	ARIMA	_____	_____	6.48	MA
Osman et al. 2014	Yes	D:~4 years	ANFIS	4:2:2:2:1	_____	13 days	GA, FS
Park et al. 2013	No	403	ANN, SVM	_____	_____	103	SSL
PREETHI et al. 2012	No	_____	ANFIS	_____	_____	_____	LSM, BPN
Qinghua et al. 2010	(-1, 1)	1050	SVM	_____	_____	50	ANN
Rajashree et al. 2016	No	512	SERNFIS, RCEFLANN	2:6:3:3:3:6:2	Gaussian	171	ANFIS, MDHS
Reza et al. 2015	Yes	162	GANN, GRNN	7:4:5:7	_____	32	BNNMAS
Neenwi et al. 2013	No	D: 2 years	ANN	4:02:03	_____	149	GFF
Olatunji et al. 2013	No	2130	ANN	3:06:02	_____	30%	BPNN
Şakir et al. 2015	No	D: 30 months	ANN	7:9:7:2	_____	8 months	Gradient Descent
Salim 2014	No	3910	ANN	2:04:01	_____	782(20%)	BPNN
Shahrokh et al. 2012	Yes	620	Levenberg–Marquardt(LM) algorithm	3:02:01	_____	120	ARIMA, BP, SVM
Shangkun et al. 2011	Yes	D:18 months	SVM	_____	_____	8 months	SP



Shie-Jue et al. 2012	No	D:12 months	Fuzzy	9:4:1:1	_____	2 months	LSM
Shu et al. 2014	No	D: 264 months	VAR, GARCH	_____	_____	_____	_____
Suanu et al. 2012	No	30 days	ANN	_____	Triangular, Trapezoidal, Gaussian	50%	Fuzzy logic
Subhabrata et al. 2014	No	225	SOM	_____	_____	_____	SVM
Sujata et al. 2012	No	4000	FLANN	6:2:2:2:1	Gaussian	450	Fuzzy log., BP
Sureshku met al. 2012	Yes	508	ANN	_____	_____	153	MLP
Tsung et al. 2011	Yes	D:12 months	ABC-RNN	_____	_____	50%	ANNs
Wei Shen et al. 2011	No	30	RBFNN	3:03:01	_____	10	AFSA
Wen et al. 2014	No	1150	SVM	_____	_____	383	SSA
Wensheng et al. 2012	Yes	1000	NLICA, NN	7:8:9:10	_____	200(20%)	BPN
Wu et al. 2010	No	887	Bankruptcy	_____	_____	237	Random Sample(RS)
Yakup et al. 2011	No	900	ANN, SVM	10:03:01	_____ -	153	PNN
Yixin et al. 2010	Yes	4255	BPNN	3:03:01	_____ -	27	MACD
Yong Hu et al. 2016	No	200 days	GA, GP	_____	_____	20 days	EC
Yudie et al. 2014	No	D:14 months	D&C	3:05:01	_____	6 months	ARIMA, GM, BPNN
YuKak 2011	No	_____	Social Media	_____	_____	_____	ICS
Yuling LIN et al. 2013	No	880	SVM	_____	_____	5%	SVM
ZheGao et al. 2014	No	433	Hybrid HC-SVR	_____	_____	_____	SVR

### MODELLING BECNHMARK

Table 4 presents how each article benchmarked its work against other techniques/models to gives further clarity to the table 3 above. From the table below most authors that use ANN models benchmarked their work with ARMA model possibly because it is a statistical technique.



Article	ANNs	LR/MLR	ARMA	RW	ARCH	NB	HAR-CJ	SVR	NSG A-II	RBF	BP	OTHE RS
Adebiyi et al. 2012	*											
Adebiyi, et al. 2011	*		*									*
Abubakar et al. 2013	*					*						
Abubakar 2014	*	*	*									*
Acheme et al. 2014					*							*
Ahmad et al. 2013							*	*				
Adetunji et al. 2013	*											
Ajao 2012				*	*							
Akintola et al. 2011	*											
Anbalagan 2015	*			*				*				
Anjeza 2015												*
Anish et al. 2015	*											*
Asadi et al. 2012	*											
Atsalakis et al. 2011	*											*
Adebiyi et al. 2014	*		*									
Azadeh et al. 2010												*
Babita et al. 2014									*	*		
Narendra et al. 2014			*		*							
Narendra et al. 2015	*		*									
Catalina-Lucia et al 2015	*		*									
Chan et al. 2011												*
Cheng et al. 2010	*		*		*							
Charkravarty et al. 2012	*											*
Chih-Fong et al. 2011	*											*
Chih-Fong et al. 2010	*											
Chih-Ming Hsu 2011	*		*									
Chi-Jie Lu 2010	*		*									
Ching-Hsue et al. 2010	*		*		*							
Chin-Yuan et al. 2011	*		*		*			*				



Global Journal of Engineering Science and Research Management

Chin-Yuan et al. 2011	.*											*
Chong et al. 2011												*
Choudhury et al. 2014	*		*		*							
Chuangxia et al. 2013					*		*					
Chun-I et al. 2010									*			*
Chunpeng 2015												*
Daniel et al. 2010												*
Dase et al. 2010	.*											*
Donglin et al. 2014	.*											
David et al. 2011	.*		*									
Duc-Hien et al. 2014	.*											*
Enric et al. 2014												*
Erkam et al. 2011	*				*							
Esmail et al. 2012	.*											*
Feng et al. 2011	.*											*
Esmail et al. 2010	.*											*
Frookh et al. 2013	.*		*									
Godknows et al. 2014	.*		*									
Hemanth et al. 2012	.*											*
Huanhuan et al. 2014	.*											*
Javad et al. 2015	.*											*
Jay et al. 2013	.*		*									
Jian-Zhou et al. 2011	.*									*		
Johan et al. 2010												*
Ju-Jie et al. 2012	.*		*									
Ju-Jie Wang et al. 2011	.*		*									
Agrawal et al. 2013	.*											*
Kao-Yi et al. 2015	.*											*
Kao-Yin et al. 2014	.*											*
KAo-Yin et al. 2016	.*											*
Kunwar et al. 2010	.*											*
LEi et al. 2011												
Liang-Ying 2013			*		*							









## Global Journal of Engineering Science and Research Management

Charkravarty et al. 2012	MAPE, RMSE
Chih-Fong et al. 2011	Return on investment(ROI)
Chih-Fong et al. 2010	_____
Chih-Ming Hsu 2011	CE, RMSE, MAE, and MAPE
Chi-Jie Lu 2010	TnA
Ching-Hsue et al. 2010	RST and GA
Chin-Yuan et al. 2011	RMSE
Chin-Yuan et al. 2011	
Chong et al 2011	UnderReaction Coefficient (URC), precision, recall and F- measures
Choudhury a et al. 2014	_____
Chuangxia et al. 2013	_____
Chun-I et al. 2010	_____
Chunpeng et al. 2015	_____
Daniel et al. 2010	RMSE, Calibration and discrimination
Dase et al. 2010	_____
DOnglin et al. 2014	MAE, RMSE, MAPE
David et al., 2011	MAE, RMSE, MAPE, ME and DA
Duc-Hien et al. 2014	NMSE, MAE and Directional symmetry(DS)
Enric et al. 2014	_____
Erkam et al. 2011	MSE and MAD
Esmail et al. 2012	_____
Feng et al. 2011	Directional symmetry (DS),Correct up-trend (CP) and correct down-trend (CD)
Esmail et al. 2010	_____
Frookh et al. 2013	MSE
Godknows et al. 2014	RMSE, MAE and NMSE
Hemanth et al. 2012	_____
Huanhuan et al. 2014	_____
Javad et al. 2015	RMSE
Jay et al. 2013	RMSE and MSE
Jian-Zhou et al. 2011	MAE, RMSE and MAPE
Johan et al. 2010	MAPE
Ju-Jie et al., 2011	MAE, RMSE, MAPE, ME and DA
Agrawal et al. 2013	_____
Kang et al. 2011	_____
Kao-Ying et al. 2015	ANNs
Kao-Yin et al . 2014	_____



## Global Journal of Engineering Science and Research Management

KAo-Yin et al. 2016	_____
Kunwar et al. 2010	Sum of Squares Error Function.
LEi, et al. 2011	_____
Liang-Ying 2013	RMSEs
Liang-Ying et al. 2011	RMSE
Li-Ping et al. 2011	_____
Luo et al. 2013	_____
Melek et al. 2010	_____
Michael et al., 2012	_____
Michael et al. 2013	_____
Michel et al. 2015	_____
Miguel et al. 2011	MSEs
Mohammad et al. 2015	_____
Muhammad et al. 2010	_____
Mustain et al. 2015	RMSE and R2
Nitin et al. 2010	AAE, RMSE, MAPE and MPSE
Olayiwola et al. 2013	_____
Osman et al. 2014	_____
Park et al. 2013	_____
Preethi et al. 2015	MAE, RMSE
PREETHI et al. 2012	_____
Qinghua et al. 2010	MSE and SCC
Rajashree et al. 2016	_____
Reza et al. 2015	_____
Neenwi et al. 2013	MSE
Olatunji et al. 2013	R2, RMSE, MAD, AND MAPE
Şakir et al. 2015	_____
Salim 2014	MAE, RMSE, MAD
Senthamarai et al. 2010	_____
Shahrokh et al. 2012	RW Model
Shangkun et al. 2011	_____
Shie-Jue et al. 2012	RMSE
Shu et al. 2014	_____
Suanu et al. 2012	_____
Subhabrata et al. 2014	_____
Sujata et al. 2012	MAPE and RMSE
Sureshkumar, et al. 2012	_____
Tsung et al. 2011	RMSE, MAE, MAPE and THEIL U



Wei Shen et al. 2011	_____
Wen et al. 2014	_____
Wensheng et al. 2012	RMSE, MAD, RMSPE and DS
Y. Wu et al. 2010	_____
Yakup et al. 2011	_____
Yixin et al. 2010	_____
Yong Hu et al. 2016	RMSE, ACCURACY, MAPE, MAE, HIT RATE AND R2
Yudie Du et al. 2014	MAPE
Yuling et al. 2013	HIT RATIO
ZheGao et al. 2014	RMSE, NMSE, MAE, and DS

## CONCLUSION

The articles surveyed in this work have used soft computing techniques to predict stock prices and index, with different approaches such as single modeling technique, hybrid technique and ensemble.. Input data, forecasting methodology, model comparisons and measures used for performance evaluation were analysed. This survey shows stock price prediction accuracy does not rely solely on the technique being employed, but on the context, data preprocessing, how the techniques are combined amongst myriads of other factors. This paper would guide future researchers to know the extent of the used of soft computing techniques to predict stock prices which inform the choice of technique to use and improve upon.

## REFERENCES

1. Adebisi Ayodele, Aderemi Oluyinka and Charles Korede Ayo (2014). "Comparisson of ARIMA and Artificial Neural Networks Models for Stock Price Prediction". Journal of Applied Mathematics, Vol. pp. 1 – 7.
2. Adebisi Ayodele, Ayo Charles, Adebisi Marion and Otoki Sunday (2012). "An Improved Stock Price Prediction using Hybrid Market Indicators". African Journal of Computing & ICT, Vol. 5. No. 5, pp. 124 -135.
3. Adebisi Ayodele, Ayo Charles and Otoki Sunday (2011). "Fuzzy-neural model with hybrid market indicators for stock forecasting". International Journal of Electronics and Finance, Vol. 5, No. 3, pp. 286 – 297.
4. Abubakar Magaji, Audu Isah, Onomza Victor and Adeboye Kayode (2013). "A Conceptual Nigeria Stock Exchange Prediction: Implementation Using Support Vector Machines-SMO Model". World of Computer Science and Information Technology Journal, Vol. 3, No. 4, pp. 85-90.
5. Abubakar Magaji and Adeboye Kayode (2014). "An Intense Nigerian Stock Exchange Market Prediction Using Logistic With Back-Propagation ANN Model". Science World Journal, Vol. 9, No 2, Pg. 8-13.
6. Acheme David, Vincent Olufunke, Folorunso Olusegun & Olusola Olasunkanmi Isaac (2014). "A Predictive Stock Market Technical Analysis Using Fuzzy Logic" Vol. 7, No. 3, pp. 1- 17.
7. Adam Westerskia, Rajaraman Kanagasabai, Jiayu Wong, and Henry Chang (2015). "Prediction of Enterprise Purchases using Markov models in Procurement Analytics Applications". International Conference on Knowledge Based and Intelligent Information and Engineering Systems Vol. 60, pg. 1357 -1366.
8. Adetunji Abigail, Aderounmu Ganiyu, Omidiora Elijah, and Adigun Abimbola (2013). "Forecasting Movement of the Nigerian Stock Exchange All Share Index using Artificial Neural and Bayesian Networks". Journal of Finance and Investment Analysis Vol. 2, No.1, pp. 41-59.
9. Ahmad Kazem, Ebrahim Sharifi, Farookh Khadeer Hussain, Morteza Saberi and Omar Khadeer Hussain (2013). "Support vector regression with chaos-based firefly algorithm for stock market price forecasting. Appl Soft Comput". Applied Soft Computing, Vol. 13, pp. 947-958.



## Global Journal of Engineering Science and Research Management

10. Ajao Mayowa and Wemambu Mary (2012). "Volatility Estimation and Stock Price Prediction in the Nigerian Stock Market". *International Journal of Financial Research*, Vol. 3, No. 1, pp. 2 – 13.
11. Akintola Kolawole, Kayode Alese & Aderonke Thompson (2011) "Time Series Forecasting With Neural Network a case study of stock prices of intercontinental bank Nigeria". *International Journal of Research and Reviews in Applied Sciences*, Vol. 9, Issue 3, pp.467 - 472.
12. Anbalagan Thirunavukarasu and Uma Maheswari (2015). "Classification and Prediction of Stock Market Index Based on Fuzzy Metagraph". *Procedia Computer Science* Vol. 47, pp. 214 – 221.
13. Andrea Nemeti and Berend Denkena (2015). "Stock-Market Related Price Determination in Consideration of Time Dynamic Cost Factors". *CIRP Conference on Intelligent Computation in Manufacturing Engineering* Vol. 33, pp. 593 – 598.
14. Anish C.M and Babita Majhi (2015). "Hybrid nonlinear adaptive scheme for stock market Prediction using feedback FLANN and factor analysis". *Journal of the Korean Statistical Society*, Vol. 07, pp. 1-13.
15. Anjeza Kadili (2015). "Predictability of stock returns of financial companies and the role of investor sentiment: A multi-country analysis". *Journal of Financial Stability* Vol. 21, pp. 26–45.
16. Aref Mahdavi and Nejat Younesi (2012). "The Impact of Dividend Policy on Share Price Volatility in The Malaysian Stock Market". *Journal of Business Studies Quarterly*, Vol. 4, No. 1, pp. 111-129.
17. Asadi Shahrokh, Esmaeil Hadavandi, Farhad Mehmanpazir and Mohammad Masoud (2012). "Hybridization of evolutionary Levenberg–Marquardt neural networks and data pre-processing for stock market prediction". *Knowledge-Based Systems* Vol. 35, pp. 245–258.
18. Atsalakis George, Emmanouil Dimitrakakis and Constantinos Zopounidis (2011). "Elliott Wave Theory and Neuro-fuzzy systems, in stock market prediction: The WASP system". *Expert Systems with Applications* Vol. 38, pp. 9196–9206.
19. Azadeh Nikfarjam, Ehsan Emadzadeh and Saravanan Muthaiyah (2010). "Text mining approaches for stock market prediction". vol. 4, pp. 256-260.
20. Babita Majhi, Minakhi Rout and Vikas Baghel (2014). "On the development and performance evaluation of a multi objective GA-based RBF adaptive model for the prediction of stock indices". *Journal of King Saud University – Computer and Information Sciences* Vol. 26, pp. 319–331.
21. C. Narendra and B. Eswara (2014). "A moving-average filter based hybrid ARIMA–ANN model for forecasting time series data". *Applied Soft Computing* Vol. 23, pp. 27–38.
22. C. Narendra and B. Eswara (2015). "Prediction of selected Indian stock using a partitioning–interpolation based ARIMA–GARCH model". *Applied Computing and Informatics* Vol. 11, pp.130–143
23. Callen Jeffrey, Mozaffar Khan and Hai Lu (2010). "Accounting Quality, Stock Price Delay and Future Stock Returns" Vol. pp. 1-49.
24. Cătălina-Lucia COCIANU & Hakob GRIGORYAN (2015). "An Artificial Neural Network for Data Forecasting Purposes". *Informatica Economică*, Vol. 19, No. 2, pp. 34 – 45.
25. Chan Samuel and James Franklin (2011). "A text-based decision support system for financial sequence prediction", *Decision Support Systems*, Vol. 52, pp. 189–198.
26. Charkravarty Sujata and Dash (2012). "A PSO based integrated functional link net and interval type-2 fuzzy logic system for predicting stock market indices. *Appl Soft. Comput.*". *Applied Soft Computing* Vol. 12, pp. 931–941.
27. Ching-Hsue Cheng , Tai-Liang Chen and Liang-Ying Wei (2010). "A hybrid model based on rough set theory and genetic algorithms for stock price forecasting". *Information Sciences* Vol. 180, pp. 1610–1629.
28. Chih-Fong Tsaia, Yuah-Chiao Linc, David C. Yen and Yan-Min Chen (2011). "Predicting stock returns by classifier ensembles". *Applied Soft Computing* Vol. 11, pp. 2452–2459.
29. Chih-Fong and Yu-Chieh (2010). "Combining multiple feature selection methods for stock prediction: Union, intersection, and multi-intersection approaches". *Decision Support Systems* Vol. 50, pp. 258–269.
30. Chih-Feng Liu, Chi-Yuan Yeh and Shie-Jue Lee (2012). "Application of type-2 Neuro-fuzzy modeling in stock price prediction". *Applied Soft Computing*, Vol. 12, pp. 1348-1358.
31. Chih-Ming Hsu (2011). "A hybrid procedure for stock price prediction by integrating self-organizing map and genetic programming". *Expert Systems with Applications* Vol. 38, pp. 14026–14036.



## Global Journal of Engineering Science and Research Management

32. Chi-Jie Lu (2010). "Integrating independent component analysis-based denoising scheme with neural network for stock price prediction". *Expert Systems with Applications* Vol. 37, pp. 7056–7064.
33. Ching-Hsue Cheng, Tai-Liang Chen and Liang-Ying Wei (2010). "A hybrid model based on rough set theory and genetic algorithms for stock price forecasting". *Information Sciences* Vol. 180, pp. 1610–1629.
34. Chi-Yuan Yeh, Chi-Wei Huang and Shie-Jue Lee (2011). "A multiple-kernel support vector regression approach for stock market price forecasting". *Expert Systems with Applications* Vol. 38, pp. 2177–2186.
35. Chin-Yuan Fan, T Warren, Jyun-lie Lin and Pei-Chann Chang, (2011). "A dynamic threshold decision system for stock trading signal detection". *Applied Soft Computing* Vol. 11, pp. 3998–4010.
36. Chong, Oh and Olivia R Liu Sheng (2011). "Investigating Predictive Power Of Stock Micro Blog Sentiment In Forecasting Future Stock Price Directional Movement", *International Conference on Information Systems*, pp. 1-19.
37. Choudhury Subhabrata, Subhajyoti Ghosh, Arnab Bhattacharya, Kiran Jude Fernandes and Manoj Kumar Tiwari (2014). "A real time clustering and SVM based price-volatility prediction for optimal trading strategy". *Neurocomputing*, Vol. 131, pp. 419 – 426.
38. Chuangxia Huang, Xu Gong, Xiaohong Chen and Fenghua Wen (2013). "Measuring and Forecasting Volatility in Chinese Stock Market Using HAR-CJ-M Model". *Abstract and Applied Analysis*, Vol. 13, pp. 1-14.
39. Chun-I Chen, Pei-Han Hsin and Chin-Shun Wu (2010) "Forecasting Taiwan's major stock indices by the Nash nonlinear Gray Bernoulli model". *Expert Systems with Applications* Vol. 37, pp. 7557–7562.
40. Chunpeng Yang and Liyun Zhou (2015). "Investor trading behavior, investor sentiment and asset prices". *North American Journal of Economics and Finance* Vol. 34, pp. 42–62.
41. Daniel M. Reeves and Duncan J Watts (2010). "Prediction without markets", pp.1-11.
42. Dase R.K and Pawar D.D. (2010). "Application of Artificial Neural Network for stock market predictions: A review of literature". *International Journal of Machine Intelligence*, ISSN: 0975–2927, Vol. 2, Issue 2, pp. 14-17.
43. Donglin Chen and Dissanayaka Seneviratna (2014). "Using Feed Forward BPNN for Forecasting All Share Price Index". *Journal of Data Analysis and Information Processing*, Vol. 2, pp. 87-94.
44. Duc-Hien Nguyen, Manh-Thanh Le (2014). "A two-stage architecture for stock price forecasting by combining SOM and fuzzy-SVM". *International Journal of Computer Science and Information Security*, Vol. 12, No. 8, pp. 1- 6.
45. Enric Junqué de Fortuny, Tom De Smedt, David Martens and Walter Daelemans (2014). "Evaluating and understanding text-based stock price prediction models". *Information Processing and Management* Vol. 50, pp. 426–441.
46. Erkam Guresen, Gulgun Kayakutlu and Tugrul U. Daim (2011). "Using artificial neural network models in stock market index prediction". *Expert Systems with Applications* Vol. 38, pp. 10389–10397.
47. Esmaeil Hadavandi, Hassan Shavandi and Arash Ghanbari (2010). "Integration of genetic fuzzy systems and artificial neural networks for stock price forecasting". *Knowledge-Based Systems* Vol. 23, pp. 800–808
48. Farookh Khadeer, Morteza Saberi and Omar Khadeer (2013). "Support vector regression with chaos-based firefly algorithm for stock market price forecasting", *Journal of Applied Soft Computing*, Vol. 13, Pg. 947–958.
49. Fazel Zarandi, Esmaeil Hadavandi and I. B. Turksen (2012). "A hybrid fuzzy intelligent agent based system for stock price Prediction". *International Journal Of Intelligent Systems*, Vol. 00, pp. 1-24.
50. Godknows M. Isenah and Olusanya E. Olubusoye (2014). "Forecasting Nigerian Stock Market Returns using ARIMA and Artificial Neural Network Models". *CBN Journal of Applied Statistics*, Vol. 5, No.2, pp. 45 – 48.
51. Hemanth Kumar P, Prashanth K. B, Nirmala T V and S. Basavara Patil (2012). "Neuro Fuzzy based Techniques for Predicting Stock Trends". *IJCSI International Journal of Computer Science Issues*, Vol. 9, Issue 4, No 3, pp. 385-391.
52. Huanhuan Yu, Rongda Chen, Guoping Zhang (2014). "A SVM Stock Selection Model within PCA". *International Conference on Information Technology and Quantitative Management, ITQM*, Vol. 31, pp. 406 – 412.



## Global Journal of Engineering Science and Research Management

53. Hsuan-Ming Feng and Hsiang-Chai Chou (2011). "Evolutional RBFNs prediction systems generation in the applications of financial time series data". *Expert Systems with Applications*, Vol. 38, pp. 8285–8292.
54. J. G. Agrawal, Dr. V. S. Chourasia, and Dr. A. K. Mittra (2013). "State-of-the-Art in Stock Prediction Techniques", *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering*. Vol. 2, Issue 4, pp. 1360 – 1366.
55. James H. Stock and Mark W. Watson (2012). "Generalized Shrinkage Methods for Forecasting using Many Predictors Supplement". Vol. pp. 1-32.
56. Javad Zahedi and Mohammad Mahdi Rounaghi (2015). "Application of artificial neural network models and principal component analysis method in predicting stock prices on Tehran Stock Exchange". *Physica A* Vol. 438 pp. 178–187.
57. Jay Desai, Arti Trivedi and Nisarg A Joshi (2013) "Forecasting of Stock Market Indices Using Artificial Neural Network". *Shri Chimanbhai Patel Institutes*, pp. 1 – 18.
58. Jeffrey L. Callen, Mozaffar Khan and Hai Lu (2010). "Accounting Quality, Stock Price Delay and Future Stock Returns". Vol. pp. 1 – 49.
59. Jian-Zhou Wang, Ju-Jie Wang, Zhe-George Zhang, Shu-Po Guo (2011). "Forecasting stock indices with back propagation neural network". *Expert Systems with Applications* Vol. 38, pp. 14346–14355.
60. Johan Bollen, Huina Mao and Xiao-Jun Zeng (2010). "Twitter mood predicts the stock market". Vol. pp. 1 – 8.
61. Ju-Jie Wang, Jian-Zhou Wang, Zhe-George Zhang and Shu-Po Guo (2011). "Stock index forecasting based on a hybrid model". *Omega* Vol. 40, pp. 758–766.
62. Jyoti Kumari and Jitendra Mahakud (2015). "Does investor sentiment predicts the asset volatility?" Evidence from emerging stock market India", *Journal of Behavioral and Experimental Finance* Vol. 8, pp. 25–39.
63. Kang Wei and Sun Cai-hong Kang (2011). "Building the model of an artificial stock market based on JASA". *Procedia Engineering* Vol. 23, pp. 835 – 841.
64. Kanghee Park and Hyunjung Shin (2013). "Stock price prediction based on a complex interrelation network of economic factors". *Engineering Applications of Artificial Intelligence*, Vol. 26, pp. 1550–1561.
65. Kao-Yi Shen and Gwo-Hshiung Tzeng (2015). "Combined soft computing model for value stock selection based on fundamental analysis". *Applied Soft Computing* Vol. 37, pp. 142–155.
66. Kunwar Singh and Ashutosh Kumar Bhatt (2010) "An Analysis of the Performance of Artificial Neural Network Technique for Stock Market Forecasting". *International Journal on Computer Science and Engineering*, Vol. 2, No. 06, , pp. 2104-2109.
67. Lei Wang and Qiang Wang (2011). "Stock market prediction using artificial neural network based on HLP". *International Conference on Intelligent Human-Machine Systems and Cybernetics*, Vol. 34, pp. 116 – 119.
68. Liang-Ying Wei (2013). "A hybrid model based on ANFIS and adaptive expectation genetic algorithm to forecast TAIEX". *Journal of Economic Modeling* Vol. 33 pp. 893–899.
69. Liang-Ying Wei, Tai-Liang Chen and Tien-Hwa Ho (2011). "A hybrid model based on adaptive-network-based fuzzy inference system to forecast Taiwan stock market". *Expert Systems with Applications*, Vol. 38, pp. 13625–13631.
70. Linkai Luo and Xi Chen (2013). "Integrating piecewise linear representation and weighted support vector machine for stock trading signal prediction". *Applied Soft Computing*, Vol. 13, pp. 806 – 816.
71. Li-Ping Ni, Zhi-Wei Ni and Ya-Zhuo Gao (2011). "Stock trend prediction based on fractal feature selection and support vector machine". *Expert Systems with Applications* Vol. 38, pp. 5569–5576.
72. Luo, Chen (2013). "Integrating piecewise linear representation and weighted support vector machine for stock trading signal prediction", *Applied Soft Computing* Vol. 13, pp. 806–816.
73. Maik Schmeling, Andreas Schrimpf and Charlotte Christiansen (2012) "A Comprehensive Look at Financial Volatility Prediction by Economic Variables". Vol. pp. 1 – 46.
74. Melek Acar Boyacioglu and Derya Avci (2010). "An Adaptive Network-Based Fuzzy Inference System (ANFIS) for the prediction of stock market return: The case of the Istanbul Stock Exchange". *Expert Systems with Applications*, Vol. 37, pp. 7908–7912.



## Global Journal of Engineering Science and Research Management

75. Michael Hagenau, Michael Liebmann, Markus Hedwig and Dirk Neumann (2012). "Automated news reading: Stock Price Prediction based on Financial News Using Context-Specific Features". 45th Hawaii International Conference on System Sciences. Vol. pp. 1040 – 1049.
76. Michael Hagenau, Michael Liebmann and Dirk Neumann (2013) "Automated news reading: Stock price prediction based on financial news using context-capturing features". Decision Support Systems Vol. 55, pp. 685–697.
77. Michel Ballings, Dirk Van den Poel, Nathalie Hespeels and Ruben Gryp (2015). "Evaluating multiple classifiers for stock price direction prediction". Expert Systems with Applications Vol. 42, pp. 7046–7056.
78. Miguel A.Ferreira and PedroSanta-Clara (2011). "Forecasting stock market returns: The sum of the parts is more than the whole". Journal of Financial Economics, Vol. 100, pp. 514–537.
79. Mohammad Mahdi Rounaghia, Mohammad Reza Abbaszadeh and Mohammad Arashi (2015). "Stock price forecasting for companies listed on Tehran stock exchange using multivariate adaptive regression splines model and semi-parametric spline technique". Physica A, Vol. 438 pp. 625–633.
80. Mohammad Bayezid Ali and Tanbir Ahmed Chowdhury (2010). "Effect of Dividend on Stock Price in Emerging Stock Market: A Study on the Listed Private, Commercial Banks in DSE". International Journal of Economics and Finance, Vol. 2, No. 4, pp. 52 – 64.
81. Mustain Billah, Sajjad Waheed and Abu Hanifa (2015). "Predicting Closing Stock Price using Artificial Neural Network and Adaptive Neuro Fuzzy Inference System (ANFIS): The Case of the Dhaka Stock Exchange". International Journal of Computer Applications ,Vol. 129, No.11, pp. 1 - 5.
82. Nitin Merh, Vinod P. Saxena and Kamal Raj Pardasani (2010). "A Comparison Between Hybrid Approaches Of Ann And Arima For Indian Stock Trend Forecasting". Business Intelligence Journal, Vol. 3. No. 2, pp. 23-43.
83. Olayiwola Olaniyi Mathew, Apantaku Fadeke Sola, Bisira Hammed Oladiran and Adewara Adedayo Amos (2013). "Prediction of Stock Price using Autoregressive Integrated Moving Average Filter ((Arima (P,D,Q)))". Global Journal of Science Frontier Research Mathematics and Decision Sciences, Vol. 13, Issue 8, pp. 1 – 11.
84. Osman Hegazy, Omar S. Soliman And Ahmed A. Toony (2014). "Hybrid of Neuro-fuzzy inference system and quantum genetic algorithm for prediction in stock market". Issues in Business Management and Economics Vol. 2, No 6, pp. 094-102.
85. Petr Hájek, Filippo Neri (2013). "An Introduction to the Special Issue on Computational Techniques for Trading Systems, Time Series Forecasting, Stock Market Modeling, Financial Assets Modeling". Wseas transactions on business and economics, Vol. 10, Issue 4, pp. 291 – 292.
86. P.G Preethia,V. Uma and Ajit kumar (2015). "Temporal Sentiment Analysis and Causal Rules Extraction from Tweets for Event Prediction". International Conference on Intelligent Computing, Communication & Convergence Vol. 48, pp. 84 – 89.
87. G. Preethi and B. Santhi (2012). "stock market forecasting techniques: a survey". Journal of theoretical and applied information technology, Vol. 46, No.1, pp. 24 – 30.
88. Qinghua Wen, Zehong Yang, Yixu Song and Peifa Jia (2010). "Automatic stock decision support system based on box theory and SVM algorithm". Expert Systems with Applications, Vol. 37, pp. 1015–1022.
89. Rajashree Dash and PradiptaKishore Dash (2016). "Efficient stock price prediction using a Self Evolving Recurrent Neuro-Fuzzy Inference System optimized through a Modified technique", Expert Systems With Applications Vol. 52, pp. 75–90.
90. Reza Hafezia, Jamal Shahrabi and Esmaeil Hadavandi (2015). "A bat-neural network multi-agent system (BNNMAS) for stock price prediction: Case study of DAX stock price". Applied Soft Computing Vol. 29, pp. 196–210.
91. S. Neenwi, P. O. Asagba and L. G. Kabari (2013). "predicting the Nigerian stock market using artificial neural network". European journal of computer science and information Vol. 1, No. 1, pp. 30-39.
92. S. O. Olatunji1, Mohammad Saad Al-Ahmadi, Moustafa Elshafei and Yaser Ahmed Fallatah (2013). "forecasting the Saudi Arabia stock prices based on artificial neural networks model". International journal of intelligent information systems Vol. 2, No. 5, pp. 77-86.



## Global Journal of Engineering Science and Research Management

93. Şakir Sakarya, Mehmet Yavuz, Aslan Deniz Karaoğlan and Necati Özdemir (2015). "Stock market index prediction with neural network during financial crises: a review on bist-100". financial risk and management reviews, Vol. 1, No. 2, pp. 53-67.
94. Salim Lahmiri (2014). "Wavelet low- and high-frequency components as features for predicting stock prices with back propagation neural networks". Journal of King Saud university – computer and information sciences Vol. 26, pp. 218–227.
95. Santosh Kumar Das, Abhishek Kumar, Bappaditya Das and A.P.Burnwa (2013). "On soft computing techniques in various areas". Computer science & information technology, pp. 59–68.
96. K. Senthamarai Kannan, P. Sailapathi Sekar, M.Mohamed Sathik and P. Arumugam (2010). "financial stock market forecast using data mining techniques". Proceedings of the international multi conference of engineers and computer scientists, Vol. 1, pp. 1 – 5.
97. Shahrokh Asadi, Esmaeil Hadavandi, Farhad Mehmanpazir and Mohammad Masoud Nakhostin (2012). "Hybridization of evolutionary Levenberg-Marquardt neural networks and data preprocessing for stock market prediction". Knowledge-based systems Vol. 35, pp. 245–258.
98. Shangkun Deng, Takashi Mitsubuchi, Kei Shioda, Tatsuro Shimada and Akito Sakurai (2011). "Combining technical analysis with sentiment analysis for stock price prediction". IEEE International conference on dependable, autonomic and secure computing, pp. 800 – 807.
99. Shen Yu and Subhash Kak (2011). "A Survey of Prediction Using Social Media". Pp. 1- 20.
100. Shu Yi Lim and Siok Kum Sek (2014). "Exploring the interrelationship between the volatilities of exchange rate and stock return". Procedia economics and finance Vol. 14, pp. 367 – 376.
101. Suanaa Neenwi, L. G Kabari and P.O. Asagba (2012). "Nigerian stock market investment using a fuzzy strategy". Journal of information engineering and applications, Vol. 2, No. 8, pp. 18 – 27.
102. Subhabrata Choudhury, Subhajyoti Ghosh, Amab Bhattacharya, Kiran Jude Femandes and Manoj Kumar Tiwari (2014). "A real time clustering and svm based price-volatility prediction for optimal trading strategy". Neurocomputing, Vol. 131, pp. 419–426.
103. Sujata Chakravarty and P.K Dash (2012). "A PSO based integrated functional link net and interval type-2 fuzzy logic system for predicting stock market indices". Applied Soft Computing, Vol. 12, pp. 931 – 941.
104. Sureshkuar K. K and N.M. Elango (2012). "Performance analysis of stock price prediction using artificial neural network". Global Journal of Computer Science and Technology, Vol. 12, Issue 1, No. 1, pp. 1 – 9.
105. Tsung-Jung Hsieh, Hsiao-Fen Hsiao and Wei-Chang Yeh (2011) "Forecasting stock markets using wavelet transforms and recurrent neural networks: An integrated system based on artificial bee colony algorithm". Applied Soft Computing, Vol. 11, pp. 2510 – 2525.
106. Wei Shen, Xiaopen Guo, Chao Wu and Desheng Wu (2011). "Forecasting stock indices using radial basis function neural networks optimized by artificial fish swarm algorithm". Knowledge-Based Systems Vol. 24, pp. 378–385.
107. Wen Fenghua, Xiao Jihong HE Zhifang and Gonh Xu (2014). "Stock Price Prediction Based on SSA and SVM". International Conference on Information Technology and Quantitative Management, Vol. 31 pp. 625 – 631.
108. Wensheng Dai, Jui-Yu Wu and Chi-Jie Lu (2012). "Combining nonlinear independent component analysis and neural network for the prediction of Asian stock market indexes". Expert Systems with Applications, Vol. 39, pp. 4444–4452.
109. Y. Wu, C. Gaunt and S. Gray (2010). "A comparison of alternative bankruptcy prediction models". Journal of Contemporary Accounting & Economics Vol. 6, pp. 34–45.
110. Yakup Kara, Melek Acar Boyacioglu and Omer Kaan Baykan (2011). "Predicting direction of stock price index movement using artificial neural networks and support vector machines: The sample of the Istanbul Stock Exchange". Expert Systems with Applications Vol. 38, pp. 5311–5319.
111. Yong Hu, Kang Liu, Xiangzhou Zhang, Lijun Su, E.W.T Ngai and Mei Liu (2015). "Application of evolutionary computation for rule discovery in stock algorithmic trading: A literature review". Applied Soft Computing, Vol. 36, pp. 534–551.





## Global Journal of Engineering Science and Research Management

112. Yudie Du, Yue Cai, Mingxin, Wei Xu, Hui Yuan and Tao Li (2014). "A Novel Divide-and-Conquer Model for CPI Prediction Using ARIMA, Gray Model and BPNN". International Conference on Information Technology and Quantitative Management, Vol. 31, pp. 842 – 851.
113. Yuling LIN, Haixiang Guo and Jinglu HU (2013). "An SVM-based Approach for Stock Market Trend Prediction". Proceedings of International Joint Conference on Neural Networks, Vol. pp. 236 – 242.
114. ZheGao and Jianjun Yang (2014) " Financial Time Series Forecasting with Grouped Predictors using Hierarchical Clustering and Support Vector Regression". International Journal of Grid Distribution Computing, Vol.7, No 5, pp.53-64.
115. Zhou Yixin and Jie Zhang (2010). "Stock data analysis based on BP neural network". International Conference on Communication Software and Networks. Vol. pp. 396 – 399.