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Forecasting Stock Market Volatility using Hybrid of Fuzzy Inference Rules with Descent Method with Haar Wavelet Function: Saudi Arabia

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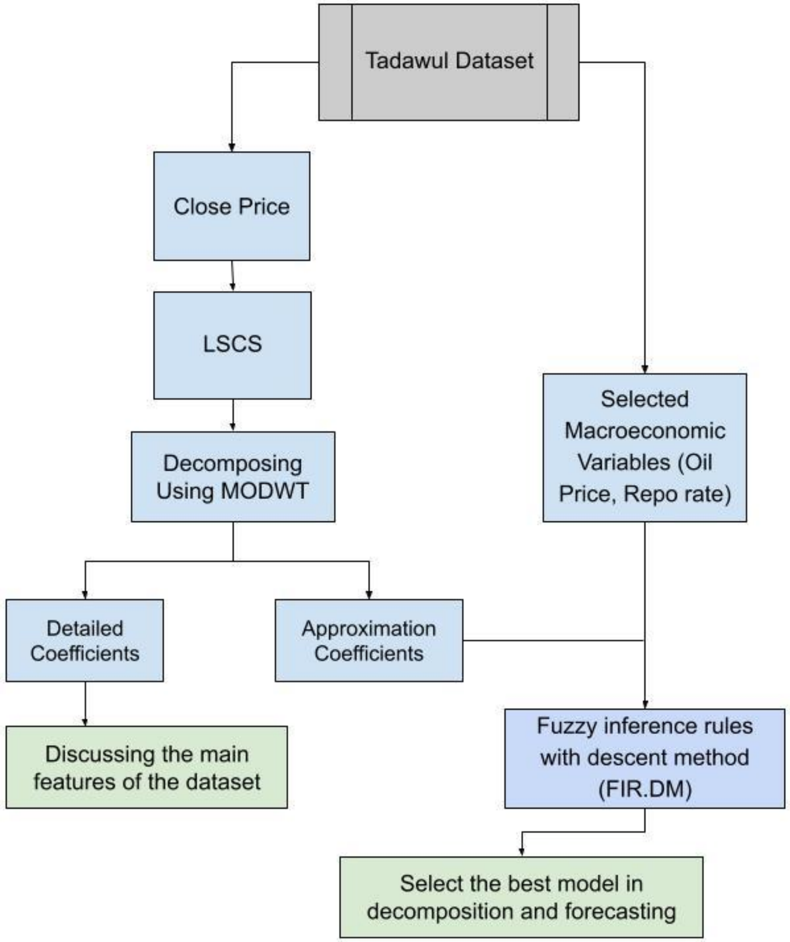
Abstract

This study aims to model and enhance the forecasting accuracy of Saudi Arabia stock exchange (Tadawul) data patterns using the daily stock price indices data with 2026 observations from October 2011 to December 2019. This study employs a nonlinear spectral model of maximum overlapping discrete wavelet transform (MODWT) with Haar mathematical functions in conjunction with fuzzy inference rules with descent method (FIR.DM). We have selected oil price (Loil) and repo rate (Repo) as input values according to multicollinearity test. The input variables in this study have been collected from Saudi Authority for Statistics and Saudi Central Bank. The output variable is obtained from Tadawul. The performance of the proposed model (MODWT-Haar-FIR.DM) is evaluated in terms of mean error (ME), the Mean absolute error (MAE), and mean absolute percentage error (MAPE). Also, we have compared the MODWT-Haar-FIR.DM model with traditional models, which are autoregressive integrated moving average (ARIMA) model and FIR.DM model. The obtained results show that the performance of MODWT-FIR.DM is better than that of the traditional models. Therefore, the proposed forecasting model is capable of decomposing in the stock markets

Methodology



Result

Table 1: Descriptive statistic of dataset in Saudi stock market

	N	Mean	Std. Deviation	Minimum	Maximum
LSCS	2026	6.7489	0.6923	3.8294	7.2194
Repo	2026	0.6963	0.2796	0.1271	4.5490
Loil	2026	4.2992	0.3535	3.3279	4.8380

Results

Table 2 : The correlations between the independent and the dependent variables

	LSCS	Repo	Loil
LSCS	1		
Repo	-.149**	1	
Loil	-.673**	.327**	1

Results

Table 3: Engle and Granger Causality test

Variables	Repo	Loil	All
Estimate	-0.006	-0.0061	-0.007
Std.Error	0.0014	0.0013	0.0016
t-stat (ϕ)	-4.201	-4.71	-4.244
p-value	2.77E-05	2.65E-06	2.30E-05
Causality Detection	Causality	Causality	Causality

Results

Table 4: The multiple regression

	Intercepte	Repo	Loil	*R-square*	*Adjusted R-square*	*F-statistic*	*p-value*
Estimate	12.427	0.264	-1.368				
Std. Error	0.147	0.047	0.036	*0.4552*	0.4546	760.3	< 2.2e-16
t value	84.41	5.683	-38.424				
Pr(>|t|)	<2E-16 ***	.54E-08 **	< 2E-1 ***				

Result

Sample	Models		ME	MAE	MAPE
80%	Haar	ARIMA(0,1,1) with drift	0.000396	0.004131	0.08893
20%	MODWT-Haar-FIR.DM		3.202469	3.202469	82.4858285
	FIR.DM		3.255506	3.255506	85.0132386
	FIR.DM+ ARIMA direct		3.256506	3.285506	86.0132386

Conclusion

We proposed a hybrid model (MODWT-Haar-FIR.DM) with gradient decent learning approach. In Saudi Arabia stock exchange (Tadawul), the model is used to forecast the closing price. According to correlation, multiple regressions, and the Engle and Granger Causality test, we picked the oil price and the repo rate as input values. The result found that the input variables had a weak correlation. On the other hand, there is a strong correlation between the price of oil and the output variable (closing price). Furthermore, the Engle and Granger Causality test shows that the input variables have been causally related to the output variables. The multiple regression test is used to determine whether the impact is significant. Consequently, the input variables have a level of significance at 5%. The output variable is based on 2026 observations from Tadawul between October 2011 and December 2019.The Saudi Authority for Statistics and the Saudi Central Bank provided the study's input variables. The MODWT technique divides variables into approximation and detailed coefficients. Haar, Daubechies (Db), least Square (LA-8), Best localization (BL14), and Coiflet (C6) are the five MODWT functions. As a result, the output variable is divided into two parts: details coefficient (highly fluctuated data) and approximation coefficient (lowly fluctuated data) which consists of the main features of data. Our MODWT-Haar- FIR.DM model is built using approximation coefficient data (MODWT-Haar) and input variables. Statistical criteria tests were used to assess the MODWT-Haar-FIR.DM, including mean error (ME), and mean absolute percentage error (MAPE). Traditional models (ARIMA and FIR.DM models) were compared to the MODWT-Haar-FIR.DM model. As a result, the new forecasting model proposed may be applied to other foreign stock markets.

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Thank You