

```
In [1]: import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import numpy as np

from statsmodels.tsa.stattools import adfuller
from statsmodels.graphics.tsaplots import plot_acf, plot_pacf
from statsmodels.tsa.ar_model import AutoReg
from statsmodels.tsa.arima.model import ARIMA
from statsmodels.stats.diagnostic import acorr_ljungbox
from sklearn.metrics import mean_squared_error

sns.set_style('darkgrid')
```

```
In [2]: df = pd.read_csv(r"C:\Users\HP\Downloads\Stock_price.csv")
prices = df['Close']

print(df.head())
```

	Open	High	Low	Close	Adj Close	Volume
0	74.059998	75.150002	73.797501	75.087502	73.059425	135480400
1	74.287498	75.144997	74.125000	74.357498	72.349144	146322800
2	73.447502	74.989998	73.187500	74.949997	72.925636	118387200
3	74.959999	75.224998	74.370003	74.597504	72.582649	108872000
4	74.290001	76.110001	74.290001	75.797501	73.750244	132079200

```
In [3]: plt.figure(figsize=(12,5))
plt.plot(prices)
plt.title('Stock Closing Prices')
plt.xlabel('Time')
plt.ylabel('Close Price')
plt.show()
```



```
In [4]: adf_result = adfuller(prices)

print('ADF Statistic:', adf_result[0])
print('p-value:', adf_result[1])

if adf_result[1] > 0.05:
    prices_diff = prices.diff().dropna()
    print("Series is non-stationary → Differenced series used")
```

```
else:  
    prices_diff = prices  
    print("Series is stationary → Original series used")
```

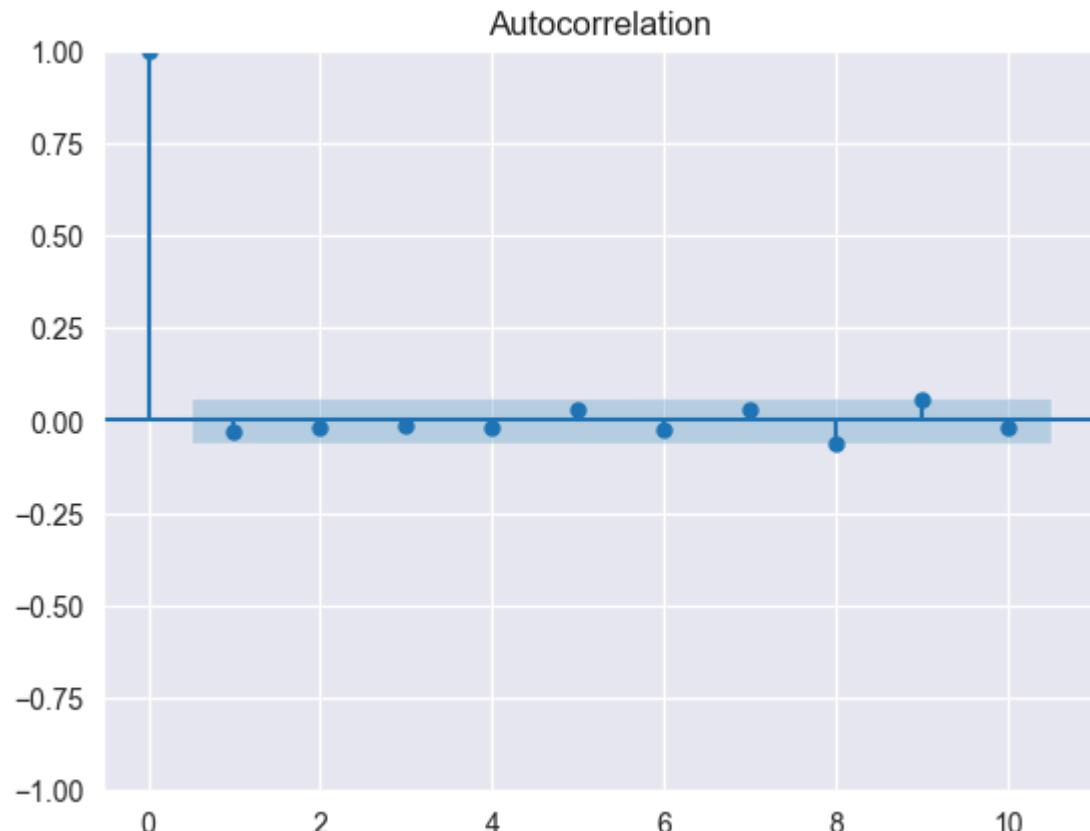
ADF Statistic: -1.9040053674009676
p-value: 0.33017921193591027
Series is non-stationary → Differenced series used

```
In [5]: plt.figure(figsize=(12,5))  
plt.plot(prices_diff)  
plt.title('Differenced Closing Prices')  
plt.show()
```



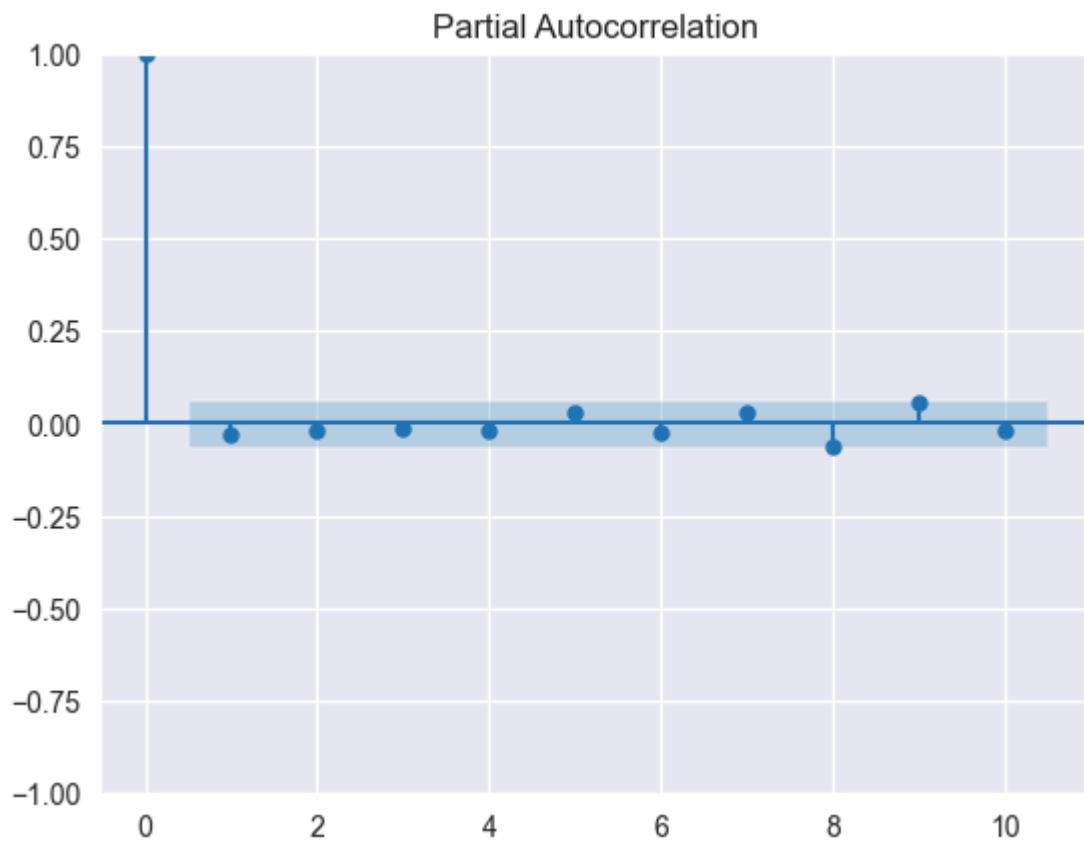
```
In [6]: plt.figure(figsize=(12,5))  
plot_acf(prices_diff, lags=10)  
plt.show()
```

<Figure size 1200x500 with 0 Axes>



```
In [7]: plt.figure(figsize=(12,5))
plot_pacf(prices_diff, lags=10)
plt.show()
```

<Figure size 1200x500 with 0 Axes>



```
In [8]: ar_lag = 2
ar_model = AutoReg(prices_diff, lags=ar_lag).fit()
print(ar_model.summary())
```

AutoReg Model Results

Dep. Variable:	Close	No. Observations:	1053			
Model:	AutoReg(2)	Log Likelihood:	-2508.864			
Method:	Conditional MLE	S.D. of innovations:	2.633			
Date:	Fri, 06 Feb 2026	AIC:	5025.727			
Time:	22:28:49	BIC:	5045.557			
Sample:	2	HQIC:	5033.246			
	1053					
	coef	std err	z	P> z	[0.025	0.975]
const	0.0973	0.081	1.196	0.232	-0.062	0.257
Close.L1	-0.0285	0.031	-0.922	0.356	-0.089	0.032
Close.L2	-0.0182	0.031	-0.591	0.554	-0.079	0.042
	Real	Imaginary	Modulus	Frequency		
AR.1	-0.7798	-7.3621j	7.4033		-0.2668	
AR.2	-0.7798	+7.3621j	7.4033		0.2668	

```
C:\Users\HP\AppData\Roaming\Python\Python310\site-packages\statsmodels\tsa\base\tsa_model.py:473: ValueWarning: An unsupported index was provided. As a result, forecasts cannot be generated. To use the model for forecasting, use one of the supported classes of index.
    self._init_dates(dates, freq)
```

In [9]:

```
ma_order = 2
ma_model = ARIMA(prices_diff, order=(0,0,ma_order)).fit()
print(ma_model.summary())
```

```
C:\Users\HP\AppData\Roaming\Python\Python310\site-packages\statsmodels\tsa\base\tsa_model.py:473: ValueWarning: An unsupported index was provided. As a result, forecasts cannot be generated. To use the model for forecasting, use one of the supported classes of index.
```

```
    self._init_dates(dates, freq)
```

```
C:\Users\HP\AppData\Roaming\Python\Python310\site-packages\statsmodels\tsa\base\tsa_model.py:473: ValueWarning: An unsupported index was provided. As a result, forecasts cannot be generated. To use the model for forecasting, use one of the supported classes of index.
```

```
    self._init_dates(dates, freq)
```

```
C:\Users\HP\AppData\Roaming\Python\Python310\site-packages\statsmodels\tsa\base\tsa_model.py:473: ValueWarning: An unsupported index was provided. As a result, forecasts cannot be generated. To use the model for forecasting, use one of the supported classes of index.
```

```
    self._init_dates(dates, freq)
```

SARIMAX Results

```
=====
Dep. Variable:                  Close   No. Observations:                 1053
Model:                          ARIMA(0, 0, 2)   Log Likelihood:            -2512.684
Date:             Fri, 06 Feb 2026   AIC:                            5033.367
Time:                     22:28:57   BIC:                            5053.205
Sample:                      0 - 1053   HQIC:                           5040.888
Covariance Type:                opg
=====
```

	coef	std err	z	P> z	[0.025	0.975]
const	0.0927	0.079	1.178	0.239	-0.062	0.247
ma.L1	-0.0290	0.026	-1.103	0.270	-0.080	0.022
ma.L2	-0.0187	0.027	-0.685	0.494	-0.072	0.035
sigma2	6.9209	0.228	30.394	0.000	6.475	7.367

=====

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```
Ljung-Box (L1) (Q):               0.00   Jarque-Bera (JB):          119.
```

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26
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```
Prob(Q):                         1.00   Prob(JB):                   0.
```

```
00
```

```
Heteroskedasticity (H):           0.94   Skew:                      -0.
```

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08
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Prob(H) (two-sided):              0.53   Kurtosis:                  4.
```

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64
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```

Warnings:

```
[1] Covariance matrix calculated using the outer product of gradients (complex-step).
```

```
In [10]: arma_model = ARIMA(prices_diff, order=(ar_lag,0,ma_order)).fit()
print(arma_model.summary())
```

```
C:\Users\HP\AppData\Roaming\Python\Python310\site-packages\statsmodels\tsa\base\t
sa_model.py:473: ValueWarning: An unsupported index was provided. As a result, fo
recasts cannot be generated. To use the model for forecasting, use one of the sup
ported classes of index.
    self._init_dates(dates, freq)
C:\Users\HP\AppData\Roaming\Python\Python310\site-packages\statsmodels\tsa\base\t
sa_model.py:473: ValueWarning: An unsupported index was provided. As a result, fo
recasts cannot be generated. To use the model for forecasting, use one of the sup
ported classes of index.
    self._init_dates(dates, freq)
C:\Users\HP\AppData\Roaming\Python\Python310\site-packages\statsmodels\tsa\base\t
sa_model.py:473: ValueWarning: An unsupported index was provided. As a result, fo
recasts cannot be generated. To use the model for forecasting, use one of the sup
ported classes of index.
    self._init_dates(dates, freq)
C:\Users\HP\AppData\Roaming\Python\Python310\site-packages\statsmodels\tsa\states
pace\sarimax.py:966: UserWarning: Non-stationary starting autoregressive paramete
rs found. Using zeros as starting parameters.
    warn('Non-stationary starting autoregressive parameters')
C:\Users\HP\AppData\Roaming\Python\Python310\site-packages\statsmodels\tsa\states
pace\sarimax.py:978: UserWarning: Non-invertible starting MA parameters found. Us
ing zeros as starting parameters.
    warn('Non-invertible starting MA parameters found.')
C:\Users\HP\AppData\Roaming\Python\Python310\site-packages\statsmodels\base\mode
l.py:607: ConvergenceWarning: Maximum Likelihood optimization failed to converge.
Check mle_retvals
    warnings.warn("Maximum Likelihood optimization failed to "
```

SARIMAX Results

```
=====
Dep. Variable:                  Close   No. Observations:                 1053
Model:                          ARIMA(2, 0, 2)   Log Likelihood:            -2503.216
Date:                          Fri, 06 Feb 2026   AIC:                   5018.431
Time:                           22:29:09     BIC:                   5048.187
Sample:                         0   HQIC:                  5029.712
                                  - 1053
Covariance Type:                opg
=====
```

	coef	std err	z	P> z	[0.025	0.975]
const	0.0927	0.080	1.153	0.249	-0.065	0.250
ar.L1	-1.8631	0.013	-144.794	0.000	-1.888	-1.838
ar.L2	-0.9791	0.013	-77.371	0.000	-1.004	-0.954
ma.L1	1.8560	0.017	106.164	0.000	1.822	1.890
ma.L2	0.9633	0.017	55.829	0.000	0.929	0.997
sigma2	6.8033	0.226	30.126	0.000	6.361	7.246

```
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```

Ljung-Box (L1) (Q):	0.01	Jarque-Bera (JB):	107.
96			
Prob(Q):	0.92	Prob(JB):	0.
00			
Heteroskedasticity (H):	0.95	Skew:	-0.
07			
Prob(H) (two-sided):	0.64	Kurtosis:	4.
56			

```
=====
==
```

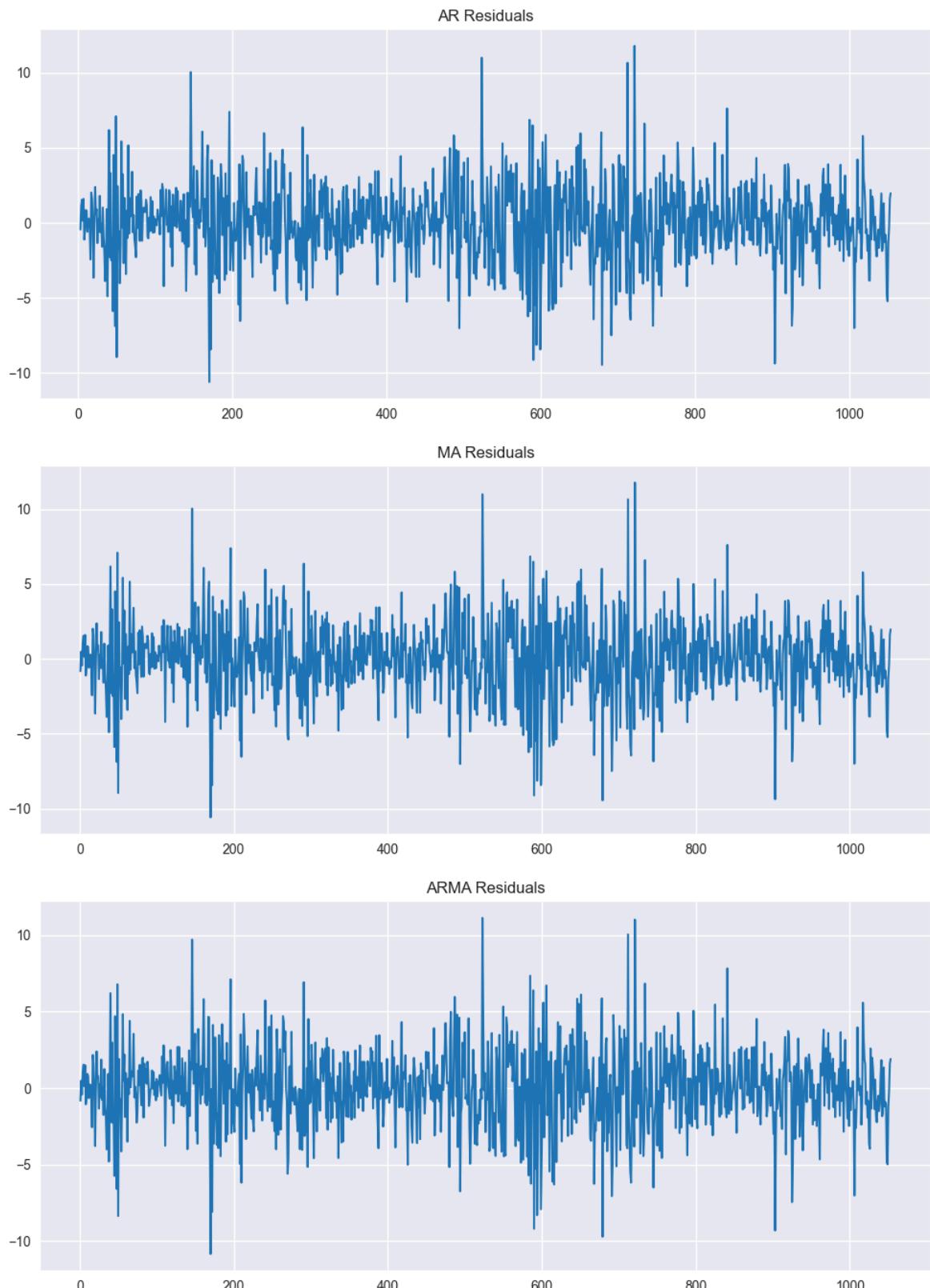
Warnings:

[1] Covariance matrix calculated using the outer product of gradients (complex-step).

```
In [11]: plt.figure(figsize=(12,5))
plt.plot(ar_model.resid)
plt.title('AR Residuals')
plt.show()

plt.figure(figsize=(12,5))
plt.plot(ma_model.resid)
plt.title('MA Residuals')
plt.show()

plt.figure(figsize=(12,5))
plt.plot(arma_model.resid)
plt.title('ARMA Residuals')
plt.show()
```



```
In [12]: lb_test = acorr_ljungbox(arma_model.resid, lags=[10], return_df=True)
print(lb_test)
```

	lb_stat	lb_pvalue
10	2.779979	0.986138

```
In [13]: print("AR AIC:", ar_model.aic, "BIC:", ar_model.bic)
print("MA AIC:", ma_model.aic, "BIC:", ma_model.bic)
print("ARMA AIC:", arma_model.aic, "BIC:", arma_model.bic)
```

```
AR  AIC: 5025.727140323777 BIC: 5045.5571298072855
MA  AIC: 5033.367301699888 BIC: 5053.204895748424
ARMA AIC: 5018.43103406367 BIC: 5048.187425136474
```

```
In [14]: forecast_steps = 5
forecast = arma_model.forecast(steps=forecast_steps)
print(forecast)
```

```
1053 -0.005696
1054 0.224722
1055 -0.057063
1056 0.242319
1057 -0.039553
Name: predicted_mean, dtype: float64
```

```
C:\Users\HP\AppData\Roaming\Python\Python310\site-packages\statsmodels\tsa\base\tsa_model.py:837: ValueWarning: No supported index is available. Prediction results will be given with an integer index beginning at `start`.
    return get_prediction_index()
C:\Users\HP\AppData\Roaming\Python\Python310\site-packages\statsmodels\tsa\base\tsa_model.py:837: FutureWarning: No supported index is available. In the next version, calling this method in a model without a supported index will result in an exception.
    return get_prediction_index()
```

```
In [15]: actual = prices_diff[-5:]
predicted = arma_model.predict(start=len(prices_diff)-5, end=len(prices_diff)-1)
rmse = np.sqrt(mean_squared_error(actual, predicted))
print("RMSE:", rmse)
```

```
RMSE: 2.5530175698750086
```

```
In [ ]:
```