

In [ ]:

```
pip install arch
```

In [ ]:

```
from arch import arch_model
from statsmodels.graphics.tsaplots import plot_acf, plot_pacf
from datetime import datetime, timedelta
```

In [4]:

```
start = datetime(2005,3,1)
end = datetime(2021,1,12)
```

In [5]:

```
df = pd.read_excel('BSE_NSE_returns.xlsx')
df.head()
```

Out[5]:

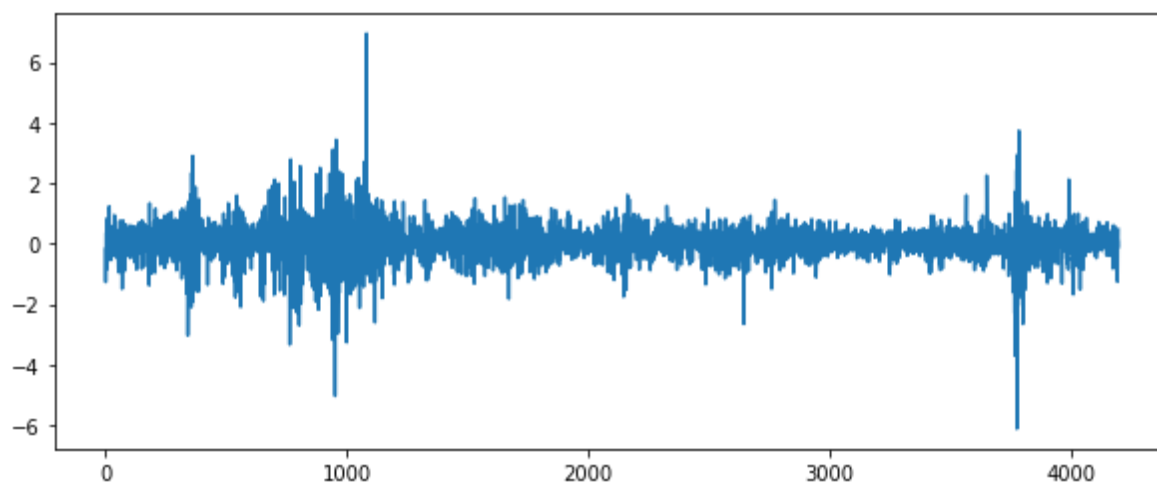
	Date	Sensex	SensexReturns	Nifty	NiftyReturns
0	2005-01-03	6679.20	NaN	2115.00	NaN
1	2005-01-04	6651.01	-0.183685	2103.75	-0.231624
2	2005-01-05	6458.84	-1.273307	2032.20	-1.502768
3	2005-01-06	6367.39	-0.619308	1998.35	-0.729489
4	2005-01-07	6420.46	0.360469	2015.50	0.371125

In [6]:

```
import matplotlib.pyplot as plt
plt.figure(figsize=(10,4))
plt.plot(df.SensexReturns)
```

Out[6]:

[<matplotlib.lines.Line2D at 0x225d7756308>]

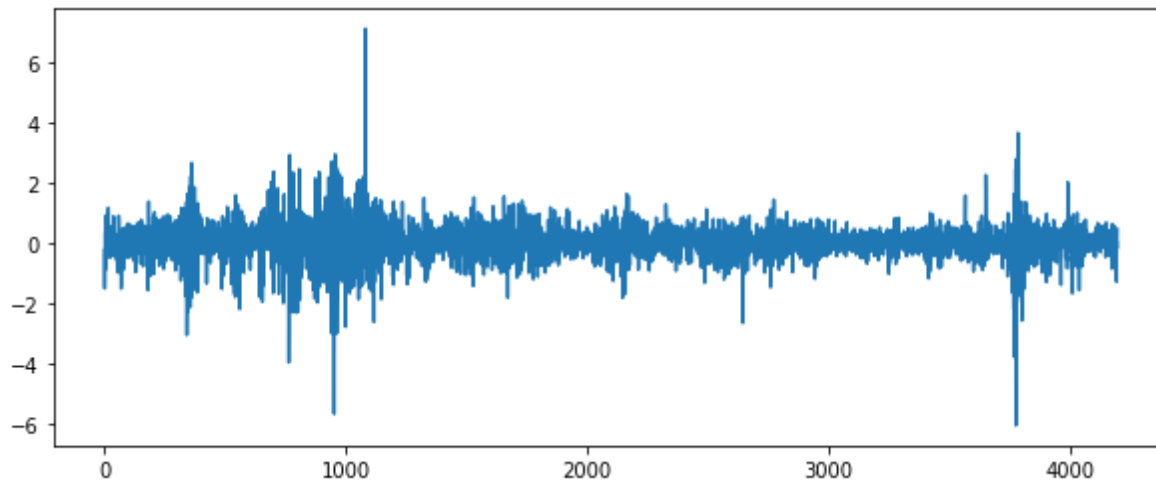


In [7]:

```
plt.figure(figsize=(10,4))  
plt.plot(df.NiftyReturns)
```

Out[7]:

[<matplotlib.lines.Line2D at 0x225d4249508>]

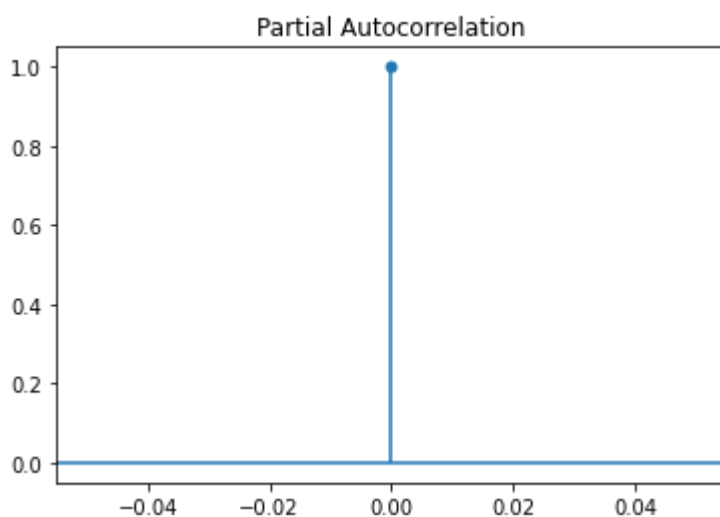


In [8]:

```
df.set_index('Date',inplace=True)
```

In [9]:

```
plot_pacf(df.SensexReturns)  
plt.show()
```



In [11]:

```
df.dropna(inplace=True)
model = arch_model(df.SensexReturns,p=1,q=1)
model_fit = model.fit()
```

Iteration:	1,	Func. Count:	6,	Neg. LLF:	2930.355560335777
Iteration:	2,	Func. Count:	17,	Neg. LLF:	2927.659646338424
Iteration:	3,	Func. Count:	25,	Neg. LLF:	2926.1438253238957
Iteration:	4,	Func. Count:	32,	Neg. LLF:	2925.5811483395555
Iteration:	5,	Func. Count:	39,	Neg. LLF:	2919.8289935967487
Iteration:	6,	Func. Count:	47,	Neg. LLF:	2918.7441869570666
Iteration:	7,	Func. Count:	54,	Neg. LLF:	2916.0731162302054
Iteration:	8,	Func. Count:	61,	Neg. LLF:	2915.9500143094137
Iteration:	9,	Func. Count:	68,	Neg. LLF:	2915.917476081117
Iteration:	10,	Func. Count:	75,	Neg. LLF:	2915.8231434797203
Iteration:	11,	Func. Count:	81,	Neg. LLF:	2915.7620134802655
Iteration:	12,	Func. Count:	87,	Neg. LLF:	2915.7614516897347
Iteration:	13,	Func. Count:	93,	Neg. LLF:	2915.761443691962

Optimization terminated successfully. (Exit mode 0)

Current function value: 2915.7614436871536

Iterations: 13

Function evaluations: 93

Gradient evaluations: 13

In [12]:

```
df.dropna(inplace=True)
model1 = arch_model(df.NiftyReturns,p=1,q=1)
model_fit1 = model1.fit()
```

Iteration:	1,	Func. Count:	6,	Neg. LLF:	2967.571470602611
Iteration:	2,	Func. Count:	17,	Neg. LLF:	2965.0987274148247
Iteration:	3,	Func. Count:	26,	Neg. LLF:	2962.9793794414813
Iteration:	4,	Func. Count:	33,	Neg. LLF:	2957.746268806226
Iteration:	5,	Func. Count:	40,	Neg. LLF:	2956.9207915781462
Iteration:	6,	Func. Count:	47,	Neg. LLF:	2955.9372307341237
Iteration:	7,	Func. Count:	54,	Neg. LLF:	2954.883864370998
Iteration:	8,	Func. Count:	61,	Neg. LLF:	2954.538868727898
Iteration:	9,	Func. Count:	70,	Neg. LLF:	2954.533008299637
Iteration:	10,	Func. Count:	76,	Neg. LLF:	2954.417834093374
Iteration:	11,	Func. Count:	82,	Neg. LLF:	2954.389447645536
Iteration:	12,	Func. Count:	88,	Neg. LLF:	2954.389193176761

Optimization terminated successfully. (Exit mode 0)

Current function value: 2954.3891926867836

Iterations: 12

Function evaluations: 89

Gradient evaluations: 12

In [15]:

```
model_fit1.summary()
```

Out[15]:

Constant Mean - GARCH Model Results

<b>Dep. Variable:</b>	NiftyReturns	<b>R-squared:</b>	0.000
<b>Mean Model:</b>	Constant Mean	<b>Adj. R-squared:</b>	0.000
<b>Vol Model:</b>	GARCH	<b>Log-Likelihood:</b>	-2954.39
<b>Distribution:</b>	Normal	<b>AIC:</b>	5916.78
<b>Method:</b>	Maximum Likelihood	<b>BIC:</b>	5942.14
		<b>No. Observations:</b>	4194
<b>Date:</b>	Mon, Dec 06 2021	<b>Df Residuals:</b>	4193
<b>Time:</b>	14:18:35	<b>Df Model:</b>	1

Mean Model

	coef	std err	t	P> t	95.0% Conf. Int.
<b>mu</b>	0.0358	6.909e-03	5.179	2.227e-07	[2.224e-02, 4.933e-02]

Volatility Model

	coef	std err	t	P> t	95.0% Conf. Int.
<b>omega</b>	3.7523e-03	1.089e-03	3.447	5.669e-04	[1.619e-03, 5.886e-03]
<b>alpha[1]</b>	0.0984	1.276e-02	7.713	1.232e-14	[7.339e-02, 0.123]
<b>beta[1]</b>	0.8933	1.255e-02	71.159	0.000	[ 0.869, 0.918]

Covariance estimator: robust

In [7]:

```
model_fit.summary()
```

Out[7]:

Constant Mean - GARCH Model Results

<b>Dep. Variable:</b>	SensexReturns	<b>R-squared:</b>	0.000
<b>Mean Model:</b>	Constant Mean	<b>Adj. R-squared:</b>	0.000
<b>Vol Model:</b>	GARCH	<b>Log-Likelihood:</b>	-2915.76
<b>Distribution:</b>	Normal	<b>AIC:</b>	5839.52
<b>Method:</b>	Maximum Likelihood	<b>BIC:</b>	5864.89
		<b>No. Observations:</b>	4194
<b>Date:</b>	Mon, Dec 06 2021	<b>Df Residuals:</b>	4193
<b>Time:</b>	14:12:18	<b>Df Model:</b>	1

Mean Model

	coef	std err	t	P> t	95.0% Conf. Int.
<b>mu</b>	0.0371	6.846e-03	5.421	5.910e-08	[2.370e-02, 5.054e-02]

Volatility Model

	coef	std err	t	P> t	95.0% Conf. Int.
<b>omega</b>	3.6328e-03	1.014e-03	3.582	3.408e-04	[1.645e-03, 5.620e-03]
<b>alpha[1]</b>	0.0956	1.228e-02	7.782	7.126e-15	[7.151e-02, 0.120]
<b>beta[1]</b>	0.8956	1.232e-02	72.686	0.000	[0.871, 0.920]

Covariance estimator: robust

In [21]:

```
df.SensexReturns[: -365]
```

Out[21]:

```
Date
2005-01-04    -0.183685
2005-01-05    -1.273307
2005-01-06    -0.619308
2005-01-07     0.360469
2005-01-10    -0.763728
...
2020-06-10     0.369782
2020-06-11    -0.908122
2020-06-12     0.312914
2020-06-15    -0.715643
2020-06-16     0.489209
Name: SensexReturns, Length: 3829, dtype: float64
```

In [13]:

```
rolling_predictions1 = []
test_size = 365

for i in range(test_size):
    train1 = df.NiftyReturns
    model1 = arch_model(train1, p=1, q=1)
    model_fit1 = model1.fit(dispatch='off')
    pred1 = model_fit1.forecast(horizon=1)
    rolling_predictions1.append(np.sqrt(pred1.variance.values[-1, :][0]))
```

C:\Users\HP\anaconda3\lib\site-packages\arch\\_\_future\_\_\utility.py:21: FutureWarning:

The default for reindex is True. After September 2021 this will change to False. Set reindex to True or False to silence this message. Alternatively, you can use the import comment

```
from arch.__future__ import reindexing
```

to globally set reindex to True and silence this warning.

FutureWarning,

C:\Users\HP\anaconda3\lib\site-packages\arch\\_\_future\_\_\utility.py:21: FutureWarning:

The default for reindex is True. After September 2021 this will change to False. Set reindex to True or False to silence this message. Alternatively, you can use the import comment

In [15]:

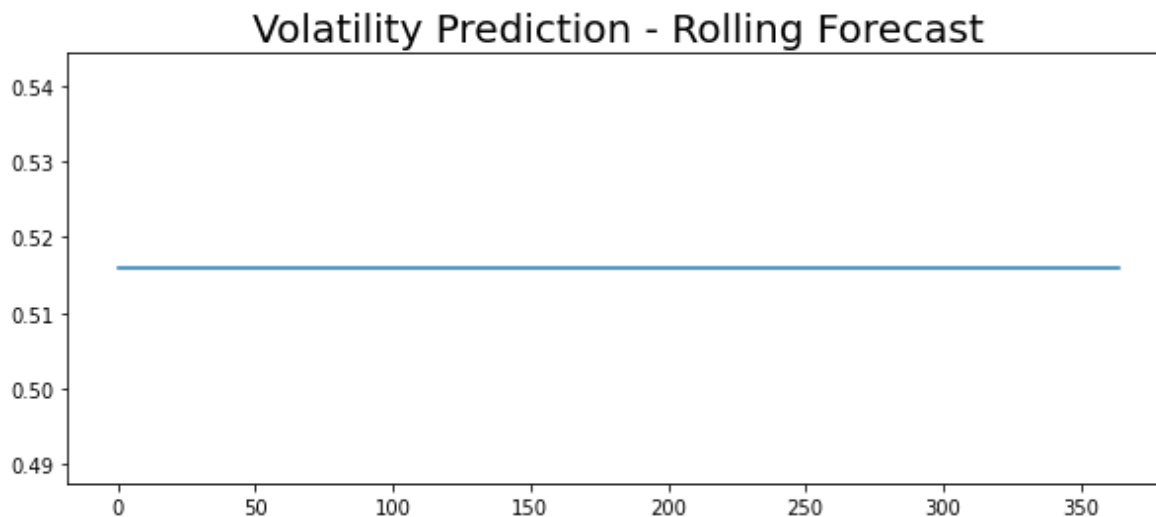
```
rolling_predictions1 = pd.Series(rolling_predictions1)
```

In [16]:

```
import matplotlib.pyplot as plt
plt.figure(figsize=(10,4))
preds, = plt.plot(rolling_predictions1)
plt.title('Volatility Prediction - Rolling Forecast', fontsize=20)
```

Out[16]:

Text(0.5, 1.0, 'Volatility Prediction - Rolling Forecast')



In [16]:

```
rolling_predictions1 = []
test_size = 365

for i in range(test_size):
    train1 = df.NiftyReturns[:-(test_size-i)]
    model1 = arch_model(train1, p=1, q=1)
    model_fit1 = model1.fit(disp='off')
    pred1 = model_fit1.forecast(horizon=1)
    rolling_predictions1.append(np.sqrt(pred1.variance.values[-1,:][0]))
```

C:\Users\HP\anaconda3\lib\site-packages\arch\\_\_future\_\_\utility.py:21: FutureWarning:

The default for reindex is True. After September 2021 this will change to False. Set reindex to True or False to silence this message. Alternatively, you can use the import comment

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C:\Users\HP\anaconda3\lib\site-packages\arch\\_\_future\_\_\utility.py:21: FutureWarning:

The default for reindex is True. After September 2021 this will change to False. Set reindex to True or False to silence this message. Alternatively, you can use the import comment

```
from arch.__future__ import reindexing
```

In [17]:

```
rolling_predictions1 = pd.Series(rolling_predictions1, index=df.NiftyReturns.index[-test_si
```

In [8]:

```
rolling_predictions = []
test_size = 365

for i in range(test_size):
    train = df.SensexReturns[:-(test_size-i)]
    model = arch_model(train, p=1, q=1)
    model_fit = model.fit(disp='off')
    pred = model_fit.forecast(horizon=1)
    rolling_predictions.append(np.sqrt(pred.variance.values[-1, :][0]))
```

```
from arch.__future__ import reindexing
```

to globally set reindex to True and silence this warning.

```
FutureWarning,
C:\Users\HP\anaconda3\lib\site-packages\arch\__future__\utility.py:21: FutureWarning:
The default for reindex is True. After September 2021 this will change to False. Set reindex to True or False to silence this message. Alternatively,
you can use the import comment
```

```
from arch.__future__ import reindexing
```

to globally set reindex to True and silence this warning.

```
FutureWarning,
C:\Users\HP\anaconda3\lib\site-packages\arch\__future__\utility.py:21: FutureWarning:
```

In [9]:

```
rolling_predictions = pd.Series(rolling_predictions, index=df.SensexReturns.index[-test_siz
```

In [28]:

```
rolling_predictions
```

Out[28]:

```
Date
2020-06-17    0.667744
2020-06-18    0.635665
2020-06-19    0.662309
2020-06-22    0.658839
2020-06-23    0.628330
...
2021-11-25    0.415357
2021-11-26    0.408268
2021-11-29    0.562264
2021-11-30    0.535676
2021-12-01    0.513488
Length: 365, dtype: float64
```

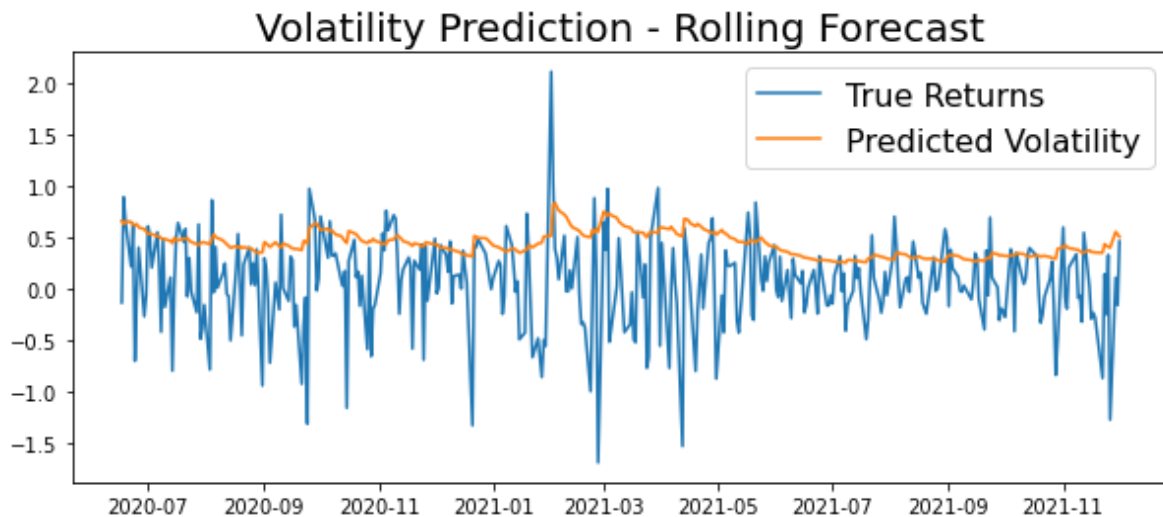


In [11]:

```
import matplotlib.pyplot as plt
plt.figure(figsize=(10,4))
true, = plt.plot(df.SensexReturns[-test_size:])
preds, = plt.plot(rolling_predictions)
plt.title('Volatility Prediction - Rolling Forecast', fontsize=20)
plt.legend(['True Returns', 'Predicted Volatility'], fontsize=16)
```

Out[11]:

&lt;matplotlib.legend.Legend at 0x1788b18be48&gt;

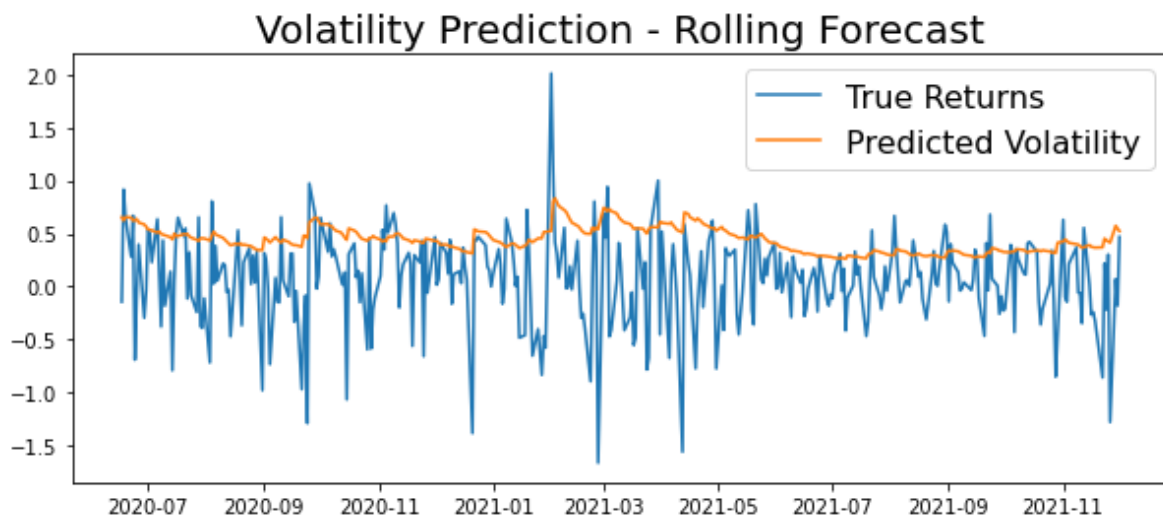


In [18]:

```
import matplotlib.pyplot as plt
plt.figure(figsize=(10,4))
true, = plt.plot(df.NiftyReturns[-test_size:])
preds, = plt.plot(rolling_predictions1)
plt.title('Volatility Prediction - Rolling Forecast', fontsize=20)
plt.legend(['True Returns', 'Predicted Volatility'], fontsize=16)
```

Out[18]:

&lt;matplotlib.legend.Legend at 0x1788c54a7c8&gt;



In [18]:

```
df.NiftyReturns[:-(730)]
```

Out[18]:

```
Date
2005-01-04    -0.231624
2005-01-05    -1.502768
2005-01-06    -0.729489
2005-01-07     0.371125
2005-01-10    -0.727915
...
2018-12-13     0.217661
2018-12-14     0.055903
2018-12-17     0.331921
2018-12-18     0.081093
2018-12-19     0.232672
Name: NiftyReturns, Length: 3464, dtype: float64
```

In [25]:

```
df.SensexReturns[-730:-480]
```

Out[25]:

```
Date
2018-12-20    -0.062730
2018-12-21    -0.829938
2018-12-24    -0.331668
2018-12-26     0.219578
2018-12-27     0.191253
...
2019-12-20     0.007940
2019-12-23    -0.040529
2019-12-24    -0.189597
2019-12-26    -0.312746
2019-12-27     0.431868
Name: SensexReturns, Length: 250, dtype: float64
```

In [35]:

```

rolling_predictions1 = []
test_size = 250

for i in range(test_size):
    train1 = df.NiftyReturns[:-(test_size-i)]
    model1 = arch_model(train1, p=1, q=1)
    model_fit1 = model1.fit(dispatch='off')
    pred1 = model_fit1.forecast(horizon=1)
    rolling_predictions1.append(np.sqrt(pred1.variance.values[-1, :][0]))

```

C:\Users\HP\anaconda3\lib\site-packages\arch\\_\_future\_\_\utility.py:21: FutureWarning:  
The default for reindex is True. After September 2021 this will change to False. Set reindex to True or False to silence this message. Alternatively, you can use the import comment

```
from arch.__future__ import reindexing
```

to globally set reindex to True and silence this warning.

FutureWarning,  
C:\Users\HP\anaconda3\lib\site-packages\arch\\_\_future\_\_\utility.py:21: FutureWarning:  
The default for reindex is True. After September 2021 this will change to False. Set reindex to True or False to silence this message. Alternatively, you can use the import comment

```

# Silence the warning

```

In [36]:

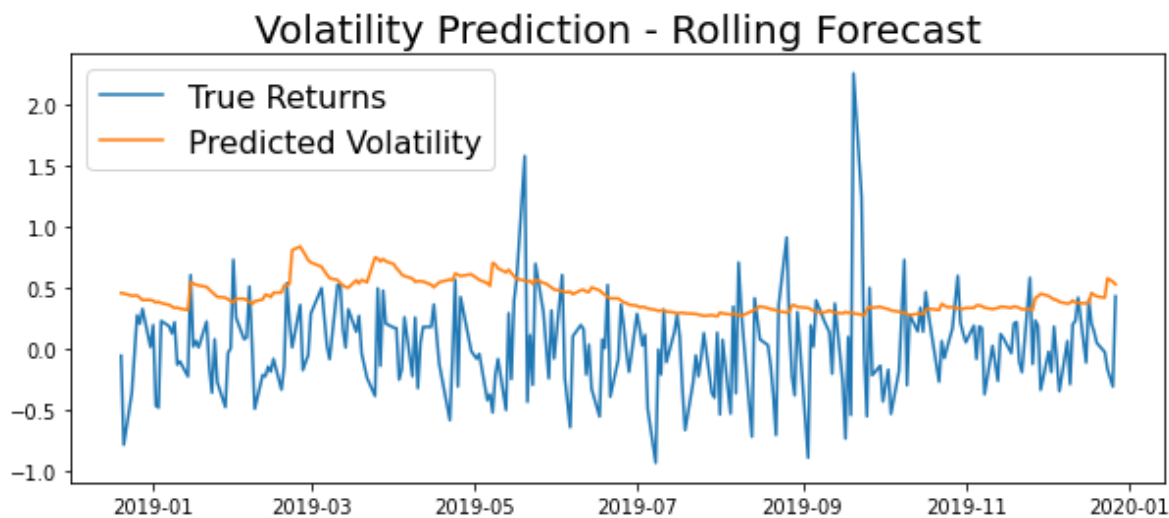
```
rolling_predictions1 = pd.Series(rolling_predictions1, index=df.NiftyReturns.index[-730:-48])
```

In [37]:

```
import matplotlib.pyplot as plt
plt.figure(figsize=(10,4))
true, = plt.plot(df.NiftyReturns[-730:-480])
preds, = plt.plot(rolling_predictions1)
plt.title('Volatility Prediction - Rolling Forecast', fontsize=20)
plt.legend(['True Returns', 'Predicted Volatility'], fontsize=16)
```

Out[37]:

&lt;matplotlib.legend.Legend at 0x225da0ecc88&gt;



In [48]:

```
rolling_predictions1 = []
test_size = 250

for i in range(test_size):
    train1 = df.SensexReturns[:-(730-i)]
    model1 = arch_model(train1, p=1, q=1)
    model_fit1 = model1.fit(disp='off')
    pred1 = model_fit1.forecast(horizon=1)
    rolling_predictions1.append(np.sqrt(pred1.variance.values[-1,:][0]))
```

C:\Users\HP\anaconda3\lib\site-packages\arch\\_\_future\_\_\utility.py:21: FutureWarning:

The default for reindex is True. After September 2021 this will change to False. Set reindex to True or False to silence this message. Alternatively, you can use the import comment

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FutureWarning,

C:\Users\HP\anaconda3\lib\site-packages\arch\\_\_future\_\_\utility.py:21: FutureWarning:

The default for reindex is True. After September 2021 this will change to False. Set reindex to True or False to silence this message. Alternatively, you can use the import comment

```
from arch.__future__ import reindexing
```

In [52]:

```
df.SensexReturns[:-(730)]
```

Out[52]:

```
Date
2005-01-04    -0.183685
2005-01-05    -1.273307
2005-01-06    -0.619308
2005-01-07     0.360469
2005-01-10    -0.763728
...
2018-12-13     0.182382
2018-12-14     0.040220
2018-12-17     0.369333
2018-12-18     0.092113
2018-12-19     0.163685
Name: SensexReturns, Length: 3464, dtype: float64
```

In [49]:

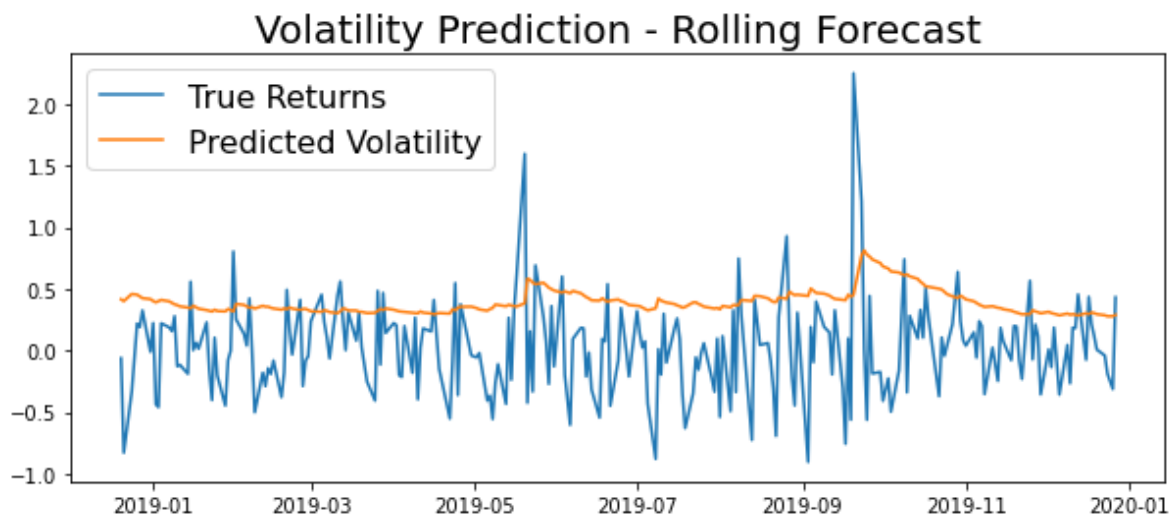
```
rolling_predictions1 = pd.Series(rolling_predictions1, index=df.SensexReturns.index[-730:-4])
```

In [50]:

```
import matplotlib.pyplot as plt
plt.figure(figsize=(10,4))
true, = plt.plot(df.SensexReturns[-730:-480])
preds, = plt.plot(rolling_predictions1)
plt.title('Volatility Prediction - Rolling Forecast', fontsize=20)
plt.legend(['True Returns', 'Predicted Volatility'], fontsize=16)
```

Out[50]:

```
<matplotlib.legend.Legend at 0x225da1e2088>
```



In [53]:

```
df.SensexReturns[-730:-480]
```

Out[53]:

```
Date
2018-12-20    -0.062730
2018-12-21    -0.829938
2018-12-24    -0.331668
2018-12-26     0.219578
2018-12-27     0.191253
...
2019-12-20     0.007940
2019-12-23    -0.040529
2019-12-24    -0.189597
2019-12-26    -0.312746
2019-12-27     0.431868
Name: SensexReturns, Length: 250, dtype: float64
```

In [54]:

```
rolling_predictions1 = []
test_size = 250

for i in range(test_size):
    train1 = df.NiftyReturns[-(730-i)]
    model1 = arch_model(train1, p=1, q=1)
    model_fit1 = model1.fit(dispatch='off')
    pred1 = model_fit1.forecast(horizon=1)
    rolling_predictions1.append(np.sqrt(pred1.variance.values[-1, :][0]))
```

```
from arch.__future__ import reindexing
```

to globally set reindex to True and silence this warning.

```
FutureWarning,
C:\Users\HP\anaconda3\lib\site-packages\arch\__future__\utility.py:21: FutureWarning:
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```

```
from arch.__future__ import reindexing
```

to globally set reindex to True and silence this warning.

```
FutureWarning,
C:\Users\HP\anaconda3\lib\site-packages\arch\__future__\utility.py:21: FutureWarning:
```

In [55]:

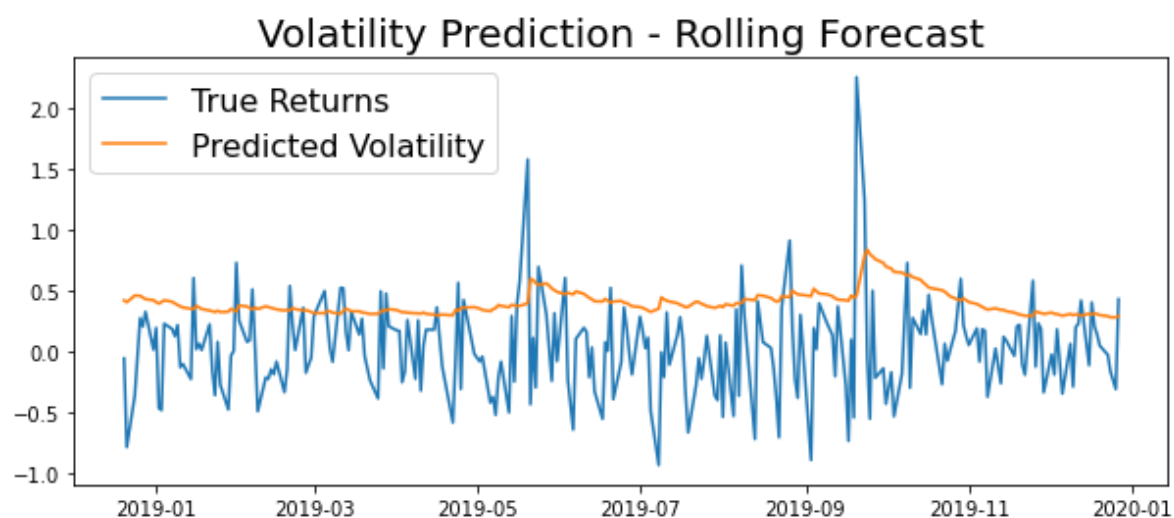
```
rolling_predictions1 = pd.Series(rolling_predictions1, index=df.NiftyReturns.index[-730:-480])
```

In [56]:

```
import matplotlib.pyplot as plt
plt.figure(figsize=(10,4))
true, = plt.plot(df.NiftyReturns[-730:-480])
preds, = plt.plot(rolling_predictions1)
plt.title('Volatility Prediction - Rolling Forecast', fontsize=20)
plt.legend(['True Returns', 'Predicted Volatility'], fontsize=16)
```

Out[56]:

<matplotlib.legend.Legend at 0x225da1b0b48>



In [ ]: