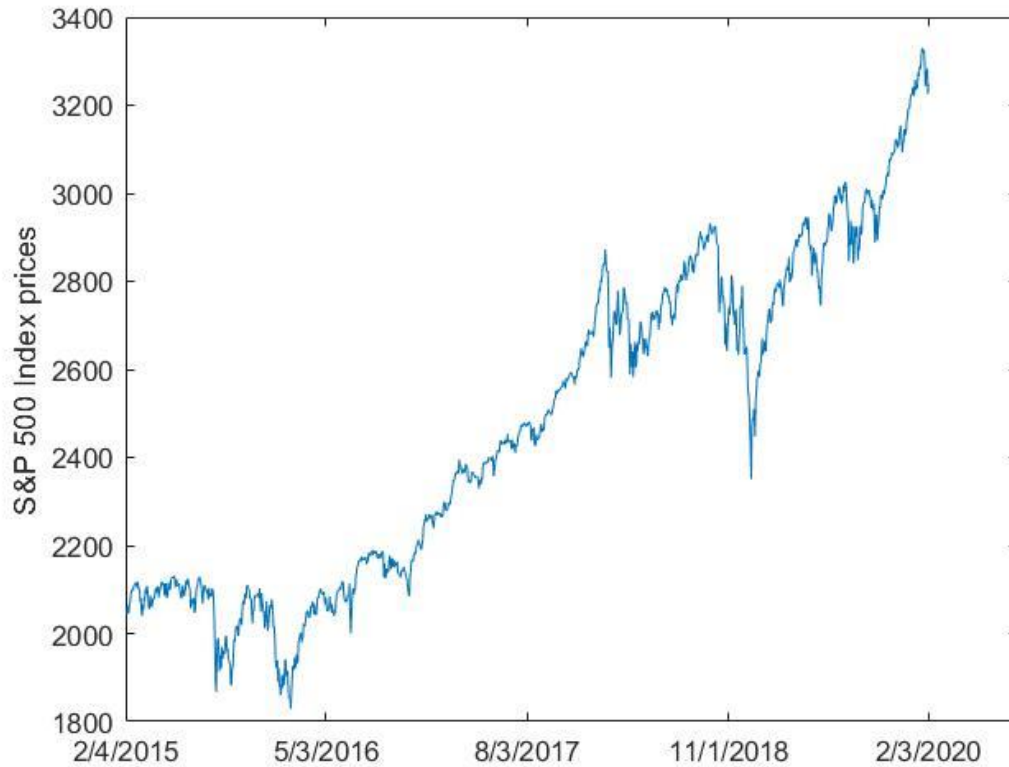


1. >> plot(GSPC)

>> set(gca,'XTick',[1 314 630 945 1259])

set(gca,'XTickLabel',{'2/4/2015' '5/3/2016' '8/3/2017' '11/1/2018' '2/3/2020'})

>> ylabel('S&P 500 Index prices')



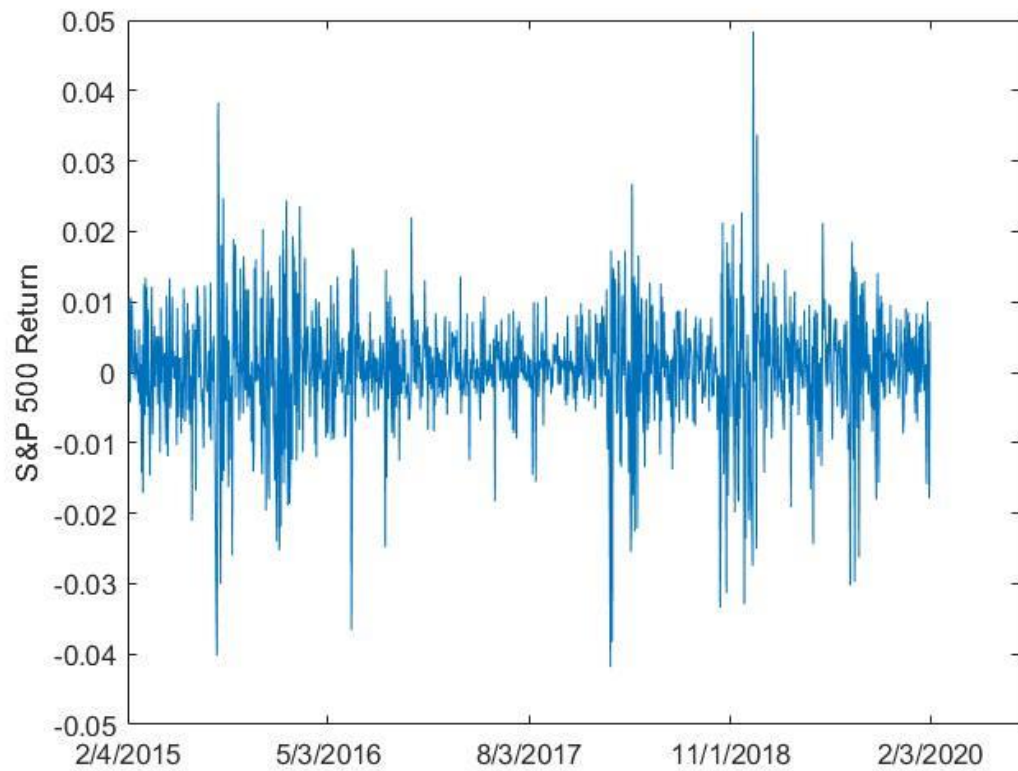
2. gspc=price2ret(GSPC)

plot(gspc)

>> set(gca,'XTick',[1 314 630 945 1259])

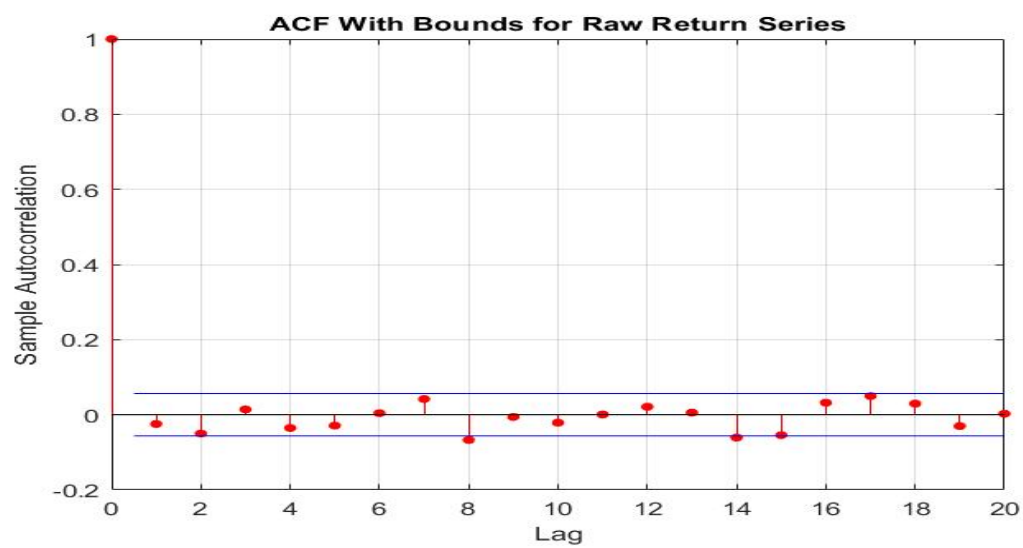
set(gca,'XTickLabel',{'2/4/2015' '5/3/2016' '8/3/2017' '11/1/2018' '2/3/2020'})

>> ylabel('S&P 500 Return')



3. autocorr(gspc)

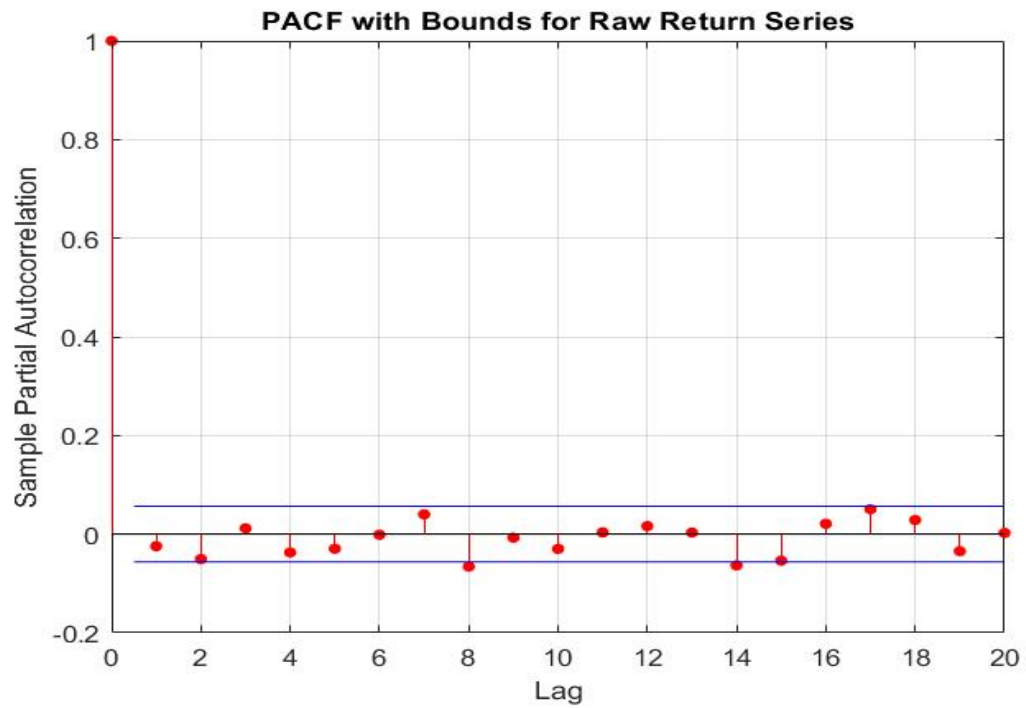
```
>> title('ACF With Bounds for Raw Return Series')
```



Result: $q=1$

```
parcorr(gspc)
```

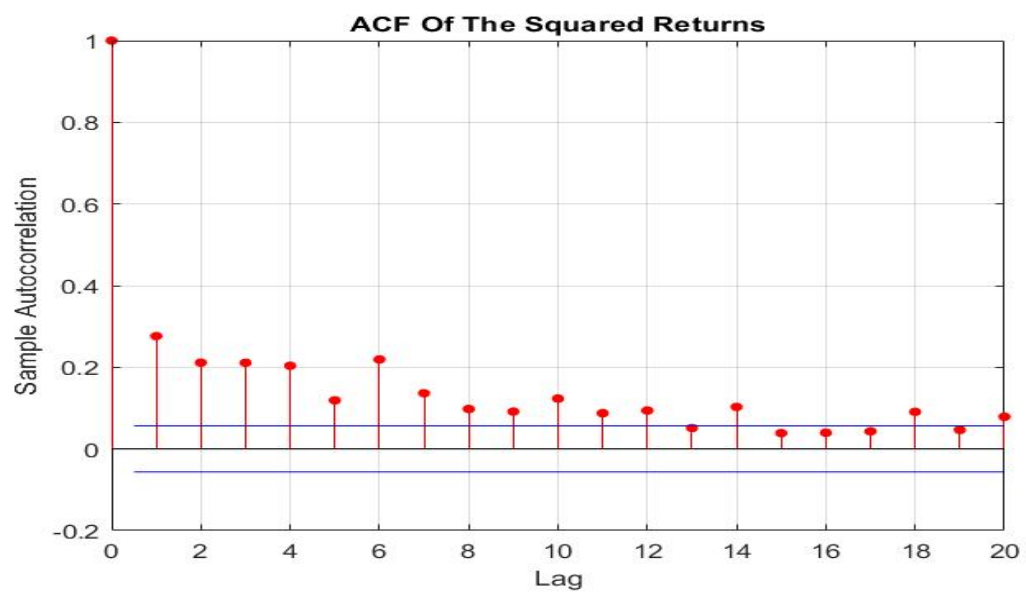
```
>> title('PACF with Bounds for Raw Return Series')
```



P=1

```
4. autocorr(gspc.^2)
```

```
>> title('ACF Of The Squared Returns')
```



This figure shows that ,although the returns themselves are largely uncorrelated, the variance process exhibits some correlation.

5.

```
>> [H,pValue,Stat,CriticalValue]=lbqtest(gspc-mean(gspc))
```

```
H =
```

```
logical
```

```
0
```

```
pValue =
```

```
0.0540
```

```
Stat =
```

```
31.0892
```

```
CriticalValue =
```

```
31.4104
```

Result:No significant serial correlation .

```
>> [H,pValue,Stat,CriticalValue]=lbqtest((gspc-mean(gspc)).^2)
```

```
H =
```

```
logical
```

```
1
```

```
pValue =
```

```
0
```

```
Stat =
```

```
471.0269
```

```
CriticalValue =
```

```
31.4104
```

Result:There is significant serial correlation in square

5. Mdl=garch(1,1)

[EstMdl,EstParamCov]=estimate(Mdl,gspc(2:end),'E0',gspc(1))

GARCH(1,1) Conditional Variance Model (Gaussian Distribution):

	Value	StandardError	TStatistic	PValue
Constant	4.3387e-06	8.2029e-07	5.2893	1.2281e-07
GARCH{1}	0.75498	0.021714	34.769	7.0485e-265
ARCH{1}	0.18705	0.017666	10.588	3.3939e-26

EstMdl =

[garch](#) with properties:

Description: "GARCH(1,1) Conditional Variance Model (Gaussian Distribution)"
Distribution: Name = "Gaussian"
P: 1
Q: 1
Constant: 4.33871e-06
GARCH: {0.754984} at lag [1]
ARCH: {0.187049} at lag [1]
Offset: 0

EstParamCov =

1.0e-03 *

0.0000 -0.0000 0.0000
-0.0000 0.4715 -0.2682
0.0000 -0.2682 0.3121

6.sub-sample-test(two parts)

Mdl=garch(1,1)

[EstMdl,EstParamCov]=estimate(Mdl,gspc(2:628),'E0',gspc(1))

Constant	5.1122e-06	1.1812e-06	4.3279	1.5057e-05
GARCH{1}	0.71189	0.031594	22.532	2.0161e-112
ARCH{1}	0.21009	0.026433	7.9478	1.8988e-15

EstMdl =

[garch](#) with properties:

Description: "GARCH(1,1) Conditional Variance Model (Gaussian Distribution)"
Distribution: Name = "Gaussian"
P: 1
Q: 1
Constant: 5.11221e-06
GARCH: {0.711887} at lag [1]
ARCH: {0.210086} at lag [1]
Offset: 0

EstParamCov =

1.0e-03 *

0.0000 -0.0000 0.0000
-0.0000 0.9982 -0.5219
0.0000 -0.5219 0.6987

```
[EstMdl,EstParamCov]=estimate(Mdl,gspc(629:1257),'E0',gspc(629))
```

Constant	3.1443e-06	1.0475e-06	3.0018	0.0026842
GARCH{1}	0.77577	0.029826	26.01	3.8215e-149
ARCH{1}	0.19509	0.027096	7.1998	6.0308e-13

EstMdl =

[garch](#) with properties:

Description: "GARCH(1,1) Conditional Variance Model (Gaussian Distribution)"

Distribution: Name = "Gaussian"

P: 1

Q: 1

Constant: 3.14428e-06

GARCH: {0.775769} at lag [1]

ARCH: {0.195089} at lag [1]

Offset: 0

EstParamCov =

1.0e-03 *

0.0000	-0.0000	0.0000
-0.0000	0.8896	-0.5983
0.0000	-0.5983	0.7342

The subsamples parameters don't change too much.