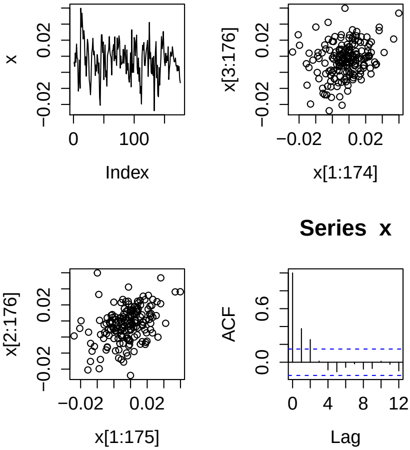
ARMA examples

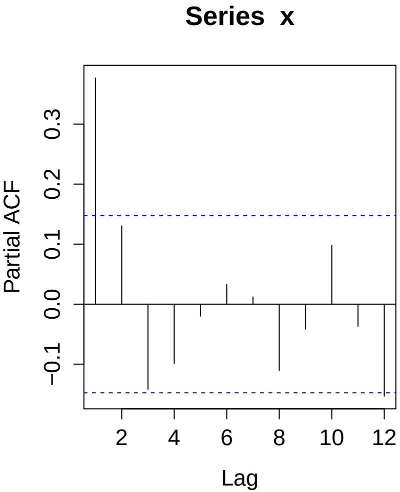
Time series for business

Example: Domestic GNP.

Quarterly DGNP data, lag plots and ACF.



The PACF

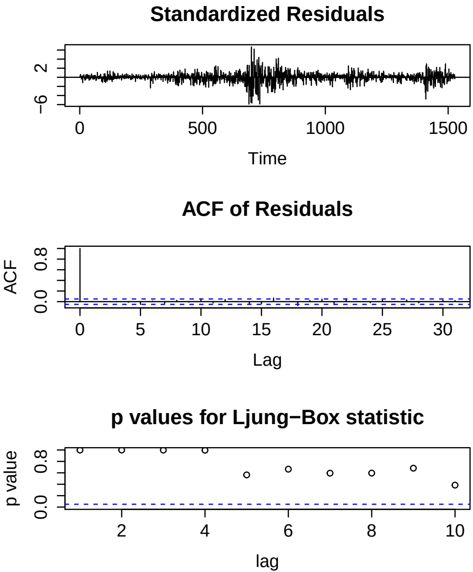


Box test and AR estimation

```
Box.test(x,lag=10,type="Ljung")

Box-Ljung test
data:  x
X-squared = 43.2345, df = 10, p-value =
4.515e-06

m1=ar(x,method="mle")
m1
Call:
ar(x = x, method = "mle")

Coefficients:
      1        2        3
 0.3480   0.1793  -0.1423
Order selected 3  sigma^2 estimated as  9.427e-05
```

```
m2=arima(x,order=c(3,0,0))

m2
Series: x
ARIMA(3,0,0) with non-zero mean

Coefficients:
         ar1     ar2      ar3  intercept
      0.3480  0.1793  -0.1423     0.0077
s.e.  0.0745  0.0778   0.0745     0.0012

sigma^2 estimated as 9.427e-05:  log likelihood=565.84
AIC=-1121.68   AICc=-1121.33   BIC=-1105.83
```

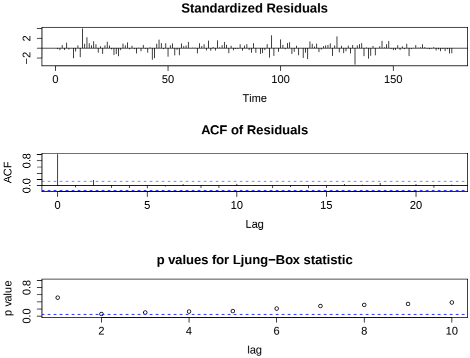
Diagnosis plot



Make prediction

```
predict(m2,8)

$pred
Time Series:
Start = 177
End = 184
Frequency = 1
[1] 0.001236254 0.004555519 0.007454906 0.007958518
[5] 0.008181442 0.007936845 0.007820046 0.007703826
$se
Time Series:
Start = 177
End = 184
Frequency = 1
[1] 0.009709322 0.010280510 0.010686305 0.010688994
[5] 0.010689733 0.010694771 0.010695511 0.010696190
```

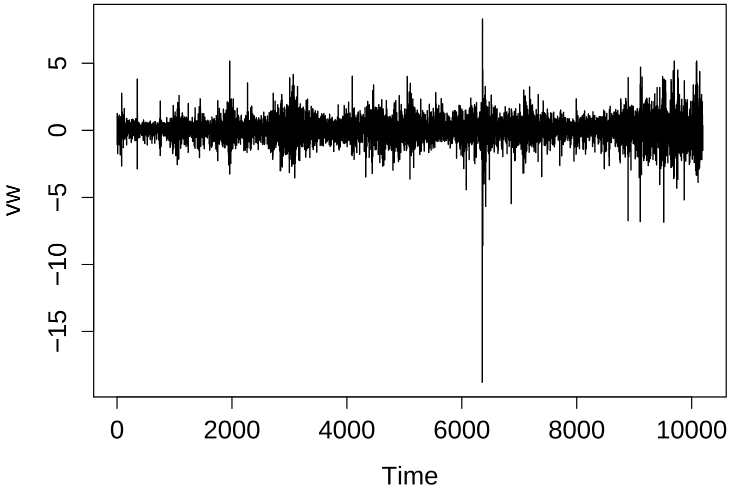
AR(1) fit and residual analysis



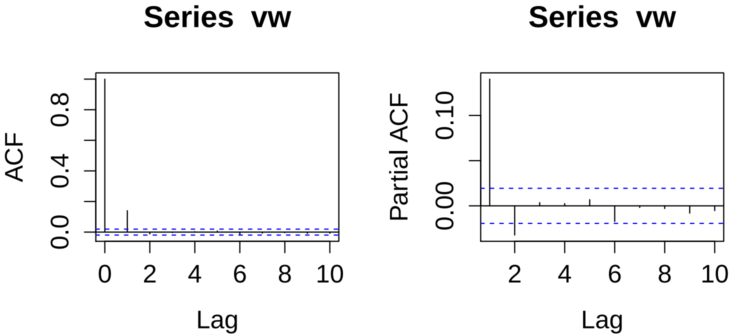
Prediction comparison

```
#Backtest using AR(3)
 backtest(m2,x,150,1)
[1] "RMSE of out-of-sample forecasts"
[1] 0.005280406
[1] "Mean absolute error of out-of-sample forecasts"
[1] 0.00392484

#Backtest using AR(1)
 backtest(m3,x,150,1)
[1] "RMSE of out-of-sample forecasts"
[1] 0.005394823
[1] "Mean absolute error of out-of-sample forecasts"
[1] 0.003973319
```

Example: value weighted index return.



ACF and PACF.



Series vw
ACF
0.0
0.4
0.8
0
2
4
6
8
10
Lag
Series vw
Partial ACF
0.00
0.10
2
4
6
8
10
Lag

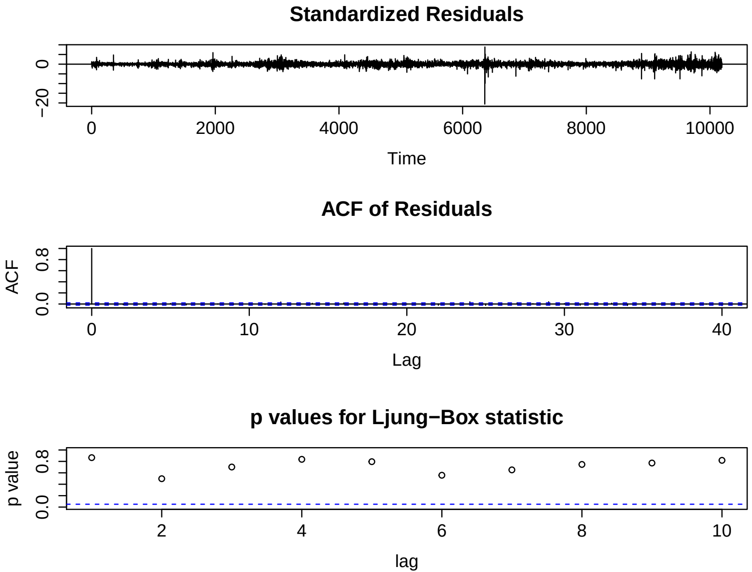
Fit an MA model

```
m1=arima(vw,order=c(0,0,1)) # fits an MA(1) model
 m1  #MA(1)
Call:
arima(x = vw, order = c(0, 0, 1))
Coefficients:
         ma1  intercept
      0.1465  0.0396
s.e.  0.0099  0.0100

sigma^2 estimated as 0.7785: log likelihood = -13188.48, a
```

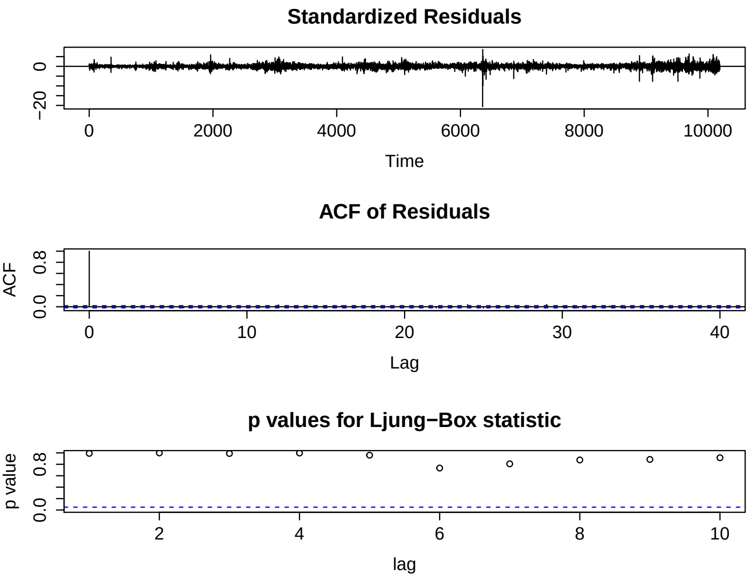
Fit an AR model

```
m2=arima(vw,order=c(2,0,0)) # fits an AR(2) model
m2 #AR(2)
Call:
arima(x = vw, order = c(2, 0, 0))
Coefficients:
         ar1      ar2  intercept
      0.1447  -0.0323     0.0396
s.e.  0.0099   0.0099     0.0098

sigma^2 estimated as 0.7784:  log likelihood = -13187.83, a
```

Diagnosis plot for MA fit



Diagnosis plot for AR fit



Prediction accuracy comparison

```
backtest(m1,vw,10000,1)
[1] "RMSE of out-of-sample forecasts"
[1] 1.689353
[1] "Mean absolute error of out-of-sample forecasts"
[1] 1.324739

backtest(m2,vw,10000,1)
[1] "RMSE of out-of-sample forecasts"
[1] 1.689947
[1] "Mean absolute error of out-of-sample forecasts"
[1] 1.324433
```