R Material for Chapter 12

```
> attach(binjuries.data)

> binjuries.data          ## Bicycle Injury Data
   year injuries
1    1     5696
2    2     5110
3    3     4731
4    4     4585
5    5     4476
6    6     4970
7    7     4991
8    8     4820
9    9     4515
10  10     4227

> reg <- lm(injuries~year)

> summary(reg)

Call:
lm(formula = injuries ~ year)

Residuals:
   Min     1Q Median     3Q    Max
-382.2 -276.3    0.4  230.0  468.6

Coefficients:
            Estimate Std. Error t value Pr(>|t|)         ## Usual LS Fit
(Intercept)  5319.73     219.50  24.236 8.96e-09 ***
year          -92.30      35.38  -2.609   0.0312 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 321.3 on 8 degrees of freedom
Multiple R-squared: 0.4597,     Adjusted R-squared: 0.3922
F-statistic: 6.807 on 1 and 8 DF,  p-value: 0.03118

>library(car)                                  ## Library required for Durbin-Watson Test

> dwt(reg)                                     ## Durbin-Watson Test

 lag Autocorrelation D-W Statistic p-value
   1       0.380236      0.9388191   0.024
 Alternative hypothesis: rho != 0

> diff1 <- rep(0,9)

> for(i in 1:9) {diff1[i] <- injuries[i+1]-.380236*injuries[i]}

> diff1
[1] 2944.176 2787.994 2786.103 2732.618 3268.064 3101.227 2922.242 2682.262
[9] 2510.234

> index1 <- rep(0,9)

> for(i in 1:9) {index1[i] <- year[i+1]-.380236*year[i]}

> index1
[1] 1.619764 2.239528 2.859292 3.479056 4.098820 4.718584 5.338348 5.958112
[9] 6.577876
```

```
> reg2 <- lm(diff1~index1)

> summary(reg2)

Call:
lm(formula = diff1 ~ index1)

Residuals:
   Min     1Q Median     3Q    Max
-255.1 -142.0 -106.6  109.9  408.6

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  3015.08     214.46  14.059 2.18e-06 ***
index1        -37.97      48.74  -0.779    0.461
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 234 on 7 degrees of freedom
Multiple R-squared: 0.0798,     Adjusted R-squared: -0.05166
F-statistic: 0.607 on 1 and 7 DF,  p-value: 0.4614

> dwt(reg2)
 lag Autocorrelation D-W Statistic p-value
   1       0.3343872      1.161235   0.048
 Alternative hypothesis: rho != 0


> diff2 <- rep(0,8)
> for(i in 1:8) {diff2[i] <- diff1[i+1] -.3343872*diff1[i] }
> diff2
[1] 1803.499 1853.834 1800.981 2354.311 2008.428 1885.231 1705.102 1613.320

> index2 <- rep(0,8)
> for(i in 1:8) {index2[i] <- index1[i+1] -.3343872*index1[i]}

> reg3 <- lm(diff2~index2)

> summary(reg3)

Call:
lm(formula = diff2 ~ index2)

Residuals:
    Min     1Q  Median     3Q    Max
-174.43 -128.10  -98.62   70.20  463.32

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  2074.65     286.92   7.231 0.000355 ***
index2        -62.57      87.45  -0.715 0.501220
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 233.8 on 6 degrees of freedom
Multiple R-squared: 0.0786,     Adjusted R-squared: -0.07496
F-statistic: 0.5118 on 1 and 6 DF,  p-value: 0.5012

> dwt(reg3)
 lag Autocorrelation D-W Statistic p-value
   1       0.1772833      1.469727   0.184
 Alternative hypothesis: rho != 0
```

```
> mdr.data                    ## State of Florida Traffic Deaths per 100 Million Vehicle Miles
                              ## Mileage Death Rate
    year  MDR
1   1986 3.29
2   1987 3.11
3   1988 3.00
4   1989 2.79
5   1990 2.68
6   1991 2.22
7   1992 2.18
8   1993 2.27
9   1994 2.25
10  1995 2.23
11  1996 2.16
12  1997 2.11
13  1998 2.11
14  1999 2.07
15  2000 2.00
16  2001 1.76
17  2002 1.76
18  2003 1.71
19  2004 1.66
20  2005 1.76

> reg <- lm(MDR~year)
> summary(reg)

Call:
lm(formula = MDR ~ year)

Residuals:
     Min       1Q   Median       3Q      Max
-0.37644 -0.06785  0.01465  0.08020  0.31529

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) 153.223827  13.674806   11.21 1.51e-09 ***
year         -0.075654   0.006853  -11.04 1.91e-09 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.1767 on 18 degrees of freedom
Multiple R-squared: 0.8713,      Adjusted R-squared: 0.8642
F-statistic: 121.9 on 1 and 18 DF,  p-value: 1.909e-09

> dwt(reg)
 lag Autocorrelation D-W Statistic p-value
   1       0.6125808     0.5097586       0          ## a very significant D-W test result
 Alternative hypothesis: rho != 0

> resdif1 <- rep(0,19)
> for(i in 1:19) {resdif1[i] <- MDR[i+1] - .6125808*MDR[i]}       ##MDR differences
> resdif1
 [1] 1.0946092 1.0948737 0.9522576 0.9708996 0.5782835 0.8200706 0.9345739
 [8] 0.8594416 0.8516932 0.7939448 0.7868255 0.8174545 0.7774545 0.7319577
[15] 0.5348384 0.6818578 0.6318578 0.6124868 0.7431159

> yeardif1 <- rep(0,19)
> for(i in 1:19) {yeardif1[i] <- year[i+1] - .6125808*year[i]}    ## year differences
> yeardif1
 [1] 770.4145 770.8020 771.1894 771.5768 771.9642 772.3516 772.7390 773.1265
 [9] 773.5139 773.9013 774.2887 774.6761 775.0636 775.4510 775.8384 776.2258
[17] 776.6132 777.0007 777.3881
```

```
> reg2 <- lm(resdif1~yeardif1)

> summary(reg2)

Call:
lm(formula = resdif1 ~ yeardif1)

Residuals:
     Min       1Q   Median       3Q      Max
-0.33225 -0.01485  0.01307  0.04780  0.13198

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  43.5219     8.9768   4.848 0.000151 ***
yeardif1     -0.0552     0.0116  -4.759 0.000182 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.1073 on 17 degrees of freedom
Multiple R-squared: 0.5712,     Adjusted R-squared: 0.546
F-statistic: 22.65 on 1 and 17 DF,  p-value: 0.0001821

> dwt(reg2)
 lag Autocorrelation D-W Statistic p-value
   1       0.0779918       1.705385   0.372          ## Now a non-significant D-W Test result
 Alternative hypothesis: rho != 0


> res2005 <- 1.76 - (112.338 - .0552*2005)        ## 2005 residual
> res2005
[1] 0.098

> F2006 <- (112.338 - .0552*2006) +.6125808*.098  ## 2006 forecast

> F2006
[1] 1.666833
```

```
> ecom.data
   time quart amt
1     1     4 0.6
2     2     1 0.8
3     3     2 0.8
4     4     3 0.9
5     5     4 1.2
6     6     1 1.1
7     7     2 1.0
8     8     3 1.1
9     9     4 1.4
10   10     1 1.4
11   11     2 1.3
12   12     3 1.4
13   13     4 1.8
14   14     1 1.8
15   15     2 1.7
16   16     3 1.8
17   17     4 2.1
18   18     1 2.1
19   19     2 2.0
20   20     3 2.1
21   21     4 2.5
22   22     1 2.5
23   23     2 2.3
24   24     3 2.4
25   25     4 2.9
26   26     1 2.9
27   27     2 2.7
28   28     3 2.8
29   29     4 3.4
30   30     1 3.3
31   31     2 3.1
32   32     3 3.2
33   33     4 3.9

> reg1 <- lm(amt~time)

> summary(reg1)

Call:
lm(formula = amt ~ time)

Residuals:
    Min      1Q  Median      3Q     Max
-0.2417 -0.1519  0.0123  0.1011  0.4706

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.50000    0.06236   8.018 4.71e-09 ***
time         0.08877    0.00320  27.738  < 2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.1751 on 31 degrees of freedom
Multiple R-squared: 0.9613,     Adjusted R-squared:  0.96
F-statistic: 769.4 on 1 and 31 DF,  p-value: < 2.2e-16
```

```
> fquart <- factor(quart)

> reg2 <- lm(amt~time +fquart)

> summary(reg2)

Call:
lm(formula = amt ~ time + fquart)

Residuals:
     Min       1Q    Median       3Q      Max
-0.17097 -0.05565 -0.01452  0.03065  0.27097

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.558468   0.044812  12.462 6.07e-13 ***
time         0.089315   0.001788  49.947  < 2e-16 ***
fquart2     -0.214315   0.048808  -4.391 0.000146 ***
fquart3     -0.203629   0.048906  -4.164 0.000271 ***
fquart4      0.123185   0.047435   2.597 0.014821 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.09755 on 28 degrees of freedom
Multiple R-squared: 0.9891,      Adjusted R-squared: 0.9876
F-statistic: 637.4 on 4 and 28 DF,  p-value: < 2.2e-16

> dwt(reg2)
 lag Autocorrelation D-W Statistic p-value
   1       0.3071253      1.000488   0.004
 Alternative hypothesis: rho != 0
```