Assignment #3 _ Econometrics

Obaid Masih

5.13

<u>Question 5.5 Pg 201</u>

a)

Increasing Crime per Capita rate by 1 unit and keeping all other variables constant will decrease house Value by $183

Increasing NITOX by 1 unit and keeping all other variables constant will decrease house Value by $22,810

Increasing Room by 1 unit and keeping all other variables constant will increase house Value by $6,371

Increasing AGE by 1 unit and keeping all other variables constant will decrease house Value by $47

Increasing DIST by 1 unit and keeping all other variables constant will decrease house Value by $1,335

Increasing ACCESS by 1 unit and keeping all other variables constant will increase house Value by $272

Increasing TAX by 1 unit and keeping all other variables constant will decrease house Value by $12

Increasing PTRATIO by 1 unit and keeping all other variables constant will decrease house Value by $1176

b)

observations 506 # of parameters or K= 9

CRIME critical t value (0.975, 497 DF) = 1.96

- 0.1834 + 1.96*0.0365 = -0.1835 + 0.0715 = -0.1119

- 0.1834 - 1.96*0.0365 = -0.1835 - 0.0715 = -0.255

[-0.255,-0.1119]

Access critical t value (0.975, 497 DF) = 1.96

0.2723 + 1.96*0.0723 = 0.2723 + 0.141 = 0.4133

0.2723 – 1.96 *0.0723 = 0.2723 -0.141 = 0.131

[0.131,0.4133]

c)

Ho → B(room) = 7

Hk → B(room) is not 7

critical t value (0.975, 497 DF) = 1.96 or -1.96

t value for Ho = 6.37 -7 /0.3924 = -1.592

-1.96 is smaller than -1.592 so we CANNOT reject HO

D)

Increasing the PT by 1, rate decreases by -1.17

decreasing the PT by 10, the increase should be by 10000$ or 1

H0 = $\beta 2 \geq -1$

H1 = $\beta 2 < -1$

t = (-1.17 + 1)/0.13

t = -1.30

|t| = 1.30

tc = 1.60

|t| < tc

hence, we cannot reject the null hypothesis.

5.9 PG 203

a) delta Wage /delta Exp = B3 + 2(B4) exp

Pluggining in data from table 5.9 we get the following

$dWAGE/dEXPER$ = β3 + β4EXPER

Marginal effect = 0.68 + 2(-0.01)Exp

0.68 -0.02Exp

b) B2 which is parameter of Education is expected to be positive because in our economy higher the education and higher the pay.

B3 which is parameter of Experience is expected to be positive because the more experience makes you more valuable Atleast in the beginning as you are proven to be more reliable.

B4 which is parameter of experience square is expected to be negative because after certain number of years your wage will hit plateau.

c) Marginal effect of experience on Wage which is also the first derivative of Exp can show us at what point wage will start to decline.

D for Delta

W for Wage

E for experience

DW /DE = B3 + 2*B4*E

When marginal effect is 0 then experience starts to give diminishing returns. MEANING rate of change of Wage wit respect to Experience has started to be negative.

0 = B3 +2*B4*E

-B3/(2*B4) = E

d)

Wage = -13.43 + 2.27Educ + 0.68Experience -0.01Exp^2

95% interval for marginal effect of Exp on wages

DF= 1000-4=996

Critical t value (0.975,996) = 1.96

DW/DEduc = 2.27

2.27 + (1.96)*(0.1394) = 2.27 + 0.273 = 2.54

2.27 – (1.96)*(0.1394) = 2.27 – 0.273 = 1.997

[1.997,2.54]

Wage = -13.43 + 2.27Educ + 0.68Experience -0.01Exp^2

95% interval for marginal effect of Exp on wages

DF= 1000-4=996

Critical t value (0.975,996) = 1.96

DW/DExp = 0.68 -0.02EXP

@ Exp =4   marginal is= 0.6

Find SE for (B3 -B4*4)

Sqrt(Var(b3) + var(b4) -2*4*COV(B3,B4))

SQRT (0.01 + 0 -8*(0)) = 0.1

INTERVAL will be   0.6 + 0.1*1.96 = 0.796

0.6 – 0.196 = 0.404

[0.40,0.796]

Wage = -13.43 + 2.27Educ + 0.68Experience -0.01Exp^2

95% interval for marginal effect of Exp on wages

DF= 1000-4=996

Critical t value (0.975,996) = 1.96

DW/DExp = 0.68 -0.02EXP

@ Exp =25   marginal is= 0.18

Find SE for (B3 -B4*4)

Sqrt(Var(b3) + 4var(b4) -2*25*COV(B3,B4)) = 0.0274

INTERVAL will be   0.18 + 0.0274*1.96 = 2.337

0.18 – 0.0274*1.96 = 0.126

[0.126,2.337]

Above two intervals show that as experience increases then rate of change Wage with Experience or marginal effect starts to diminish.

5.12

Question is solved in R studio . Complete code is shown at the end

a)   Quantity is expected to be negative as the wholesale rule goes higher the volume and more the discount. So price should decrease

Quality is always associated with higher price. So that is expected to be positive.

Trend goes from 1984 to 1991. These are the epidemic years of cocaine. Which means that supply increased with every year. Assuming demand remained stable then price should decrease.

b) results are as follows: printed from R studio

```
Coefficients:
             Estimate Std. Error t value Pr(>|t|)    
(Intercept) 90.84669    8.58025  10.588 1.39e-14 ***
quant       -0.05997    0.01018  -5.892 2.85e-07 ***
qual         0.11621    0.20326   0.572   0.5700    
trend       -2.35458    1.38612  -1.699   0.0954 .  
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 20.06 on 52 degrees of freedom
Multiple R-squared:  0.5097,	Adjusted R-squared:  0.4814 
F-statistic: 18.02 on 3 and 52 DF,  p-value: 3.806e-08
```

Final equation is as follows:

Price = 90.84 -0.05997QUANT+0.1162QUAL-2.354TREND

Results are exactly as expected.

c) R^2 is 0.50 9 meaning that 50.9% of variation is explained within the model jointly by the 3 variables.

(d) for the given hypothesis,

$H_0 = \beta_2 \geq 0$

$H_1 = \beta_2 < 0$ Critical T value for this is $t = -1.645$

$se(\beta_2) = 0.01018$

given, $t = (-0.0599 - 0)/0.01018$

$t = -5.88$

Since t value is less than -1.645 so HO can be rejected

e)

$H_0 = \beta_3 \leq 0$

$H_1 = \beta_3 > 0$ Critical t value for this is 1.645

$se(\beta_3) = 0.203$

$t = (0.1162 - 0)/ 0.203$

$t = 0.572$

t value found is less than 1.645 so HO cannot be rejected.

f)

Average annual change in cocaine is the marginal effect.

D price / D Time = -2.35

This means that price is decreasing with time. Data shows that Cocaine epidemic is fading out as we progress from 1984 to 1991

5.13

Question is solved in R studio. Complete code is shown at the end

a)..

```
Coefficients:
              Estimate Std. Error t value Pr(>|t|)    
(Intercept) -41947.696   6989.636  -6.001 2.67e-09 ***
sqft            90.970      2.403  37.855  < 2e-16 ***
age           -755.041    140.894  -5.359 1.02e-07 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

(i) Price = -41947.7 + 90.97*SQFT -755.04*AGE

Increasing SQFT by 1 unit will increase the price by $90.97

Increasing AGE by 1 unit will decrease the price by $755.04

(ii)

95% interval for marginal effect D price /D SQFT

D price /D sqft = 90.97

Critical value for T = 1.96 @ 0.975 and more than 1000 degrees of freedom

Inter1 <- 90.97 + (2.403*1.96)

print(Inter1)

Inter2 <- 90.97 -(2.403*1.96)

print(Inter2)

[86.26, 95.67]

(iii)

HO is B3 >-1000 and H1 B3 < 1000

critical t value is -1.645

tvalhO <-(-755.041 - (-1000))/140.894

print(tvalhO)

value is 1.7386

1.7386 is more than -1.645 so HO cannot be rejected

Part b

model2 <- lm(price~sqft+age +sqsqft + sqage, data=context)

```
Coefficients:
              Estimate Std. Error t value Pr(>|t|)    
(Intercept)  1.701e+05  1.043e+04  16.310  < 2e-16 ***
sqft        -5.578e+01  6.389e+00  -8.731  < 2e-16 ***
age         -2.798e+03  3.051e+02  -9.170  < 2e-16 ***
sqsqft       2.315e-02  9.642e-04  24.013  < 2e-16 ***
sqage        3.016e+01  5.071e+00   5.948 3.68e-09 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Price = 170100 -55.78*SQFT -2798.0*AGE +0.0231*SQSQFT + 30.16*SQAGE

(i)

Marginal effect for Price/SQFT = -55.78 + 2*0.0231*SQFT

SQFT = min(context$sqft)

mareff <- -55.78 +(2*0.02315*SQFT)

print(mareff)

-25.129

SQFT = max(context$sqft)

mareff <- -55.78 +(2*0.02315*SQFT)

print(mareff)

309.8511

SQFT = 2300

mareff <- -55.78 +(2*0.02315*SQFT)

print(mareff)

50.71

They seem realistic as impact of sqft on price increases after a certain number of sqft. It's not a perfect linear relation. As houses are small and we add SQFT then pass a certain limit only then marginal effect becomes positive and increase drastically as it approaches towards bigger numbers of SQFT

(ii)

Marginal effect for Price/AGE = -2798 + 2*30.16*AGE

AGE = min(context$age)

mareff <- -2798 +(2*30.16*AGE)

print(mareff)

-2737.68

AGE = max(context$age)

mareff <- -2798 +(2*30.16*AGE)

print(mareff)

2027

AGE = 20

mareff <- -2798 +(2*30.16*AGE)

print(mareff)

-1591.6

They seem realistic. It starts as negative as some years pass by it become positive. Then with time the value appreciates and prices increase.

(iii) 95% Interval

B2 + 2*B3*SQFT

SQFT = 2300

mareff <- -55.78 +(2*0.02315*SQFT)

print(mareff)

50.71

Find standard error.

Cov matric from R is shown below

```
              (Intercept)          sqft           age        sqsqft          s
qage
(Intercept)  1.088320e+08 -6.110570e+04 -1.340396e+06  8.152671e+00  1.601762
e+04
sqft        -6.110570e+04  4.082499e+01  3.205761e+02 -5.870334e-03 -3.547411
e+00
age         -1.340396e+06  3.205761e+02  9.309548e+04 -3.955193e-02 -1.434561
e+03
sqsqft       8.152671e+00 -5.870334e-03 -3.955193e-02  9.296015e-07  4.459434
e-04
sqage        1.601762e+04 -3.547411e+00 -1.434561e+03  4.459434e-04  2.571554
e+01
```

Standard error calculated by R is 2.54 – Code shown below in code section

Critical value of T to be 1.96

Inter1 = mareff + SE*1.96

print(Inter1)

Inter2 = mareff - SE*1.96

print(Inter2)

[45.71,55.70]

(iv)

HO D price / D age >= -1000

H1 D Price /D age < -1000

critical t value is -1.645

SE(B3 +2*20*B5) = 139.51 calculated from R studio

tvalho <- (-1591.6 + 1000)/SE

print(tvalho)

-4.23

Since -4.23 is less than -1.645 so HO can be rejected.

Part C

model3 <- lm(price~sqft+age +sqsqft + sqage + sq_age, data=context)

```
               Estimate Std. Error t value Pr(>|t|)
(Intercept)  1.146e+05  1.214e+04   9.437  < 2e-16 ***
sqft        -3.073e+01  6.898e+00  -4.455 9.27e-06 ***
age         -4.420e+02  4.106e+02  -1.077    0.282
sqsqft       2.218e-02  9.425e-04  23.537  < 2e-16 ***
sqage        2.652e+01  4.939e+00   5.370 9.66e-08 ***
sq_age      -9.306e-01  1.124e-01  -8.277 3.72e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Price = 114600 – 30.7* SQFT -442*AGE+0.021*SQFT^2+26.52*AGE^2 -0.09306*SQFT_AGE

(i)

Marginal effect of DW/SSQT

B2 + 2B4+ AGE*B6

MIN_SQFT = min(context$sqft)

AGE=20

me1 <- -30.7 + 2*0.02218*MIN_SQFT + AGE*(-0.93)

print(me1)

-19.93

MAX_SQFT = max(context$sqft)

AGE=20

me1 <- -30.7 + 2*0.02218*MAX_SQFT + AGE*(-0.93)

```
print(me1)
```

301.01

```
Val_SQFT = 2300
AGE=20
me1 <- -30.7 + 2*0.02218*Val_SQFT +  AGE*(-0.93)
print(me1)
```

52.728

(ii)

Marginal effect of D W/D AGE

B3 + 2*B5*AGE + B6*SQFT

```
SQFT = 2300
min_age = min(context$age)
me2 = -442 + (2*26.52*min_age) -0.93*SQFT
print(me2)
```

-2527

```
SQFT = 2300
max_age = max(context$age)
me2 = -442 + (2*26.52*max_age) -0.93*SQFT
print(me2)
```

1662

```
SQFT = 2300
val_age = 20
me2 = -442 + (2*26.52*val_age) -0.93*SQFT
print(me2)
```

-1520

(iii)

Marginal effect of DW/SSQT

B2 + 2B4 SQFT+ AGE*B6

Val_SQFT = 2300

AGE=20

me1 <- -30.7 + 2*0.02218*Val_SQFT + AGE*(-0.93)

print(me1)

52.728

find standard error to find the interval

get the equation in the format of Betas only

SE (B2 +4600B4+20B6) = 2.22

i1 = me1 + SE1*1.96

print(i1)

i2 = me1 - SE1*1.96

print(i2)

[48.3,57.08]

(iv)

Marginal effect of D W/D AGE

B3 + 2B5 + B6*SQFT

SQFT = 2300

age = 20

me2 = -442 + (2*26.52*age) -(0.93*SQFT)

print(me2)

-1520.2

SE(B3+2B5*age+b6*sqft) = 135.63

k = -1000

tval3 = (me2 - k)/SE3

print(tval3)

-3.83

T critical value = 1.65

$|t| > t_c$

Therefore, we can reject the null hypothesis that for a 20-year-old house, with an area of 2300 sqft, increasing a year would decrease the price by 1000$.

******************* Code for 5.12 ***********************

```
## Drop everything
rm(list=ls(all=TRUE))

## Use the data.table library for fast importing and manipulation
library(data.table)

## Read the DATA
context <- fread("coc.csv")
## get the summary of data and get familiar with it
summary(context)
head(context)

model <- lm(price~quant +qual +trend, data=context)
summary(model)
```

******************* Code for 5.13 ***********************

```
## Drop everything
rm(list=ls(all=TRUE))
```

```
## Use the data.table library for fast importing and manipulation
library(data.table)

## Read the data
context <- fread("BR2.csv")
## get the summary of data and get familiar with it
summary(context)
head(context)


## part a
model <- lm(price~sqft+age, data=context)
summary(model)

# 95% INTERVAL FOR b1
Inter1 <- 90.97 + (2.403*1.96)
print(Inter1)
Inter2 <- 90.97 -(2.403*1.96)
print(Inter2)

## HO is B3 >-1000  and H1 B3 < 1000
## critical t value is -1.645

tvalhO <-(-755.041 - (-1000) )/140.894
print(tvalhO)
## val is 1.7386
## val is more than -1.645 so HO cannot be rejected

#########PART B
```

```
sqsqft= context$sqft^2

sqage = context$age^2

model2 <- lm(price~sqft+age +sqsqft + sqage, data=context)

summary(model2)


## find marginal effect Price / SQ

##  B2 + 2*B3*SQFT

SQFT = min(context$sqft)

mareff <- -55.78 +(2*0.02315*SQFT)

print(mareff)

## -25.129

SQFT = max(context$sqft)

mareff <- -55.78 +(2*0.02315*SQFT)

print(mareff)

##309.8511

SQFT = 2300

mareff <- -55.78 +(2*0.02315*SQFT)

print(mareff)

## 50.71


## find marginal effect Price / age

##  B3 + 2*B5*AGE

AGE = min(context$age)

mareff <- -2798 +(2*30.16*AGE)

print(mareff)

## -2737.68

AGE = max(context$age)

mareff <- -2798 +(2*30.16*AGE)

print(mareff)
```

```
## 2027

AGE = 20

mareff <- -2798 +(2*30.16*AGE)

print(mareff)

## -1591.6


# iii

##  B2 + 2*B3*SQFT

SQFT = 2300

mareff <- -55.78 +(2*0.02315*SQFT)

print(mareff)

## 50.71

## find standard error for (B2 + 2b3*SQFT)

sum_model2 = vcov(model2)


var1 = sum_model2[2,2]

print(var1)

var2 = sum_model2[4,4]

print(var2)

var3 = sum_model2[4,2]

print(var3)

temp = var1 + 4600*4600*var2 +2*4600*var3

SE <- sqrt(temp)

print(SE)


Inter1 = mareff + SE*1.96

print(Inter1)

Inter2 = mareff - SE*1.96

print(Inter2)
```

```
##############################################
### D Price /D Age  = B3 + a* B5 * AGE
AGE = 20
mareff <- -2798 +(2*30.16*AGE)
print(mareff)
## -1591.6
## HO   D price / D age >= -1000
### H1  D Price /D age < -1000

## critical t value is -1.645

## find SE(B3 +2*20*B5)
## again use sum_model2[]
var1 = sum_model2[3,3]
print(var1)
var2 = sum_model2[5,5]
print(var2)
var3 = sum_model2[5,3]
print(var3)
temp = var1 + 1600*var2 +2*40*var3
SE <- sqrt(temp)
print(SE)
tvalho <- (-1591.6 + 1000)/SE
print(tvalho)
## -2.13394
## HO can be rejecetd since t

###################################################
```

```
############ Part c

sq_age = context$sqft * context$age
model3 <- lm(price~sqft+age +sqsqft + sqage + sq_age, data=context)
summary(model3)
sum_model3 = vcov(model3)

### part (i)
## Marginal effect of DW/SSQT
## B2 + 2B4+ AGE*B6
## PART (i)
MIN_SQFT = min(context$sqft)
AGE=20
me1 <- -30.7 + 2*0.02218*MIN_SQFT +  AGE*(-0.93)
print(me1)
## -19.93

MAX_SQFT = max(context$sqft)
AGE=20
me1 <- -30.7 + 2*0.02218*MAX_SQFT +  AGE*(-0.93)
print(me1)
## 301.01

Val_SQFT = 2300
AGE=20
me1 <- -30.7 + 2*0.02218*Val_SQFT +  AGE*(-0.93)
print(me1)
##52.728
```

```
##### pART (ii)

### part (i)

## Marginal effect of D W/D AGE

## B3 + 2B5 + B6*SQFT

SQFT = 2300

min_age = min(context$age)

me2 = -442 + (2*26.52*min_age) - (0.93*SQFT)

print(me2)

### -2527


SQFT = 2300

max_age = max(context$age)

me2 = -442 + (2*26.52*max_age) -0.93*SQFT

print(me2)

### 1662


SQFT = 2300

val_age = 20

me2 = -442 + (2*26.52*val_age) -0.93*SQFT

print(me2)

##-1520


### Part (iii)

## Marginal effect of DW/SSQT

## B2 + 2B4 SQFT+ AGE*B6


Val_SQFT = 2300

AGE=20

me1 <- -30.7 + 2*0.02218*Val_SQFT +  AGE*(-0.93)
```

```
print(me1)

## 52.728


## find standard error to find the interval

## get the equation in the format of Betas only

## ( B2 +4600B4+20B6)^2

##  B2.b2 + 4600B4.B2 + 20.b6.b2 + 4600b4.B2 + 4600*4600*B4.B4 + 4600.B4.20.B6

##  20B6.B2 + 20.4600.B4.B6 + 20.20.b6.b6

##--- concise equation becomes

##  Var(B2) + 9200.cov(B4,B2) + 40.COV(B6,B2) + (4600)^2.VAR(B4) + 2.20.4600. COV(B4,B6)

### + 400.var(b6)

varB2 = sum_model3[2,2]

print(varB2)

varb4 = sum_model3[4,4]

print(varb4)

varB6 = sum_model3[6,6]

print(varB6)

covB4.B2 = sum_model3[4,2]

print(covB4.B2)

covb6.b2 = sum_model3[6,2]

print(covb6.b2)

covb4.b6 = sum_model3[6,4]

print(covb4.b6)

temp = varB2 + 400*varB6 + 4600*4600*varb4 + 2*4600*covB4.B2 + 40*covb6.b2+ 20*4600*covb4.b6

SE1 <- sqrt(temp)

print(SE1)

## 95% INTERVAL

i1 = me1 + SE1*1.96

print(i1)
```

```
i2 = me1 - SE1*1.96

print(i2)


#######Part (iv)

### D pRICE / D  age

## Marginal effect of D W/D AGE

## B3 + 2B5 + B6*SQFT

SQFT = 2300

age = 20

me2 = -442 + (2*26.52*age) -(0.93*SQFT)

print(me2)

### H0 is D price /D age >= -1000

### H1 is D price /D age < - 1000

#### Find the standard error for ( B3 + 2*20*B5+2300*B6)

### we will use sum_model3 to find variances and covariances

varB3 =  sum_model3[3,3]

print(varB3)

varB5 = sum_model3[5,5]

print(varB5)

varB6 = sum_model3[6,6]

print(varB6)

covB3.B5 =   sum_model3[3,5]

print(covB3.B5)

covB3.B6 = sum_model3[3,6]

covB5.b6 =  sum_model3[5,6]

#### finding stanndard error of (B3 +40B5 +2300B6)^2

te <- varB3 + 40*40*varB5 + 2300*2300*varB6 + 80*covB3.B5 + 4600*covB3.B6 + 80*2300*covB5.b6

SE3 = sqrt(te)

print(SE3)
```

```
### finding t val \

k = -1000

tval3 = (me2 - k)/SE3

print(tval3)
```