Assignment 1

Pizza Shop's manager would like to estimate the company's cost function by using the following observed data under different level of production:

Cost (Baht)	No. of Pizza	Mgmt Style
410,000	4,000	0
600,000	5,000	0
700,000	6,000	0
830,000	7,000	0
940,000	8,000	0
920,000	9,000	0
1,000,000	10,000	0
1,020,000	11,000	1
1,110,000	12,000	1
1,190,000	13,000	1
1,390,000	14,000	1
1,610,000	15,000	1

(a) Estimate linear cost function using ordinary least squares (OLS) method

$$TC_i = \beta_0 + \beta_1 Q_i + e_i$$

where TC_i is total cost (baht)
Q_i is number of pizza
e_i is error term

Evaluate and interpret estimated result.

```
. reg TC Q

      Source |       SS           df       MS      Number of obs   =        12
-------------+----------------------------------   F(1, 10)        =    161.82
       Model |  1.1332e+12         1  1.1332e+12   Prob > F        =    0.0000
    Residual |  7.0030e+10        10  7.0030e+09   R-squared       =    0.9418
-------------+----------------------------------   Adj R-squared   =    0.9360
       Total |  1.2033e+12        11  1.0939e+11   Root MSE        =     83684

------------------------------------------------------------------------------
          TC |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           Q |   89.02098   6.997982    12.72   0.000      73.4285    104.6135
       _cons |   130967.4   70733.87     1.85   0.094    -26637.52    288572.3
------------------------------------------------------------------------------

. mat b1=e(b)

. sca b11=el(b1,1,1)

. predict TC1, xb
```

```
(3 missing values generated)

. g AC1=TC1/Q
(3 missing values generated)

. g MC1=b11
```

(b) Estimate cubic cost function using OLS method

$$TC_i = \beta_0 + \beta_1 Q_i + \beta_2 Q_i^2 + \beta_3 Q_i^3 + e_i$$

Evaluate and interpret estimated result, compare estimated result of cubic cost function with linear cost function in (a) and plot graph of total cost (TC), average cost (AC) and marginal cost (MC) from the two estimated results (a) and (b).

```
. g Q2=Q^2
(3 missing values generated)

. g Q3=Q^3
(3 missing values generated)

. reg TC Q Q2 Q3

      Source |       SS           df       MS      Number of obs   =        12
-------------+----------------------------------   F(3, 8)         =    597.77
       Model |  1.1979e+12         3  3.9931e+11   Prob > F        =    0.0000
    Residual |  5.3440e+09         8   667993921   R-squared       =    0.9956
-------------+----------------------------------   Adj R-squared   =    0.9939
       Total |  1.2033e+12        11  1.0939e+11   Root MSE        =     25846

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          TC |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           Q |   638.9399   61.44377    10.40   0.000     497.2504    780.6295
          Q2 |  -.0644883   .0068806    -9.37   0.000    -.0803551   -.0486215
          Q3 |   2.31e-06   2.40e-07     9.63   0.000     1.76e-06    2.87e-06
       _cons |   -1273216   168309.6    -7.56   0.000     -1661339   -885093.6
------------------------------------------------------------------------------

. mat b2=e(b)

. sca b20=el(b2,1,4)

. sca b21=el(b2,1,1)

. sca b22=el(b2,1,2)

. sca b23=el(b2,1,3)

. predict TC2, xb
(3 missing values generated)

. g AC2=TC2/Q
(3 missing values generated)

. g MC2=b21+2*b22*Q+3*b23*Q2
(3 missing values generated)

. g AC=TC/Q
(3 missing values generated)
```
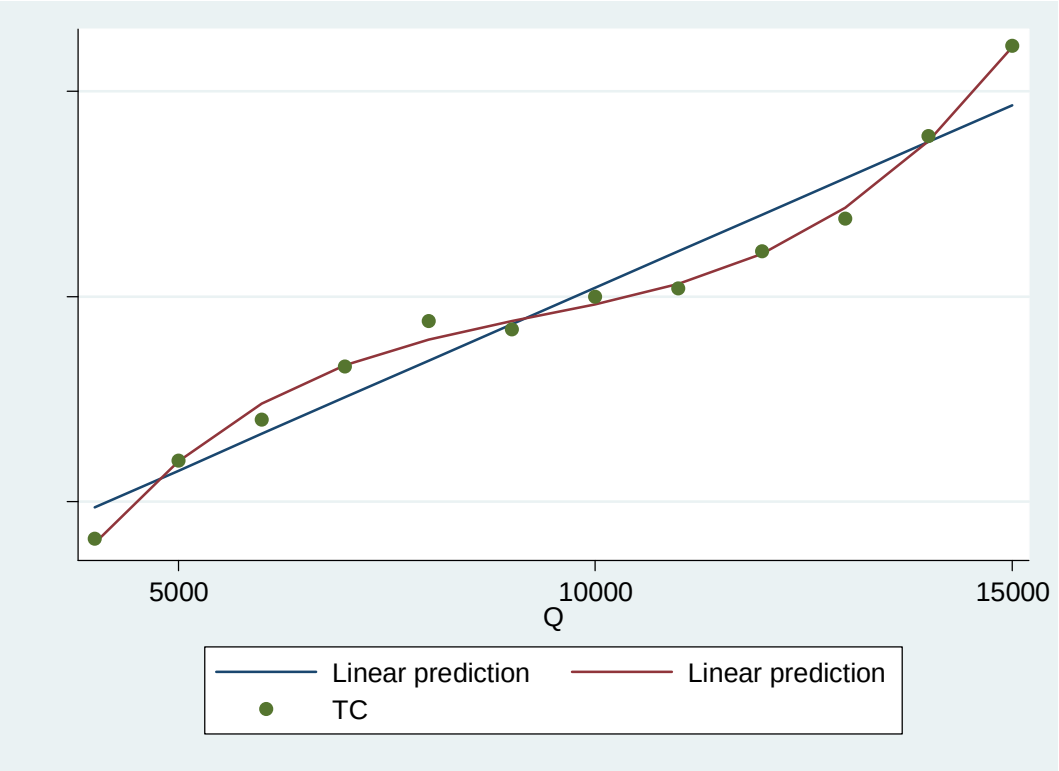
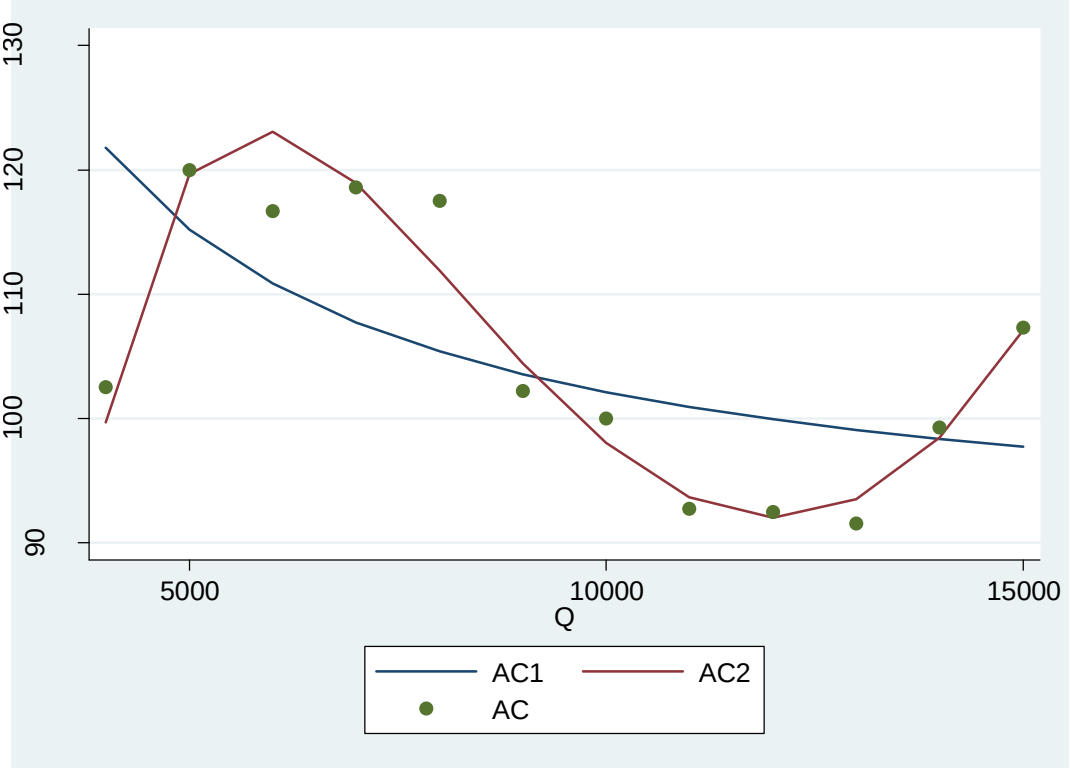
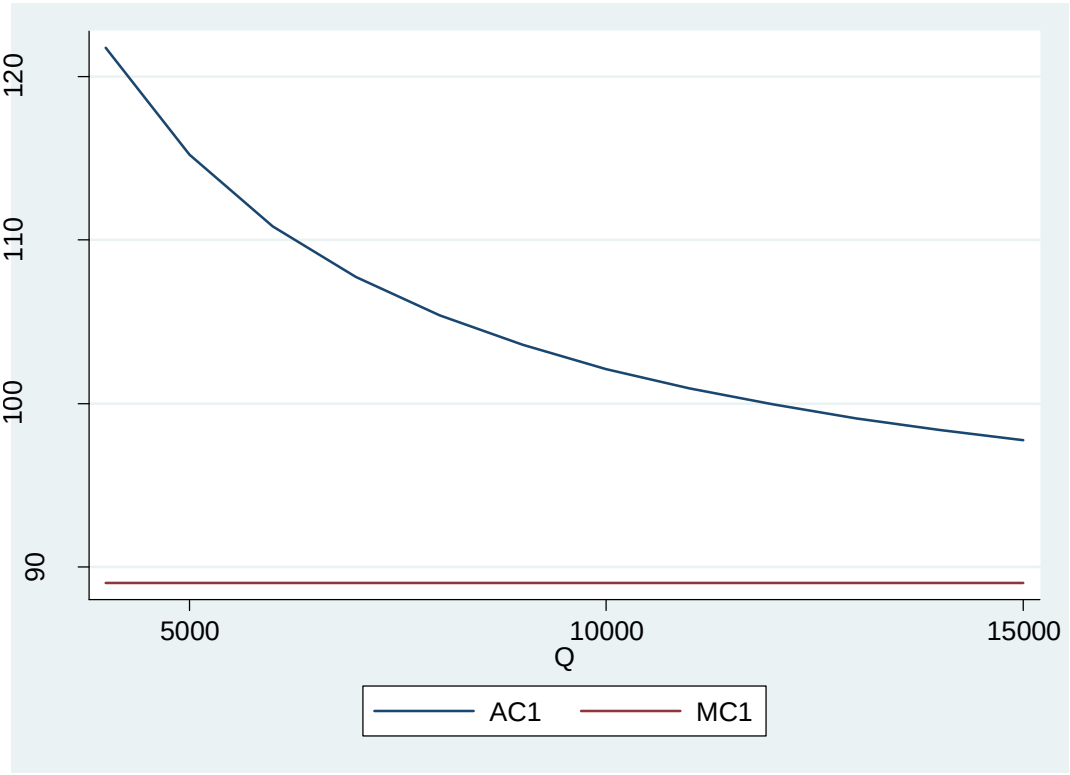

```
. tw (line TC1 TC2 Q) (scatter TC Q)
```



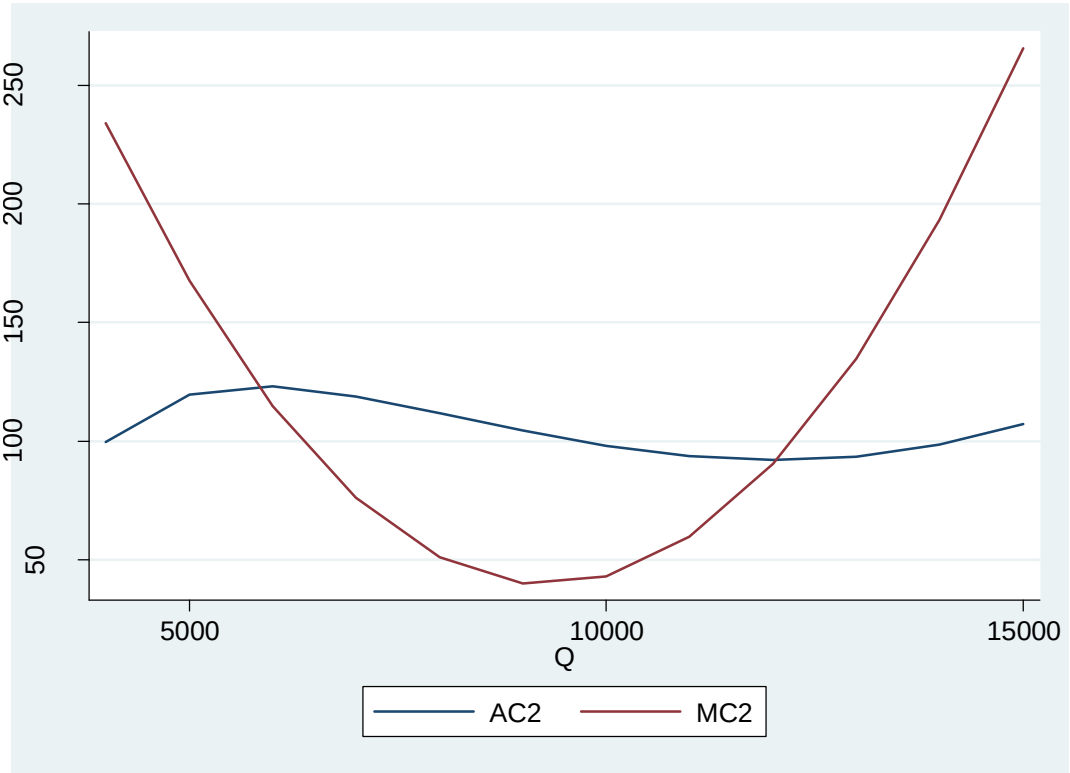

```
. tw (line AC1 AC2 Q) (scatter AC Q)
```



```
. tw (line AC1 MC1 Q)
```




```
. tw (line AC2 MC2 Q)
```



(c) If you are the manager, which cost function, (a) or (b), are you going to choose? Why?

Concerning on fixed vs variable cost, choose (a). Concerning on law of diminishing marginal return, choose (b).

(d) Estimate the following cost function using OLS method

$$TC_i = \beta_0 + \beta_1 Q_i + \gamma_1 D_i + e_i$$

where D_i is management style, $D=0$ for style A
$D=1$ for style B

Determine whether different management style lead to statistically significant different cost functions.

```
. reg TC Q Dm

      Source |       SS           df       MS      Number of obs   =        12
-------------+----------------------------------   F(2, 9)         =    101.51
       Model |  1.1522e+12         2  5.7609e+11   Prob > F        =    0.0000
    Residual |  5.1077e+10         9  5.6752e+09   R-squared       =    0.9576
-------------+----------------------------------   Adj R-squared   =    0.9481
       Total |  1.2033e+12        11  1.0939e+11   Root MSE        =     75334

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          TC |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           Q |   108.1579   12.22077     8.85   0.000     80.51259    135.8032
          Dm |  -156375.9   85570.34    -1.83   0.101    -349949.5    37197.62
       _cons |   14323.31   90159.63     0.16   0.877    -189631.9    218278.6
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```

(e) Estimate the following log-linear cost function using OLS method

$$lnTC_i = \beta_0 + \beta_1 lnQ_i + e_i$$

where $lnTC_i$ is natural log of TC_i
lnQ_i is natural log of Q_i

Determine whether the estimated cost function is economy of scale or diseconomy of scale.

```
. g lnTC=ln(TC)
(3 missing values generated)

. g lnQ=ln(Q)
(3 missing values generated)

. reg lnTC lnQ

      Source |       SS           df       MS      Number of obs   =        12
-------------+----------------------------------   F(1, 10)        =    193.96
       Model |  1.44947606         1  1.44947606   Prob > F        =    0.0000
    Residual |  .074729127        10  .007472913   R-squared       =    0.9510
-------------+----------------------------------   Adj R-squared   =    0.9461
       Total |  1.52420518        11  .138564108   Root MSE        =    .08645

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        lnTC |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         lnQ |   .8589839   .0616772    13.93   0.000     .7215586    .9964092
       _cons |   5.930779   .5607928    10.58   0.000     4.681255    7.180304
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```

Furthermore, the manager would also like to determine which factors have impacts on pizza sale volume, thus, the data of 15 pizza competitors were observed, including monthly sale volume, own price, competitor's price, advertising budget, and average income of consumer in that area.

Sale volume	Own Price	Competitor price	Advertising Budget	Consumer Income
14,210	280	275	9,220	7,400
15,550	250	285	9,440	7,820
17,110	300	320	12,180	8,020
16,320	315	305	11,120	8,840
17,720	250	325	12,880	8,360
17,090	300	315	12,140	8,960
15,560	300	290	10,420	7,980
17,070	280	305	11,580	8,720
17,140	280	325	11,120	8,340
17,940	245	330	12,020	8,240
16,060	305	290	10,140	8,800
15,080	320	280	9,300	8,660
16,180	310	300	11,720	8,200
14,050	270	270	8,560	7,660
18,530	255	330	12,960	8,820

(f) From law of demand, pizza price has inverse relationship with sale volume. Competitor price, advertising budget, and income are positively related to sale volume. Construct linear demand function model for pizza and estimate the model using OLS method. Evaluate and interpret the estimated results.

```
. reg Qx Px Py Ad Inc

      Source |       SS           df       MS      Number of obs   =        15
-------------+----------------------------------   F(4, 10)        =    123.12
       Model |  23793825.4         4  5948456.35   Prob > F        =    0.0000
    Residual |  483134.614        10  48313.4614   R-squared       =    0.9801
-------------+----------------------------------   Adj R-squared   =    0.9721
       Total |    24276960        14  1734068.57   Root MSE        =     219.8

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          Qx |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          Px |  -9.271557   2.937977    -3.16   0.010    -15.81778   -2.725337
          Py |   34.30665   8.219175     4.17   0.002     15.99319    52.62012
          Ad |   .2598177   .1150753     2.26   0.048     .0034141    .5162214
         Inc |    .680138   .1655894     4.11   0.002     .3111819    1.049094
       _cons |   98.02061   1815.676     0.05   0.958    -3947.557    4143.599
------------------------------------------------------------------------------
```

(g) Predict sale volume given own price = 250, competitor price = 300, advertising budget = 12,000, and consumer income = 10,000

```
. mat b3=e(b)

. mat X=(250, 300, 12000, 10000, 1)

. mat Sale=X*b3'

. mat list Sale

symmetric Sale[1,1]
            y1
r1  17991.32
```

(h) Estimate log-linear demand model using OLS method:

```
. g lnQx=ln(Qx)

. g lnPx=ln(Px)

. g lnPy=ln(Py)

. g lnAd=ln(Ad)

. g lnInc=ln(Inc)

. reg lnQx lnPx lnPy lnAd lnInc

      Source |       SS           df       MS      Number of obs   =        15
-------------+----------------------------------   F(4, 10)        =    122.41
       Model |   .09155579         4  .022888948   Prob > F        =    0.0000
    Residual |  .001869881        10  .000186988   R-squared       =    0.9800
-------------+----------------------------------   Adj R-squared   =    0.9720
       Total |  .093425672        14  .006673262   Root MSE        =    .01367

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        lnQx |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lnPx |  -.1551815   .0513285    -3.02   0.013    -.2695484   -.0408145
        lnPy |   .6247439   .1638533     3.81   0.003     .2596561    .9898318
        lnAd |   .1792849   .0811252     2.21   0.052    -.0014732     .360043
       lnInc |   .3486902   .0850299     4.10   0.002     .1592319    .5381486
       _cons |   2.194464   .6185899     3.55   0.005     .8161603    3.572768
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```

(1) If the manager would like to raise up the total revenue, which policy, price increase or decrease, should be employed? Why?
(2) Is product of the competitor substitute or complement product? Why?
(3) Is pizza of this company normal or inferior goods? Why?

(i) If competitor price = 300, advertising budget = 10,000, and consumer income = 8,000, determine price and sale volume which lead the company to maximum profit using estimated linear cost function from (a).