- [Assignment - 2: BUAN 6312 Harikrishna Dev HXD220000]
    - [Answers]

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Answers

1. Use the data in APPLE to answer this question.

- Define a binary variable as ecobuy = 1 if ecolbs > 0 and ecobuy = 0 if ecolbs = 0. In other words, ecobuy indicates whether, at the prices given, a family would buy any ecologically friendly apples. What fraction of families claim they would buy ecolabeled apples?

The fraction of families claim they would buy ecolabeled apples are 62.42%

```
. gen ecobuy = 0

. replace ecobuy = 1 if ecolbs > 0
(412 real changes made)

. tabulate ecobuy

     ecobuy |      Freq.     Percent        Cum.
------------+-----------------------------------
          0 |        248       37.58       37.58
          1 |        412       62.42      100.00
------------+-----------------------------------
      Total |        660      100.00
```

- Estimate the linear probability model below and and report the results in the usual form. Carefully interpret the coefficients on the price variables (*ecoprc* and *regprc*).

$$ecobuy = \beta_0 + \beta_1 ecoprc + \beta_2 regprc + \beta_3 faminc + \beta_4 hhsize + \beta_5 educ + \beta_6 age + u$$

We get the LRM equation as follows:

$$ecobuy = 0.4236865 + -0.8026219 \times ecoprc + 0.7192675 \times regprc + 0.0005518 \times faminc + 0.0238227 \times hhsize + 0.02$$

From the following equation, we can see that coefficients of ***ecoprc*** and ***regprc*** are ***0.803*** and ***0.719***. The p-values of these coefficients are less than 0.05, therefore they are statistically significant. We can also conclude that

$$\frac{\Delta ecoprc}{\Delta ecobuy} = -0.8026219$$

i.e. One dollar increase in price of ecolabeled apples results in a decrease in probablity of a purchase of ecobuy apples by 0.80

$$\frac{\Delta regprc}{\Delta ecobuy} = 0.7192675$$

i.e. One dollar increase in price of regular apples results in a increase in probablity of a purchase of ecobuy apples by 0.71

```
. reg ecobuy ecoprc regprc faminc hhsize educ age

      Source |       SS           df       MS      Number of obs   =       660
-------------+----------------------------------   F(6, 653)       =     13.43
       Model |  17.0019785         6  2.83366308   Prob > F        =    0.0000
    Residual |  137.810143       653  .211041566   R-squared       =    0.1098
-------------+----------------------------------   Adj R-squared   =    0.1016
```

```
       Total |  154.812121       659  .234919759   Root MSE        =    .45939

------------------------------------------------------------------------------
      ecobuy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
      ecoprc |  -.8026219   .1094037    -7.34   0.000    -1.017447   -.5877963
      regprc |   .7192675    .131639     5.46   0.000     .4607808    .9777543
      faminc |   .0005518   .0005295     1.04   0.298     -.000488    .0015916
      hhsize |   .0238227   .0125262     1.90   0.058    -.0007739    .0484193
        educ |   .0247849   .0083743     2.96   0.003      .008341    .0412287
         age |  -.0005008   .0012499    -0.40   0.689    -.0029551    .0019536
       _cons |   .4236865   .1649674     2.57   0.010      .099756     .747617
------------------------------------------------------------------------------
```

- Are the nonprice variables jointly significant in the LPM? (Use the usual F statistic, even though it is not valid when there is heteroskedasticity.) Which explanatory variable other than the price variables seems to have the most significant effect on the decision to buy ecolabeled apples? Does this make sense to you?

We can see that we conduct a hypothesis tests on the non price variables gives us a *p_value < 0.05*. Therefore, we can reject the null hypothesis i.e. non-price variables are jointly significant. As *t(educ) = 2.96* is the highest t statistic value among the non price variable, we can conclude that ***education*** makes most significant effect on purchase of eco-labeled apples. This makes sense that educated customers would prefer ecolabeled apples as they would be more well equipped in understanding the benefit of the consumption of them.

```
. test faminc hhsize educ age

 ( 1)  faminc = 0
 ( 2)  hhsize = 0
 ( 3)  educ = 0
 ( 4)  age = 0

       F(  4,   653) =    4.43
            Prob > F =    0.0015
```

- In the model from part (ii), replace $faminc$ with $log(faminc)$. Given the R^2, which model fits the data better? How many estimated probabilities are negative? How many are bigger than one? Should you be concerned? [Hint: Use command predict y to generate fitted values.]

```
. gen lfaminc = ln(faminc)

. reg ecobuy ecoprc regprc lfaminc hhsize educ age

      Source |       SS           df       MS      Number of obs   =       660
-------------+----------------------------------   F(6, 653)       =     13.67
       Model |  17.278689         6  2.8797815   Prob > F        =    0.0000
    Residual |  137.533432       653  .210617813   R-squared       =    0.1116
-------------+----------------------------------   Adj R-squared   =    0.1034
       Total |  154.812121       659  .234919759   Root MSE        =    .45893

------------------------------------------------------------------------------
      ecobuy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
      ecoprc |  -.8006664   .1092981    -7.33   0.000    -1.015285   -.5860482
      regprc |    .721377   .1315196     5.48   0.000     .4631247    .9796294
     lfaminc |   .0445162   .0287239     1.55   0.122    -.0118861    .1009185
      hhsize |   .0227002    .012543     1.81   0.071    -.0019294    .0473297
        educ |    .023093   .0084508     2.73   0.006      .006499     .039687
         age |  -.0003865   .0012517    -0.31   0.758    -.0028444    .0020713
       _cons |   .3037519   .1789605     1.70   0.090    -.0476555    .6551593
------------------------------------------------------------------------------
```

We see that the *Adj-R sqr* of the second model is greater in the first model. This indicates that the second model fits better. In the second model, there are two fitted probabilities are above 1 and in the range of 0.185 to 1.051. The two values aren't of concern as the source has 660 observations and the values are very close to 1. There are no negative probabilities.

2. Use the data in EZANDERS for this exercise. The data are on monthly unemployment claims in Anderson Township in Indiana, from January 1980 through November 1988. In 1984, an enterprise zone (EZ) was located in Anderson (as well as other cities in Indiana).

- Regress log(uclms) on a monthly linear time trend and 11 monthly dummy variables. [Hint: Use jan as the base month for the monthly dummy variables.]What was the overall trend in unemployment claims over this period? (Interpret the coefficient on the time trend.) Is there evidence of seasonality in unemployment claims?

```
. use "C:\Users\hxd220000\Desktop\Data Sets- STATA\EZANDERS.DTA"

. regress luclms year feb mar apr may jun jul aug sep oct nov dec

      Source |       SS           df       MS      Number of obs   =       107
-------------+----------------------------------   F(12, 94)       =     14.36
       Model |  27.0363482        12  2.25302901   Prob > F        =    0.0000
    Residual |  14.7491008        94  .156905327   R-squared       =    0.6470
-------------+----------------------------------   Adj R-squared   =    0.6020
       Total |  41.7854489       106  .394202348   Root MSE        =    .39611

------------------------------------------------------------------------------
      luclms | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
        year |  -.1665437   .0149503   -11.14   0.000    -.1962279   -.1368595
         feb |  -.0132261   .1867294    -0.07   0.944    -.3839816    .3575294
         mar |  -.0661643   .1867294    -0.35   0.724    -.4369198    .3045912
         apr |  -.3649279   .1867294    -1.95   0.054    -.7356834    .0058276
         may |  -.5147779   .1867294    -2.76   0.007    -.8855334   -.1440224
         jun |  -.5541234   .1867294    -2.97   0.004    -.9248789   -.1833679
         jul |  -.5191558   .1867294    -2.78   0.007    -.8899113   -.1484003
         aug |  -.3378477   .1867294    -1.81   0.074    -.7086032    .0329078
         sep |  -.7528584   .1867294    -4.03   0.000    -1.123614   -.3821029
         oct |  -.7867943   .1867294    -4.21   0.000     -1.15755   -.4160388
         nov |  -.6816665   .1867294    -3.65   0.000    -1.052422    -.310911
         dec |  -.3740492   .1926213    -1.94   0.055    -.7565034    .0084049
       _cons |   339.4264   29.66172    11.44   0.000     280.5323    398.3204
------------------------------------------------------------------------------
```

We see that coefficient of **YEAR** is *-0.1665*. This implies that the overall trend of unemployment claims decreases by *16.65%* per year. As the p-value < threshold value, we can conclude that the yearly trend is significant.

We can see that some of the monthly dummy variables are significant at a 5% level of significance, whereas some are not significant at the same threshold. This helps us understand that there is a presence of seasonal factors behind unemplyment claims.

To confirm the joint significance, we perform the Wald test on the 11 monthly dummy variables.

$$H_0 : feb - dec = 0$$

$$H_1 : feb - dec \neq 0$$

```
. test feb mar apr may jun jul aug sep oct nov dec

 ( 1)  feb = 0
 ( 2)  mar = 0
 ( 3)  apr = 0
 ( 4)  may = 0
 ( 5)  jun = 0
 ( 6)  jul = 0
 ( 7)  aug = 0
 ( 8)  sep = 0
 ( 9)  oct = 0
 (10)  nov = 0
 (11)  dec = 0

       F( 11,    94) =    4.32
            Prob > F =    0.0000
```

As the p-value < threshold, we can reject the null hypothesis. Therefore, we can conclude that the monthly dummy variables are jointly significant.

- Add ez, a dummy variable equal to one in the months Anderson had an EZ, to the regression in part (i). Does having the enterprise zone seem to decrease unemployment claims? By how much?

```
. regress luclms year feb mar apr may jun jul aug sep oct nov dec ez

      Source |       SS           df       MS      Number of obs   =       107
-------------+----------------------------------   F(13, 93)       =     15.76
       Model |  28.7422487        13  2.21094221   Prob > F        =    0.0000
    Residual |  13.0432002        93  .140249465   R-squared       =    0.6879
-------------+----------------------------------   Adj R-squared   =    0.6442
       Total |  41.7854489       106  .394202348   Root MSE        =     .3745

------------------------------------------------------------------------------
      luclms | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
        year |  -.0811489   .0282722    -2.87   0.005    -.1372918    -.025006
         feb |  -.0132261   .1765405    -0.07   0.940    -.3638005    .3373484
         mar |  -.0661643   .1765405    -0.37   0.709    -.4167388    .2844101
         apr |  -.3649279   .1765405    -2.07   0.042    -.7155023   -.0143534
         may |  -.5147779   .1765405    -2.92   0.004    -.8653523   -.1642034
         jun |  -.5541234   .1765405    -3.14   0.002    -.9046978    -.203549
         jul |  -.5191558   .1765405    -2.94   0.004    -.8697303   -.1685814
         aug |  -.3378477   .1765405    -1.91   0.059    -.6884222    .0127267
         sep |  -.7528584   .1765405    -4.26   0.000    -1.103433   -.4022839
         oct |  -.7867943   .1765405    -4.46   0.000    -1.137369   -.4362198
         nov |  -.6816665   .1765405    -3.86   0.000    -1.032241   -.3310921
         dec |  -.3595756   .1821582    -1.97   0.051    -.7213057    .0021546
          ez |  -.5080266   .1456667    -3.49   0.001    -.7972917   -.2187614
       _cons |   170.2854   56.02201     3.04   0.003     59.03674     281.534
------------------------------------------------------------------------------
```

When ez is added to the regression, its coefficient is about –.508 (se ≈ .146). EZ decreases the unemplyment claims by:

$$100(1 - e^{-0.508}) = 39.82\%$$

3. Use the data in HSEINV for this exercise.

- Find the first order autocorrelation in log(invpc) and log(price) respectively. Which of the two series may have a unit root?

```
. use "C:\Users\hxd220000\Desktop\Data Sets- STATA\HSEINV.DTA"

. tsset year

Time variable: year, 1947 to 1988
        Delta: 1 unit

. corr linvpc linvpc_1
(obs=41)

             |   linvpc linvpc_1
-------------+------------------
      linvpc |   1.0000
    linvpc_1 |   0.6391   1.0000
```

The first order autocorrelation for *log(invpc)* is 0.6391.

```
. corr lprice lprice_1
(obs=41)

             |   lprice lprice_1
-------------+------------------
      lprice |   1.0000
    lprice_1 |   0.9492   1.0000
```

The first order autocorrelation for *log(price)* is 0.9492.

As the correlation coefficient is high, we can assume they both have a unit root.

- Based on your findings in part (i), estimate the equation below and report the results in standard form. Interpret the coefficient β_1 and determine whether it is statistically significant.

$$log(invpc_t) = \beta_0 + \beta_1 \times \Delta log(price_t) + \beta_2 \times t + u_t$$

```
. reg linvpc gprice t

      Source |       SS           df       MS      Number of obs   =        41
-------------+----------------------------------   F(2, 38)        =     19.77
       Model |  .575457228         2  .287728614   Prob > F        =    0.0000
    Residual |  .553167094        38  .014557029   R-squared       =    0.5099
-------------+----------------------------------   Adj R-squared   =    0.4841
       Total |  1.12862432        40  .028215608   Root MSE        =    .12065

------------------------------------------------------------------------------
      linvpc | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
      gprice |   3.878646   .9579971     4.05   0.000     1.939282     5.81801
           t |    .008037   .0015952     5.04   0.000     .0048077    .0112664
       _cons |  -.8532545    .040291   -21.18   0.000    -.9348193   -.7716897
------------------------------------------------------------------------------
```

We can see that the co-efficient of gprice is statistically significant. This implies that 1% growth of price results in 3.87% increase in per capita in the housing investment above it mean value.

- Now use Δlog(invpc_t) as the dependent variable. Re-run the equation and report the results in standard form. How do your results of the coefficient β^_1 change from part (ii)? Is the time trend still significant? Why or why not?

```
. reg ginvpc gprice t

      Source |       SS           df       MS      Number of obs   =        41
-------------+----------------------------------   F(2, 38)        =      0.95
       Model |  .039000234         2  .019500117   Prob > F        =    0.3968
    Residual |  .782237921        38  .020585208   R-squared       =    0.0475
-------------+----------------------------------   Adj R-squared   =   -0.0026
       Total |  .821238155        40  .020530954   Root MSE        =    .14348

------------------------------------------------------------------------------
      ginvpc | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
      gprice |   1.566526   1.139214     1.38   0.177    -.7396933    3.872745
           t |    .000037    .001897     0.02   0.985    -.0038032    .0038772
       _cons |   .0059315   .0479125     0.12   0.902    -.0910623    .1029253
------------------------------------------------------------------------------
```

We see that the co-efficient is 1.567 and is not statistically significant. The time trend is not significant at 5% level of significance as the p value is 0.902.

4. Recall that in the example of testing Efficient Markets Hypothesis, it may be that the expected value of the return at time t, given past returns, is a quadratic function of $return_{t-1}$.

- To check this possibility, use the data in NYSE to estimate

$$return_t = \beta_0 + \beta_1 return_{t-1} + \beta_2 return_{t-1}^2 + u_t$$

report the results in standard form.

```
. reg return return_1 return_1_2

      Source |       SS           df       MS      Number of obs   =       689
-------------+----------------------------------   F(2, 686)       =      2.16
       Model |  19.2169743         2  9.60848717   Prob > F        =    0.1161
    Residual |  3051.20782       686  4.4478248    R-squared       =    0.0063
```

```
-------------+----------------------------------   Adj R-squared   =    0.0034
       Total |  3070.42479       688  4.46282673   Root MSE        =     2.109

------------------------------------------------------------------------------
      return | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
    return_1 |   .0485723   .0387224     1.25   0.210    -.0274563    .1246009
  return_1_2 |   -.009735   .0070296    -1.38   0.167     -.023537     .004067
       _cons |   .2255486    .087234     2.59   0.010     .0542708    .3968263
------------------------------------------------------------------------------
```

We can see both estimates are not statistically significant at 5%.

- State and test the null hypothesis that E(return_t |return_(t-1)) does not depend on returnt-1. [Hint: There are two restrictions to test here.] What do you conclude?

$$H_0 : \beta_1 = 0 \qquad \beta_2 = 0$$

```
. test return_1 return_1_2

 ( 1)  return_1 = 0
 ( 2)  return_1_2 = 0

       F(  2,   686) =    2.16
            Prob > F =    0.1161
```

We need to satisfy the above null for our hypothesis to be satisfied. As the p value > 0.05, we cannot reject the nnull hypothesis.

- Drop $return^2_{t-1}$ from the model, but add the interaction term $return_{t-1} \times return_{t-2}$. Now test the efficient markets hypothesis. [Hint: stata can create lag (or lead) variables using subscripts conveniently. For example, you can use the command gen return_2 = return[_n-2] to create $return_{t-2}$ fast.]

```
. gen return_2 = return[_n-2]
(3 missing values generated)

. gen return_2_1 = return_1*return_2
(3 missing values generated)

. reg return return_1 return_2_1

      Source |       SS           df       MS      Number of obs   =       688
-------------+----------------------------------   F(2, 685)       =      1.80
       Model |  16.0639248         2  8.03196242   Prob > F        =    0.1658
    Residual |  3053.36998       685  4.45747442   R-squared       =    0.0052
-------------+----------------------------------   Adj R-squared   =    0.0023
       Total |   3069.4339       687   4.4678805   Root MSE        =    2.1113

------------------------------------------------------------------------------
      return | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
    return_1 |   .0687116   .0392472     1.75   0.080    -.0083476    .1457709
  return_2_1 |   .0113384   .0100134     1.13   0.258    -.0083222     .030999
       _cons |   .1731605   .0809626     2.14   0.033     .0141959    .3321251
------------------------------------------------------------------------------

. test return_1 return_2_1

 ( 1)  return_1 = 0
 ( 2)  return_2_1 = 0

       F(  2,   685) =    1.80
            Prob > F =    0.1658
```

$$H_0 : \beta_1 = 0 \qquad \beta_2 = 0$$

Since the p value of the Wald test > 0.05, we cannot reject the H0

- What do you conclude about predicting weekly stock returns based on past stock returns?

As both models look very weak when we look at the R sqr and summary statistics, we cannot predict weekly stock returns from our models.

5. Use the data in KIELMC for this exercise.

- The variable dist is the distance from each home to the incinerator site, in feet. Consider the model

$$log(price) = \beta_0 + \delta_0 y_{81} + \beta_1 log(dist) + \delta_1 y_{81} \cdot log(dist) + u.$$

If building the incinerator reduces the value of homes closer to the site, what is the sign of δ1? What does it mean if β1 > 0?

Assuming all the other variables remain constant, we can conlcude that cost of home is positively correlated to the distance from the incinerator. Therefore,

$$\delta_1 > 0$$

Assuming β1 > 0, We can assume the distance between the expensive houses and the incinerator is large.

- Estimate the model from part (i) and report the results in the usual form. Interpret the coefficient on $y_8 1 \cdot log(dist)$. What do you conclude?

```
. use "C:\Users\hxd220000\Desktop\Data Sets- STATA\KIELMC.DTA"

. reg lprice y81 ldist y81ldist

      Source |       SS           df       MS      Number of obs   =       321
-------------+----------------------------------   F(3, 317)       =     69.22
       Model |  24.3172548         3  8.10575159   Prob > F        =    0.0000
    Residual |  37.1217306       317  .117103251   R-squared       =    0.3958
-------------+----------------------------------   Adj R-squared   =    0.3901
       Total |  61.4389853       320  .191996829   Root MSE        =     .3422

------------------------------------------------------------------------------
      lprice | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
         y81 |  -.0113101   .8050622    -0.01   0.989     -1.59525     1.57263
       ldist |    .316689   .0515323     6.15   0.000     .2153005    .4180775
    y81ldist |   .0481862   .0817929     0.59   0.556    -.1127394    .2091117
       _cons |   8.058468   .5084358    15.85   0.000     7.058133    9.058803
--------
```

From our analysis, we get the following equation:

$$\widehat{lprice} = 8.06 - 0.0113 \times y81 + 0.317 ldist + 0.0481 \times y81 \times ldist$$

$$n = 321, R^2 = 0.3958, Adj R^2 = 0.3901$$

We see that δ1 = 0.0481862, but the p-value > 0.05. So, it is not statistically significant.

- Add $age, age^2, rooms, baths, log(intst), log(land), andlog(area)$ to the equation. Now, what do you conclude about the effect of the incinerator on housing values?

```
. reg lprice y81 ldist y81ldist age agesq rooms baths lintst lland larea

      Source |       SS           df       MS      Number of obs   =       321
-------------+----------------------------------   F(10, 310)      =    114.55
       Model |   48.353762        10   4.8353762   Prob > F        =    0.0000
    Residual |  13.0852234       310  .042210398   R-squared       =    0.7870
-------------+----------------------------------   Adj R-squared   =    0.7802
       Total |  61.4389853       320  .191996829   Root MSE        =    .20545

------------------------------------------------------------------------------
      lprice | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
         y81 |  -.2254466   .4946914    -0.46   0.649    -1.198824    .7479309
       ldist |   .0009226   .0446168     0.02   0.984    -.0868674    .0887125
    y81ldist |   .0624668   .0502788     1.24   0.215     -.036464    .1613976
```

```
     age |  -.0080075   .0014173    -5.65   0.000    -.0107962   -.0052187
   agesq |   .0000357   8.71e-06     4.10   0.000     .0000186    .0000528
   rooms |   .0461389   .0173442     2.66   0.008     .0120117    .0802662
   baths |   .1010478   .0278224     3.63   0.000     .0463032    .1557924
  lintst |  -.0599757   .0317217    -1.89   0.060    -.1223929    .0024414
   lland |   .0953425   .0247252     3.86   0.000      .046692     .143993
   larea |   .3507429   .0519485     6.75   0.000     .2485266    .4529592
   _cons |   7.673854   .5015718    15.30   0.000     6.686938    8.660769
------------------------------------------------------------------------------
```

We can see that δ1 = 0.0624668 with a p-value = 0.215. As the summary of the regression output conducts a two-tailed test, we can assume for the one tailed test

$$H_0 : \delta_1 = 0$$

$$H_1 : \delta_1 > 0$$

$$p-value_{one-tailed} = \frac{p-value_{two-tailed}}{2} = \frac{0.215}{2} = 0.107$$

As the p-value > 0.05, we can conclude that the distance from the incinerator is not affecting the price of the houses.

- Why is the coefficient on $log(dist)$ positive and statistically significant in part (ii) but not in part (iii)? What does this say about the controls used in part (iii)?

We can see that in the first model, the coefficient of dist is statistically significant, where it is insignificant in the second model. This is due to the absense of these additional factor. To ensure they are jointly significant, we can perform the Wald's test.

```
. test age agesq rooms baths lintst lland larea

 ( 1)  age = 0
 ( 2)  agesq = 0
 ( 3)  rooms = 0
 ( 4)  baths = 0
 ( 5)  lintst = 0
 ( 6)  lland = 0
 ( 7)  larea = 0

       F(  7,   310) =   81.35
            Prob > F =    0.0000
```

As the p-value of the test is lesser than the threshold, we can conclude they are jointly significant.

6. Use the data in PHILLIPS for this exercise. As we mentioned in Lecture 7, instead of the static Phillips curve model, we can estimate an expectations-augmented Phillips curve of the form

$$\Delta inf_t = \beta_0 + \beta_1 unem_t + e_t$$

where $\Delta inf_t = inf_t - inf_{t-1}$

- Estimate this equation by OLS and report the results in the usual form. In estimating this equation by OLS, we assumed that the supply shock, et, was uncorrelated with unemt. If this is false, what can be said about the OLS estimator of β1?

```
. reg cinf unem

      Source |       SS           df       MS      Number of obs   =        55
-------------+----------------------------------   F(1, 53)        =      6.13
       Model |  32.6324798         1  32.6324798   Prob > F        =    0.0165
    Residual |  282.055894        53  5.32180932   R-squared       =    0.1037
-------------+----------------------------------   Adj R-squared   =    0.0868
       Total |  314.688374        54  5.82756247   Root MSE        =    2.3069

------------------------------------------------------------------------------
        dinf | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
```

```
        unem |  -.5176487    .209045    -2.48   0.017    -.9369398   -.0983576
       _cons |   2.828202   1.224871     2.31   0.025     .3714212    5.284982
------------------------------------------------------------------------------
```

We obtain the following equation by running a regression as follows:

$$\Delta inf_t = 2.83 - 0.518 \times unem_t + e_t$$

If *e_t* is correlated with *unem_t*, then the estimator for β1 would be biased and inconsistent.

As the p-value of estimate of unem < 0.05, the estimate is significant at 5%.

- Suppose that et is unpredictable given all past information: $E(e_t \mid inf(t-1), unem(t-1), \ldots) = 0$. Explain why this makes $unem_t - 1$ a good IV candidate for $unem_t$.

Assuming e_t is unpredictable, we can choose unme_t-1 as it correlated with the endogenous variable unem_t, but not to e_t. therefore, it can serve as IV for unem_t. As it satisfies the E(et/unem_t-1)=0, we can conclude that unem_t-1 is not correlated to e_t. By using unem_t-1 as an IV for unem_t in the regression, we can obtain consistent estimates of the causal effect of unem_t on dinf, even if unem_t is endogenous.

- Does $unem_t - 1$ satisfy the instrument relevance assumption? [Hint: You need to run a regression to answer this question.]

```
. reg unem unem_1

      Source |       SS           df       MS      Number of obs   =        55
-------------+----------------------------------   F(1, 53)        =     69.12
       Model |  68.9295284         1  68.9295284   Prob > F        =    0.0000
    Residual |  52.8515619        53  .99719928    R-squared       =    0.5660
-------------+----------------------------------   Adj R-squared   =    0.5578
       Total |   121.78109        54  2.25520538   Root MSE        =     .9986

------------------------------------------------------------------------------
        unem | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
      unem_1 |   .7423824   .0892927     8.31   0.000     .5632839    .9214809
       _cons |   1.489685   .5202033     2.86   0.006      .446289     2.53308
------------------------------------------------------------------------------
```

As we can see that p-value of the unem_1 is below the threshold, we can conclude that the unem_t-1 is strongly correlated with unem_t and satisfies the assumption.

- Estimate the expectations augmented Phillips curve by 2SLS using $unem_t - 1$ as an IV for $unem_t$. Report the results in the usual form and compare them with the OLS estimates from (i).

IV Model

```
. ivregress 2sls cinf (unem = unem_1)

Instrumental variables 2SLS regression          Number of obs   =        55
                                                Wald chi2(1)    =      0.21
                                                Prob > chi2     =    0.6430
                                                R-squared       =    0.0457
                                                Root MSE        =    2.3367

------------------------------------------------------------------------------
        cinf | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
        unem |  -.1304462   .2814517    -0.46   0.643    -.6820813    .4211889
       _cons |   .6338199   1.625886     0.39   0.697    -2.552857    3.820497
------------------------------------------------------------------------------
Instrumented: unem
 Instruments: unem_1
```

The co-efficient of unem for the IV model is statistically isgnificant at 5%, whereas the OLS estimate of unem is significant at 5%.

```
. gen ecobuy = 0

. replace ecobuy = 1 if ecolbs > 0
(412 real changes made)

. tabulate ecobuy

     ecobuy |      Freq.     Percent        Cum.
------------+-----------------------------------
          0 |        248       37.58       37.58
          1 |        412       62.42      100.00
------------+-----------------------------------
      Total |        660      100.00

. reg ecobuy ecoprc regprc faminc hhsize educ age

      Source |       SS           df       MS      Number of obs   =       660
-------------+----------------------------------   F(6, 653)       =     13.43
       Model |  17.0019785         6  2.83366308   Prob > F        =    0.0000
    Residual |  137.810143       653  .211041566   R-squared       =    0.1098
-------------+----------------------------------   Adj R-squared   =    0.1016
       Total |  154.812121       659  .234919759   Root MSE        =    .45939

------------------------------------------------------------------------------
      ecobuy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
      ecoprc |  -.8026219   .1094037    -7.34   0.000    -1.017447   -.5877963
      regprc |   .7192675    .131639     5.46   0.000     .4607808    .9777543
      faminc |   .0005518   .0005295     1.04   0.298     -.000488    .0015916
      hhsize |   .0238227   .0125262     1.90   0.058    -.0007739    .0484193
        educ |   .0247849   .0083743     2.96   0.003      .008341    .0412287
         age |  -.0005008   .0012499    -0.40   0.689    -.0029551    .0019536
       _cons |   .4236865   .1649674     2.57   0.010      .099756     .747617
------------------------------------------------------------------------------

. test faminc hhsize educ age

 ( 1)  faminc = 0
 ( 2)  hhsize = 0
 ( 3)  educ = 0
 ( 4)  age = 0

       F(  4,   653) =    4.43
            Prob > F =    0.0015

. gen lfaminc = ln(faminc)

. reg ecobuy ecoprc regprc lfaminc hhsize educ age

      Source |       SS           df       MS      Number of obs   =       660
-------------+----------------------------------   F(6, 653)       =     13.67
       Model |   17.278689         6   2.8797815   Prob > F        =    0.0000
    Residual |  137.533432       653  .210617813   R-squared       =    0.1116
-------------+----------------------------------   Adj R-squared   =    0.1034
       Total |  154.812121       659  .234919759   Root MSE        =    .45893

------------------------------------------------------------------------------
      ecobuy | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
      ecoprc |  -.8006664   .1092981    -7.33   0.000    -1.015285   -.5860482
      regprc |    .721377   .1315196     5.48   0.000     .4631247    .9796294
     lfaminc |   .0445162   .0287239     1.55   0.122    -.0118861    .1009185
      hhsize |   .0227002    .012543     1.81   0.071    -.0019294    .0473297
        educ |    .023093   .0084508     2.73   0.006      .006499     .039687
         age |  -.0003865   .0012517    -0.31   0.758    -.0028444    .0020713
       _cons |   .3037519   .1789605     1.70   0.090    -.0476555    .6551593
------------------------------------------------------------------------------

. use "C:\Users\hxd220000\Desktop\Data Sets- STATA\EZANDERS.DTA"

. regress luclms year feb mar apr may jun jul aug sep oct nov dec

      Source |       SS           df       MS      Number of obs   =       107
-------------+----------------------------------   F(12, 94)       =     14.36
       Model |  27.0363482        12  2.25302901   Prob > F        =    0.0000
    Residual |  14.7491008        94  .156905327   R-squared       =    0.6470
-------------+----------------------------------   Adj R-squared   =    0.6020
       Total |  41.7854489       106  .394202348   Root MSE        =    .39611

------------------------------------------------------------------------------
      luclms | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
        year |  -.1665437   .0149503   -11.14   0.000    -.1962279   -.1368595
         feb |  -.0132261   .1867294    -0.07   0.944    -.3839816    .3575294
```

```
         mar |  -.0661643   .1867294    -0.35   0.724    -.4369198    .3045912
         apr |  -.3649279   .1867294    -1.95   0.054    -.7356834    .0058276
         may |  -.5147779   .1867294    -2.76   0.007    -.8855334   -.1440224
         jun |  -.5541234   .1867294    -2.97   0.004    -.9248789   -.1833679
         jul |  -.5191558   .1867294    -2.78   0.007    -.8899113   -.1484003
         aug |  -.3378477   .1867294    -1.81   0.074    -.7086032    .0329078
         sep |  -.7528584   .1867294    -4.03   0.000    -1.123614   -.3821029
         oct |  -.7867943   .1867294    -4.21   0.000     -1.15755   -.4160388
         nov |  -.6816665   .1867294    -3.65   0.000    -1.052422    -.310911
         dec |  -.3740492   .1926213    -1.94   0.055    -.7565034    .0084049
       _cons |   339.4264   29.66172    11.44   0.000     280.5323    398.3204
------------------------------------------------------------------------------
. test feb mar apr may jun jul aug sep oct nov dec

 ( 1)  feb = 0
 ( 2)  mar = 0
 ( 3)  apr = 0
 ( 4)  may = 0
 ( 5)  jun = 0
 ( 6)  jul = 0
 ( 7)  aug = 0
 ( 8)  sep = 0
 ( 9)  oct = 0
 (10)  nov = 0
 (11)  dec = 0

       F( 11,    94) =    4.32
            Prob > F =    0.0000
. regress luclms year feb mar apr may jun jul aug sep oct nov dec ez

      Source |       SS           df       MS      Number of obs   =       107
-------------+----------------------------------   F(13, 93)       =     15.76
       Model |  28.7422487        13  2.21094221   Prob > F        =    0.0000
    Residual |  13.0432002        93  .140249465   R-squared       =    0.6879
-------------+----------------------------------   Adj R-squared   =    0.6442
       Total |  41.7854489       106  .394202348   Root MSE        =     .3745

------------------------------------------------------------------------------
      luclms | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
        year |  -.0811489   .0282722    -2.87   0.005    -.1372918    -.025006
         feb |  -.0132261   .1765405    -0.07   0.940    -.3638005    .3373484
         mar |  -.0661643   .1765405    -0.37   0.709    -.4167388    .2844101
         apr |  -.3649279   .1765405    -2.07   0.042    -.7155023   -.0143534
         may |  -.5147779   .1765405    -2.92   0.004    -.8653523   -.1642034
         jun |  -.5541234   .1765405    -3.14   0.002    -.9046978    -.203549
         jul |  -.5191558   .1765405    -2.94   0.004    -.8697303   -.1685814
         aug |  -.3378477   .1765405    -1.91   0.059    -.6884222    .0127267
         sep |  -.7528584   .1765405    -4.26   0.000    -1.103433   -.4022839
         oct |  -.7867943   .1765405    -4.46   0.000    -1.137369   -.4362198
         nov |  -.6816665   .1765405    -3.86   0.000    -1.032241   -.3310921
         dec |  -.3595756   .1821582    -1.97   0.051    -.7213057    .0021546
          ez |  -.5080266   .1456667    -3.49   0.001    -.7972917   -.2187614
       _cons |   170.2854   56.02201     3.04   0.003     59.03674     281.534
------------------------------------------------------------------------------
. use "C:\Users\hxd220000\Desktop\Data Sets- STATA\HSEINV.DTA"

. tsset year

Time variable: year, 1947 to 1988
        Delta: 1 unit

. corr linvpc linvpc_1
(obs=41)

             |   linvpc linvpc_1
-------------+------------------
      linvpc |   1.0000
    linvpc_1 |   0.6391   1.0000
. corr lprice lprice_1
(obs=41)

             |   lprice lprice_1
-------------+------------------
      lprice |   1.0000
    lprice_1 |   0.9492   1.0000

. reg linvpc gprice t

      Source |       SS           df       MS      Number of obs   =        41
-------------+----------------------------------   F(2, 38)        =     19.77
       Model |  .575457228         2  .287728614   Prob > F        =    0.0000
    Residual |  .553167094        38  .014557029   R-squared       =    0.5099
-------------+----------------------------------   Adj R-squared   =    0.4841
       Total |  1.12862432        40  .028215608   Root MSE        =    .12065
```

```
------------------------------------------------------------------------------
      linvpc | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
      gprice |   3.878646   .9579971     4.05   0.000     1.939282     5.81801
           t |    .008037   .0015952     5.04   0.000     .0048077    .0112664
       _cons |  -.8532545    .040291   -21.18   0.000    -.9348193   -.7716897
------------------------------------------------------------------------------

. reg ginvpc gprice t

      Source |       SS           df       MS      Number of obs   =        41
-------------+----------------------------------   F(2, 38)        =      0.95
       Model |  .039000234         2  .019500117   Prob > F        =    0.3968
    Residual |  .782237921        38  .020585208   R-squared       =    0.0475
-------------+----------------------------------   Adj R-squared   =   -0.0026
       Total |  .821238155        40  .020530954   Root MSE        =    .14348

------------------------------------------------------------------------------
      ginvpc | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
      gprice |   1.566526   1.139214     1.38   0.177    -.7396933    3.872745
           t |    .000037    .001897     0.02   0.985    -.0038032    .0038772
       _cons |   .0059315   .0479125     0.12   0.902    -.0910623    .1029253
------------------------------------------------------------------------------

. reg return return_1 return_1_2

      Source |       SS           df       MS      Number of obs   =       689
-------------+----------------------------------   F(2, 686)       =      2.16
       Model |  19.2169743         2  9.60848717   Prob > F        =    0.1161
    Residual |  3051.20782       686   4.4478248   R-squared       =    0.0063
-------------+----------------------------------   Adj R-squared   =    0.0034
       Total |  3070.42479       688  4.46282673   Root MSE        =     2.109

------------------------------------------------------------------------------
      return | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
    return_1 |   .0485723   .0387224     1.25   0.210    -.0274563    .1246009
  return_1_2 |   -.009735   .0070296    -1.38   0.167     -.023537     .004067
       _cons |   .2255486    .087234     2.59   0.010     .0542708    .3968263
------------------------------------------------------------------------------

. test return_1 return_1_2

 ( 1)  return_1 = 0
 ( 2)  return_1_2 = 0

       F(  2,   686) =    2.16
            Prob > F =    0.1161

. gen return_2 = return[_n-2]
(3 missing values generated)

. gen return_2_1 = return_1*return_2
(3 missing values generated)

. reg return return_1 return_2_1

      Source |       SS           df       MS      Number of obs   =       688
-------------+----------------------------------   F(2, 685)       =      1.80
       Model |  16.0639248         2  8.03196242   Prob > F        =    0.1658
    Residual |  3053.36998       685  4.45747442   R-squared       =    0.0052
-------------+----------------------------------   Adj R-squared   =    0.0023
       Total |   3069.4339       687   4.4678805   Root MSE        =    2.1113

------------------------------------------------------------------------------
      return | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
    return_1 |   .0687116   .0392472     1.75   0.080    -.0083476    .1457709
  return_2_1 |   .0113384   .0100134     1.13   0.258    -.0083222     .030999
       _cons |   .1731605   .0809626     2.14   0.033     .0141959    .3321251
------------------------------------------------------------------------------

. test return_1 return_2_1

 ( 1)  return_1 = 0
 ( 2)  return_2_1 = 0

       F(  2,   685) =    1.80
            Prob > F =    0.1658


. use "C:\Users\hxd220000\Desktop\Data Sets- STATA\KIELMC.DTA"

. reg lprice y81 ldist y81ldist

      Source |       SS           df       MS      Number of obs   =       321
-------------+----------------------------------   F(3, 317)       =     69.22
```

```
       Model |  24.3172548         3  8.10575159   Prob > F        =    0.0000
    Residual |  37.1217306       317  .117103251   R-squared       =    0.3958
-------------+----------------------------------   Adj R-squared   =    0.3901
       Total |  61.4389853       320  .191996829   Root MSE        =     .3422

------------------------------------------------------------------------------
      lprice | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
         y81 |  -.0113101   .8050622    -0.01   0.989     -1.59525     1.57263
       ldist |    .316689   .0515323     6.15   0.000     .2153005    .4180775
    y81ldist |   .0481862   .0817929     0.59   0.556    -.1127394    .2091117
       _cons |   8.058468   .5084358    15.85   0.000     7.058133    9.058803
--------

. reg lprice y81 ldist y81ldist age agesq rooms baths lintst lland larea

      Source |       SS           df       MS      Number of obs   =       321
-------------+----------------------------------   F(10, 310)      =    114.55
       Model |   48.353762        10   4.8353762   Prob > F        =    0.0000
    Residual |  13.0852234       310  .042210398   R-squared       =    0.7870
-------------+----------------------------------   Adj R-squared   =    0.7802
       Total |  61.4389853       320  .191996829   Root MSE        =    .20545

------------------------------------------------------------------------------
      lprice | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
         y81 |  -.2254466   .4946914    -0.46   0.649    -1.198824    .7479309
       ldist |   .0009226   .0446168     0.02   0.984    -.0868674    .0887125
    y81ldist |   .0624668   .0502788     1.24   0.215     -.036464    .1613976
         age |  -.0080075   .0014173    -5.65   0.000    -.0107962   -.0052187
       agesq |   .0000357   8.71e-06     4.10   0.000     .0000186    .0000528
       rooms |   .0461389   .0173442     2.66   0.008     .0120117    .0802662
       baths |   .1010478   .0278224     3.63   0.000     .0463032    .1557924
      lintst |  -.0599757   .0317217    -1.89   0.060    -.1223929    .0024414
       lland |   .0953425   .0247252     3.86   0.000      .046692     .143993
       larea |   .3507429   .0519485     6.75   0.000     .2485266    .4529592
       _cons |   7.673854   .5015718    15.30   0.000     6.686938    8.660769
------------------------------------------------------------------------------

. test age agesq rooms baths lintst lland larea

 ( 1)  age = 0
 ( 2)  agesq = 0
 ( 3)  rooms = 0
 ( 4)  baths = 0
 ( 5)  lintst = 0
 ( 6)  lland = 0
 ( 7)  larea = 0

       F(  7,   310) =   81.35
            Prob > F =    0.0000

. reg cinf unem

      Source |       SS           df       MS      Number of obs   =        55
-------------+----------------------------------   F(1, 53)        =      6.13
       Model |  32.6324798         1  32.6324798   Prob > F        =    0.0165
    Residual |  282.055894        53  5.32180932   R-squared       =    0.1037
-------------+----------------------------------   Adj R-squared   =    0.0868
       Total |  314.688374        54  5.82756247   Root MSE        =    2.3069

------------------------------------------------------------------------------
        dinf | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
        unem |  -.5176487    .209045    -2.48   0.017    -.9369398   -.0983576
       _cons |   2.828202   1.224871     2.31   0.025     .3714212    5.284982
------------------------------------------------------------------------------
. reg unem unem_1

      Source |       SS           df       MS      Number of obs   =        55
-------------+----------------------------------   F(1, 53)        =     69.12
       Model |  68.9295284         1  68.9295284   Prob > F        =    0.0000
    Residual |  52.8515619        53   .99719928   R-squared       =    0.5660
-------------+----------------------------------   Adj R-squared   =    0.5578
       Total |   121.78109        54  2.25520538   Root MSE        =     .9986

------------------------------------------------------------------------------
        unem | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
      unem_1 |   .7423824   .0892927     8.31   0.000     .5632839    .9214809
       _cons |   1.489685   .5202033     2.86   0.006      .446289     2.53308
------------------------------------------------------------------------------


. ivregress 2sls cinf (unem = unem_1)
```

```
Instrumental variables 2SLS regression            Number of obs   =         55
                                                  Wald chi2(1)    =       0.21
                                                  Prob > chi2     =     0.6430
                                                  R-squared       =     0.0457
                                                  Root MSE        =     2.3367

------------------------------------------------------------------------------
        cinf | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
        unem |  -.1304462   .2814517    -0.46   0.643    -.6820813    .4211889
       _cons |   .6338199   1.625886     0.39   0.697    -2.552857    3.820497
------------------------------------------------------------------------------
Instrumented: unem
 Instruments: unem_1
```