Exercise 7

To examine the quantity theory of money, Brumm (2005) [''Money Growth, Output Growth, and Inflation: A Reexamination of the Modern Quantity Theory's Linchpin Prediction,'' *Southern Economic Journal*, 71(3), 661–667] specifies the equation:

$$Inflation = \beta_0 + \beta_1 * Money + \beta_2 * Output + u$$

where *INFLAT* is the growth rate of the general price level, *MONEY* is the growth rate of the money supply, and *OUTPUT* is the growth rate of national output. According to theory we should observe that $\beta_0 = 0, \beta_1 = 1$, and $\beta_2 = -1$. The data used in this paper is contained in the file *brumm.gdt*. It consists of 1995 year data on 76 countries.

a) Estimate the model by OLS and interpret all the parameters.

ols Inflation const Money Output

```
Model 1: OLS, using observations 1-76
Dependent variable: Inflation

             coefficient   std. error   t-ratio     p-value
  ---------------------------------------------------------
  const       -0.234214    0.979925     -0.2390    0.8118
  Money        1.03313     0.00904221   114.3      4.65e-084 ***
  Output      -1.66201     0.250566      -6.633    4.95e-09  ***

Mean dependent var   25.35395   S.D. dependent var   58.94767
Sum squared resid    1356.034   S.E. of regression   4.309966
R-squared            0.994797   Adjusted R-squared   0.994654
F(2, 73)             6978.325   P-value(F)           4.41e-84
Log-likelihood      -217.3396   Akaike criterion     440.6792
Schwarz criterion    447.6714   Hannan-Quinn         443.4736
```

b) Test the joint hypothesis that $\beta_0 = 0, \beta_1 = 1$ and $\beta_2 = -1$. What do you conclude?

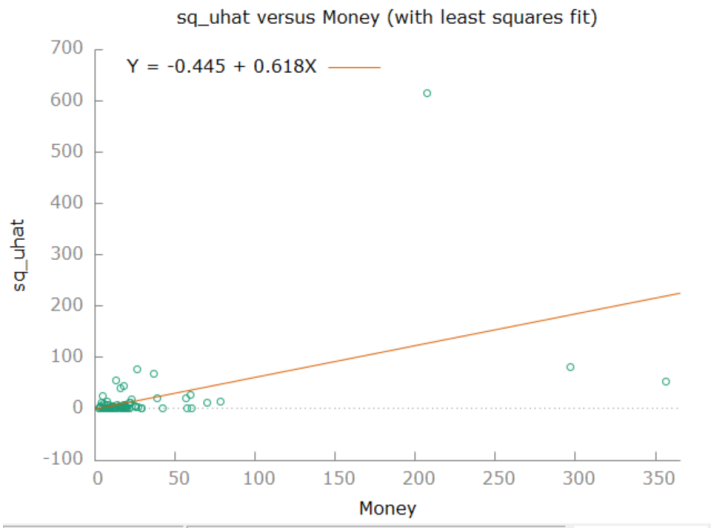
restrict
b[1] = 0
b[2] = 1
b[3] = -1
end restrict

```
Restriction set
 1: b[const] = 0
 2: b[Money] = 1
 3: b[Output] = -1

Test statistic: F(3, 73) = 10.5158, with p-value = 7.88962e-006

Restricted estimates:

             coefficient   std. error   t-ratio   p-value
  ---------------------------------------------------------
  const        0.000000    0.000000      NA        NA
  Money        1.00000     0.000000      NA        NA
  Output      -1.00000     0.000000      NA        NA

  Standard error of the regression = 5.05503
```

c) Examine the least squares residuals for the presence of heteroskedasticity related to the variable *Money*.

series resid=$uhat

gnuplot resid_sq Money



modtest --white

d) Obtain robust standard errors for the model and compare them to the OLS standard errors. Does your conclusion change in part (b) after using robust standard errors?

ols Inflation const Money Output –robust

```
Model 3: OLS, using observations 1-76
Dependent variable: Inflation
Heteroskedasticity-robust standard errors, variant HC1

             coefficient   std. error   t-ratio    p-value
  ------------------------------------------------------------
  const       -0.234214    0.619615     -0.3780   0.7065
  Money        1.03313     0.0236942    43.60     5.08e-054 ***
  Output      -1.66201     0.175914     -9.448    2.71e-014 ***

Mean dependent var   25.35395   S.D. dependent var   58.94767
Sum squared resid    1356.034   S.E. of regression   4.309966
R-squared            0.994797   Adjusted R-squared   0.994654
F(2, 73)             956.8215   P-value(F)           4.26e-53
Log-likelihood      -217.3396   Akaike criterion     440.6792
Schwarz criterion    447.6714   Hannan-Quinn         443.4736
```

Conclusion does not change – they are jointly not equal to the theoretical parameters

e) It is argued that *Output* may be endogenous. Four instrumental variables are proposed, *INITIAL* = initial level of real GDP, *SCHOOL* = a measure of the population's educational attainment, *INVEST* = average investment as a share of GDP, and *POPRATE* = average

population growth rate. Using these instruments, obtain instrumental variables (2SLS) estimates of the inflation equation (do the two stage procedure).

First stage:

ols Output const initial poprate school invest Money

series Output_hat=$yhat

Second stage:

ols Inflation const Money Output_hat

```
Model 5: OLS, using observations 1-76
Dependent variable: Inflation

             coefficient   std. error   t-ratio    p-value
  ---------------------------------------------------------
  const       -1.54267     2.10357      -0.7334   0.4657
  Money        1.04166     0.0110451    94.31     5.12e-078 ***
  yhat        -1.30970     0.646320     -2.026    0.0464    **

Mean dependent var   25.35395   S.D. dependent var   58.94767
Sum squared resid    2057.570   S.E. of regression   5.309039
R-squared            0.992105   Adjusted R-squared   0.991889
F(2, 73)             4586.595   P-value(F)           1.79e-77
Log-likelihood      -233.1841   Akaike criterion     472.3683
Schwarz criterion    479.3605   Hannan-Quinn         475.1627
```

f) Are the instruments strong? **Only invest predicts the Output significantly, other variables are weak instruments. The theoretical parameters are again jointly rejected. The impact of output on the inflation is now lower than before.**