Time Series Analysis for Investment Demand Function: 1957:1 to 2001:4

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INTRODUCTION

The model that we are estimating is Investment & Demand. According to Bernt, ER (1991), since investment expenditure is so volatile, it is important to understand the causes of variations in investment. A few potential variables are productive capacity, employment demand, personal income, and balance of payments. If we can better predict the volatility in investment, we can be better informed in terms of implementing government fiscal or monetary policies. One of the important variables is demand. Demand affects goods produced and sold, affecting investment as a result.

Specifically, we are focusing on the flexible accelerator model. An important feature of the accelerator model is that it is based on the assumption of a fixed capital/ output ratio. That means that such factors as prices, wages, taxes, and interest rates have direct impact on capital spending. Also, we will use the log form of investment, as levels of investment depends on changes in output.

To explain investment, we also need to be aware that a change in output in period t does not only affect investment in the same period. Its effect is distributed over an infinite number of future time periods, which is why we include dynamics in the model.

Dixit, A (1989) explains that "hysteresis" is an important feature that needs to be taken into account. That is defined as the failure of an effect to reverse itself when its underlying cause is reversed. For instance, the foreign firms entering U.S. market when the U.S. dollars appreciated did not exit then the dollars fell back to the original levels. Also, an investment entails some levels of sunk cost, which creates inertia in investment decisions (Dixit, A 1992).

The model that we are using in this paper is:

$$lnI_t = \alpha_0 + \sum_{i=0}^{8} \gamma_i \; lnY_{t-i} + \sum_{i=0}^{8} \rho_j \; lnI_{t-j} + u_t$$

DATA DESCRIPTION

The variables used are defined as follow.

Variable name	Description
I	U.S. gross private domestic fixed business investment in billions of chained (2005) dollars. 8 lags of its log value are also included in the model.
Y	U.S. gross domestic business product in billions of chained (2005) dollars. This means product demand, which is a determinant for investment. 8 lags of its log value are also included in the model.

The time period of the analysis is from 1957 quarter 1 to 2000 quarter 4. The data are quarterly. Here is the summary statistics.

variable	mean	median	sd	min	max
I	778.63	699.20	406.63	229.30	1926.30
Y	4278.81	4091.70	1853.46	1705.60	8575.90

On average, between 1957 and 2000, U.S. gross private domestic fixed business investment is $778.63 billions of chained (2005) dollars. On average, between 1957 and 2000, U.S. gross domestic business products is $4278.81 billions of chained (2005) dollars.

Table 1 – Time Trends Regression

In terms of time trends, we find that dependent variable is has a quadratic time trend over the period of analysis. The average quarterly change in U.S. gross domestic business products over the period 1957:1 to 2000:4 was $7.47 billion (2005 dollars).

Figure 1 – Quadratic Time Trend of Investment

To test for Granger causality, first, we need to determine the number of lags included in the model. We decided to remain the model specification by including 8 lags. Also, as data are quarterly, 8 lags are reasonable to reflect the frequency of data.

Table 2 – Regression for Granger Causality

When conducting Granger causality test from I to Y, we found that the p-value is smaller than 1% significance level. Therefore, we can reject the null hypothesis that I causes Y. When conducting Granger causality test from Y to I, we found that the p-value is much larger than then 1% significance level. Therefore, we cannot reject the null hypothesis that Y causes I. Combining results from two hypothesis tests, we can conclude that there is unidimensional Granger causality from Y to I.

The causal structure of the model is consistent with my result. The model assumes that demand causes investment, and my results reflect that relationship. A possible explanation is that as demand increases, businesses have bigger markets to product more goods, leading to better sales. That would be an important indicator of investment.

To test for ARCH/ GARCH, we first start with 4 lags of the dependent variable investment, as well as 4 lags of the ARCH and GARCH variables. After that, we identify the lag length for the ARCH and GARCH components of the model. The estimation has 20 iterations.

Table 3 - ARCH/ GARCH Regression Results

I	L.I	1.167 (0.078)***	1.165 (0.085)***	1.096 (0.084)***	1.079 (0.085)***
	L2.I	-0.076 (0.109)	-0.089 (0.126)	0.038 (0.144)	0.071 (0.143)
	L3.I	-0.094 (0.088)	-0.079 (0.103)	-0.114 (0.145)	-0.126 (0.139)
	L4.I	0.016 (0.067)	0.018 (0.079)	-0.006 (0.102)	-0.010 (0.101)
	_cons	-1.481 (4.018)	-2.350 (4.176)	-0.780 (4.535)	-0.595 (4.663)

ARCH	L.arch	0.257	0.277	0.140	0.154
		(0.130)**	(0.135)**	(0.097)	(0.070)**
	L2.arch	-0.097	0.219	0.214	
		(0.202)	(0.089)**	(0.091)**	
	L3.arch	-0.395	-0.211		
		(0.128)***	(0.155)		
	L4.arch	0.230			
		(0.153)			
	L.garch	0.809	-0.270	-0.009	0.813
		(0.666)	(0.343)	(0.428)	(0.086)***
	L2.garch	0.923	0.673	0.568	
		(0.387)**	(0.085)***	(0.416)	
	L3.garch	-0.450	0.292		
		(0.450)	(0.276)		
	L4.garch	-0.276			
		(0.404)			
	_cons	-0.348	49.141	102.089	37.919
		(36.072)	(47.201)	(91.013)	(37.824)
R-Squared		.	.	.	.
N		172	172	172	172
SER		.	.	.	.

* *p*<0.1; ** *p*<0.05; *** *p*<0.01
Standard errors in parentheses

The result is that quarterly investment is modeled as a 4th order autoregressive process with 2nd order ARCH and 1st order GARCH. As the coefficient estimates for the ARCH terms are positive, the squared errors are positively correlated. This implies that a large disturbance in investment in the last two periods (quarter t-1 and t-2) implies a larger variance in investment today (time t).

Figure 2 - GARCH Variances: 1957:1 – 2000:4

The graph shows that investment is volatile the most around 1976 and between 1980 and 1989. Indeed, 1980s is considered as one of the most volatile decades in investment. Silber, K (2008) explains that there were numerous causes to the volatility, including weakening dollar values, Wall Street insider trading and illegal dealings scandals, and dampened market sentiment due to Iranian missiles hitting a US-flagged oil tanker.

EMPIRICAL ANALYSIS

First, we decided to test to see if the dependent variable or the independent variables should be first-differenced using the Dickey-Fuller test. The null hypothesis is that a unit root is present in the autoregressive model. The alternative hypothesis is that the model is stationary.

For the dependent variable, as p-value is 0.9335, which is not statistically significant at the 1% significance level, we fail to reject the null hypothesis. Therefore, the null hypothesis is true. A unit root is present. When it comes to the independent variable, p-value for the Dickey-Fuller test is 0.9556, which is much larger than the 1% significance level. Therefore, we also fail to reject the null hypothesis. The conclusion here is that we need to first-difference both dependent and independent variables.

However, after first-differencing, we need to further test that if the model needs another first-difference. P-values from 2 Dickey-Fuller tests of first-differenced dependent and independent variables are smaller than 1% significance level; therefore, we can conclude that we do not need to further first-difference.

Moving forward, we will continue the following tests with the first-differenced dependent and independent variables. The model becomes:

$$\Delta lnI_t = \theta_0 + \sum_{i=0}^{8} \gamma_i \, \Delta lnY_{t-i} + \sum_{i=0}^{8} \rho_j \, \Delta lnI_{t-j} + \epsilon_t$$

Now, we will test for cointegration and then determine if an error correction model is appropriate. First, we regress the first-differenced dependent variable on the first-differenced independent variable. Then, we find the residual from the regression. After that, we conduct a Dickey-Fuller test on the error term. The p-value is much smaller than the 1% significance level; therefore, we do reject the null hypothesis that there is not a unit root in the residual. Also, the null hypothesis of no cointegration is also rejected. Therefore, the first-differenced dependent variable and its predicted value is cointegrated with parameter β. Because β is unknown, we need to include the predicted residual term in the model.

Therefore, moving forward, the model becomes:

$$\Delta lnI_t = \theta_0 + \sum_{i=0}^{8} \gamma_i \, \Delta lnY_{t-i} + \sum_{i=0}^{8} \rho_j \, \Delta lnI_{t-j} + \delta \hat{s}_{t-1} + \epsilon_t$$

Table 4 - Error Correction Model

The error correction term is negative and significant (1%). If U.S. gross private domestic fixed business investment is larger than its predicted value by 1 unit ($1 billion), then change in U.S. gross private domestic fixed business investment decreases by $0.269 billion of chained (2005) dollars in the next period, on average.

Next, we will test for serial correlation in the model.

Table 5 - Test for 1st and 4th-order Serial Correlation

The p-value for the 1^{st}-order serial correlation test 0.564, which is much larger than the 1% significance level; therefore, we can conclude that there is no 1^{st}-order serial correlation. The p-value for the 4^{st}-order serial correlation test 0.995, which is much larger than the 1% significance level; therefore, we can conclude that there is no 4^{st}-order serial correlation.

Regarding time trend, when regressing the updated dependent variable on both linear and quadratic time variables, we do not find any sign that there is linear or quadratic time trend. The p-value for the hypothesis test on linear time trend is 0.589, and the p-value for the quadratic time trend is 0.508. Both are not statistically significant at the 1% significance level. Therefore, we can conclude that there is no need to include time trend in the model.

For seasonality, the p-value for the F-test is 0.599, which is not statistically significant at the 1% significance level. Therefore, we can conclude that there is no seasonality effect in this model, and we do not need to include seasonality in the model.

Table 6- Test for Lag Length

Finally, we will test for lag length. We choose the number of lag lengths to start with is 8. This is because the data are quarterly, and 8 is a large enough lag length to start the testing process. The results show that none of the lags are significant for both dependent and independent variables. Therefore, we can conclude that the model needs no lags. However, we decide to keep the first lag for the dependent variable even it is not significant.

Moving forward, the model becomes:

$$\Delta lnI_t = \theta_0 + \gamma \Delta lnY_t + \sum_{i=0}^{1} \rho_j \ \Delta lnI_{t-j} + \delta \hat{s}_{t-1} + \epsilon_t$$

This is also the final model (a.k.a. Model 2) that we will be using in the upcoming sections. Here are the regression results for Model 2.

Table 7 – Regression Results for Model 2

	I_fd
L.I_fd	0.036
	(0.054)
Y_fd	3.204
	(0.175)***
ect	-0.237
	(0.093)**
_cons	-0.018
	(0.003)***
R-Squared	0.692
N	174
SER	0.03

* p<0.1; ** p<0.05; *** p<0.01
Standard errors in parentheses

The short-run impact multiplier is 3.20. That means a temporary, one period $1 billion of chained (2005) dollars increase in U.S. gross domestic business products will lead to $3.20 billions of chained (2005) dollars increase in U.S. gross private domestic fixed business investment in the same period, on average.

The long-run propensity is 3.32. That means on average, a permanent $1 billion of chained (2005) dollars increase in U.S. gross domestic business products will lead to $3.32 billions of chained (2005) dollars increase in U.S. gross private domestic fixed business investment in the long-run.

In terms of short-run elasticity, one period 1% increase in U.S. gross domestic business products will lead to a 3.20% increase in U.S. gross private domestic fixed business investment in the same period, on average.

For long-run elasticity, a permanent 1% increase in U.S. gross domestic business products will lead to a 3.32% increase in U.S. gross private domestic fixed business investment in the long-run, on average. Both of the short-run and long-run elasticities are smaller than 20%; therefore, they are not economically significant.

Figure 3 - First-differenced Log of Investment Over Time

Looking at the graph of the actual values of the dependent variable and the sample regression line, we can see that the dependent variable values are centered around 0 as it is already first-differenced.

Now, we will move to dynamic forecasting for the last four periods. First, we estimate an AR(4) model for the independent variable using the following equation:

$$\Delta lnY_t = \delta_0 + \delta_1 \Delta lnY_{t-1} + \delta_2 \Delta lnY_{t-2} + \delta_3 \Delta lnY_{t-3} + \delta_4 \Delta lnY_{t-4} + \nu_t$$

After that, we obtain the predicted value of the independent variable for periods n+1, n+2, n+3, and n+4, then replace the independent variable with the predicted values. We re-estimate Model 2 and generate the dynamic forecast. Here is the comparison between actual dependent variables and its predicted ones. We can see that the model tends to over-predict the dependent variable.

Time	$\Delta \boldsymbol{lnI_t}$	$\widehat{\Delta \boldsymbol{lnI_t}}$
2001q1	-.0059357	.0036152
2001q2	-.0157375	.0130963
2001q3	-.0106668	.0190771
2001q4	-.0256343	.0190701

The final test is the Predictive Accuracy test. The purpose of this test is to see if Model 2 is correctly specified or not. First, we find the sum of squares of the residuals from the forecast. Then, using the provided equation, PA is 5.32. However, the chi-square value is 13.23. Therefore, we do not reject the null hypothesis that the model is correctly specified. The conclusion is that the model is correctly specified.

REFERENCES

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TABLES & GRAPHS

Table 1 - Time Trends Regression

	I
time	1.387
	(0.537)**
time2	0.040
	(0.003)***
_cons	338.910
	(17.627)***
R-Squared	0.935
N	176
SER	104.23

* p<0.1; ** p<0.05; *** p<0.01
Standard errors in parentheses

Figure 1 - Quadratic Time Trend of Investment

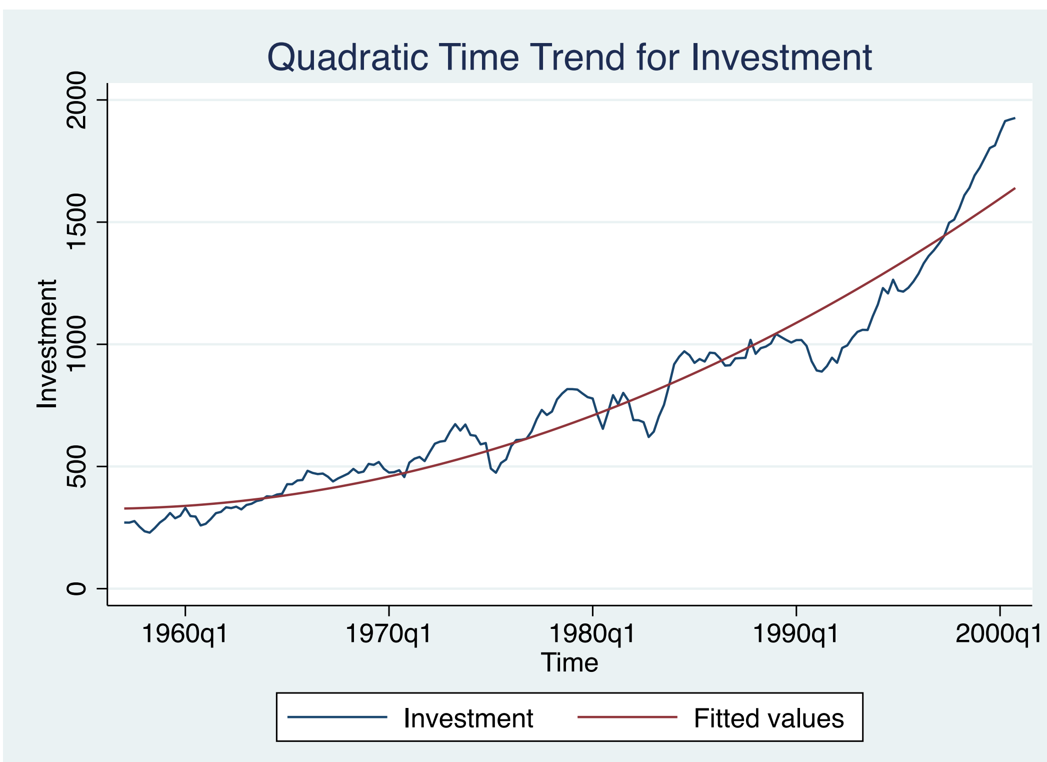


Table 2 – Regression for Granger Causality

	I	Y
L.I	0.697	0.013
	(0.124)***	(0.196)
L2.I	0.094	-0.270
	(0.150)	(0.239)
L3.I	0.228	0.221
	(0.152)	(0.241)
L4.I	-0.194	-0.042
	(0.154)	(0.244)
L5.I	0.141	0.135
	(0.160)	(0.254)
L6.I	0.171	0.242
	(0.161)	(0.256)
L7.I	-0.131	-0.250
	(0.160)	(0.254)
L8.I	-0.057	-0.060
	(0.125)	(0.199)
L.Y	0.354	1.190
	(0.078)***	(0.124)***
L2.Y	-0.134	0.109
	(0.103)	(0.163)
L3.Y	-0.232	-0.246
	(0.107)**	(0.170)
L4.Y	0.130	0.030
	(0.114)	(0.181)
L5.Y	-0.223	-0.182
	(0.122)*	(0.193)
L6.Y	0.041	-0.037
	(0.124)	(0.197)
L7.Y	-0.032	-0.024
	(0.125)	(0.198)
L8.Y	0.108	0.170
	(0.093)	(0.147)
_cons	-13.171	-2.323
	(7.911)*	(12.547)
R-Squared	0.995	0.999
N	168	168
SER	28.55	45.28

* p<0.1; ** p<0.05; *** p<0.01
Standard errors in parentheses

Note: The p-value for the first hypothesis test (I causes Y) is 0.0003, and the p-value for the second hypothesis test (Y causes I) is 0.7819.

Figure 2 - GARCH Variances: 1957:1 – 2000:4

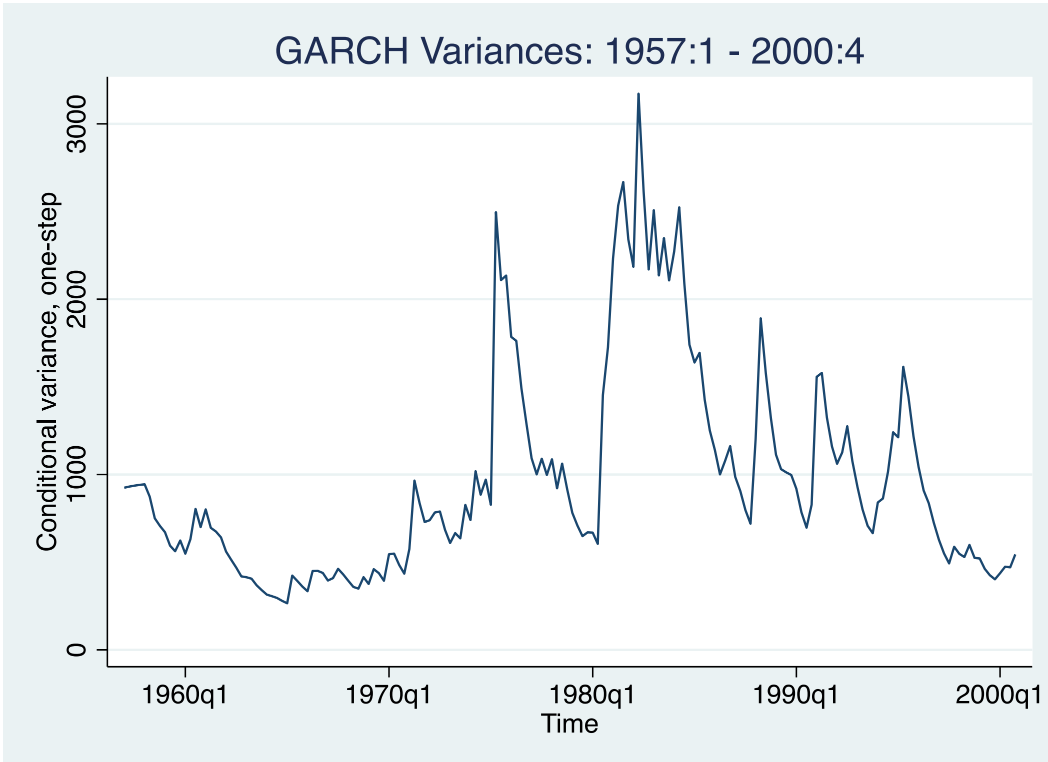


Table 4 - Error Correction Model

	I_fd
Y_fd	3.040
	(0.195)***
oL.Y_fd	0.000
	(0.000)
L2.Y_fd	0.253
	(0.327)
L3.Y_fd	0.073
	(0.329)
L4.Y_fd	0.785
	(0.332)**
L5.Y_fd	-0.227
	(0.324)
L6.Y_fd	-0.005
	(0.325)
L7.Y_fd	-0.212
	(0.326)
L8.Y_fd	-0.435
	(0.330)

L.I_fd	0.034
	(0.059)
L2.I_fd	-0.097
	(0.081)
L3.I_fd	-0.081
	(0.081)
L4.I_fd	-0.182
	(0.080)**
L5.I_fd	-0.064
	(0.080)
L6.I_fd	0.044
	(0.079)
L7.I_fd	-0.001
	(0.079)
L8.I_fd	-0.043
	(0.080)
ect	-0.269
	(0.097)***
_cons	-0.014
	(0.006)**
R-Squared	0.726
N	167
SER	0.03

* p<0.1; ** p<0.05; *** p<0.01
Standard errors in parentheses

Table 5 - Test for 1st and 4th-order Serial Correlation

	cresid2	cresid2
L.cresid2	-0.045	-0.051
	(0.078)	(0.081)
L2.cresid2		0.001
		(0.081)
L3.cresid2		0.018
		(0.080)
L4.cresid2		-0.076
		(0.081)
Y_fd		-0.088
		(0.182)
L.Y_fd		0.105
		(0.184)
L2.Y_fd		0.028
		(0.185)
L3.Y_fd		-0.049
		(0.183)

L4.Y_fd		-0.006
		(0.176)
_cons		0.000
		(0.003)
R-Squared	0.002	0.011
N	166	163
SER	0.02	0.02

* *p*<0.1; ** *p*<0.05; *** *p*<0.01
Standard errors in parentheses

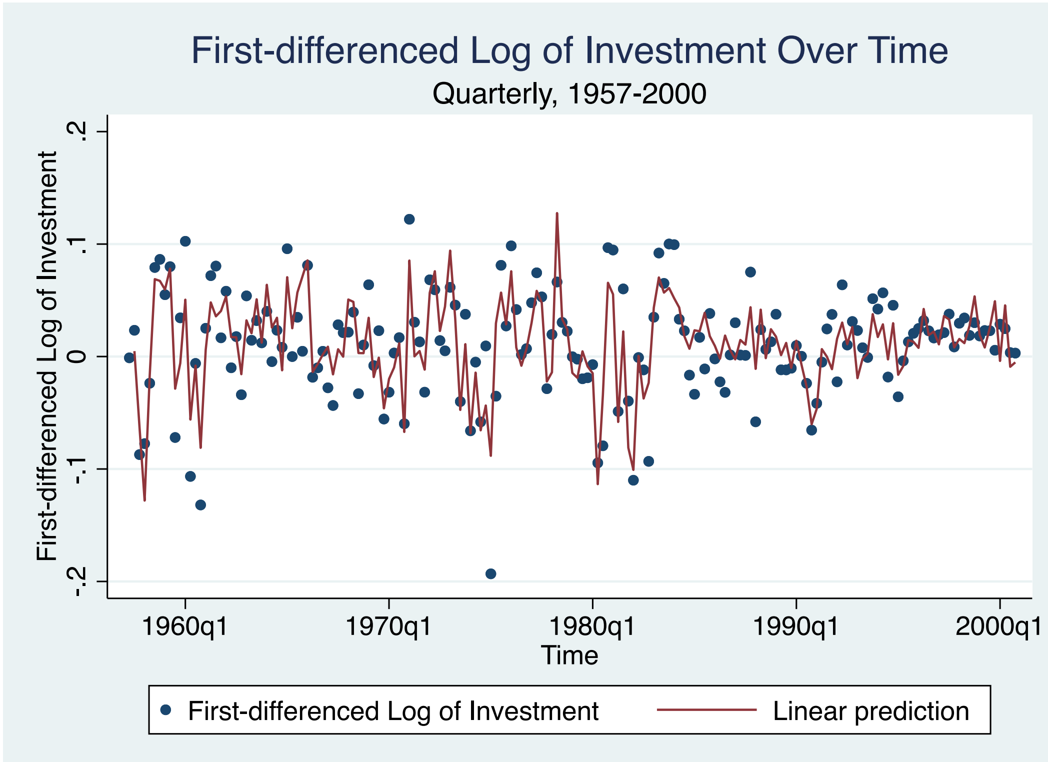
Table 6 - Test for Lag Length

	I_fd	I_fd	I_fd	I_fd	I_fd	I_fd	I_fd	I_fd
Y_fd	3.040	3.086	3.138	3.154	3.219	3.161	3.188	3.204
	(0.195)***	(0.192)***	(0.191)***	(0.187)***	(0.186)***	(0.180)***	(0.178)***	(0.175)***
oL.Y_fd	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
L2.Y_fd	0.253	0.219	0.159	0.148	0.098	0.139	0.156	
	(0.327)	(0.334)	(0.334)	(0.316)	(0.318)	(0.321)	(0.311)	
L3.Y_fd	0.073	-0.035	-0.113	-0.108	-0.162	-0.306		
	(0.329)	(0.335)	(0.320)	(0.317)	(0.319)	(0.315)		
L4.Y_fd	0.785	0.726	0.676	0.683	0.549			
	(0.332)**	(0.323)**	(0.323)**	(0.320)**	(0.315)*			
L5.Y_fd	-0.227	-0.328	-0.358	-0.324				
	(0.324)	(0.331)	(0.331)	(0.320)				
L6.Y_fd	-0.005	-0.038	-0.153					
	(0.325)	(0.332)	(0.325)					
L7.Y_fd	-0.212	-0.391						
	(0.326)	(0.325)						
L8.Y_fd	-0.435							
	(0.330)							
L.I_fd	0.034	0.054	0.060	0.059	0.060	0.052	0.040	0.036
	(0.059)	(0.060)	(0.060)	(0.059)	(0.056)	(0.057)	(0.056)	(0.054)
L2.I_fd	-0.097	-0.090	-0.057	-0.062	-0.044	-0.035	-0.052	
	(0.081)	(0.083)	(0.081)	(0.079)	(0.079)	(0.080)	(0.077)	

L3.I_fd	-0.081	-0.024	-0.013	-0.016	-0.008	0.035		
	(0.081)	(0.081)	(0.080)	(0.078)	(0.079)	(0.078)		
L4.I_fd	-0.182	-0.165	-0.149	-0.152	-0.146			
	(0.080)**	(0.080)**	(0.080)*	(0.079)*	(0.078)*			
L5.I_fd	-0.064	-0.030	-0.024	-0.034				
	(0.080)	(0.081)	(0.081)	(0.078)				
L6.I_fd	0.044	0.053	0.056					
	(0.079)	(0.081)	(0.079)					
L7.I_fd	-0.001	0.008						
	(0.079)	(0.079)						
L8.I_fd	-0.043							
	(0.080)							
ect	-0.269	-0.247	-0.253	-0.257	-0.254	-0.264	-0.256	-0.237
	(0.097)***	(0.099)**	(0.099)**	(0.098)***	(0.095)***	(0.096)***	(0.096)***	(0.093)**
_cons	-0.014	-0.016	-0.018	-0.019	-0.021	-0.016	-0.019	-0.018
	(0.006)**	(0.006)***	(0.005)***	(0.005)***	(0.004)***	(0.004)***	(0.003)***	(0.003)***
R-Squared	0.726	0.709	0.705	0.707	0.697	0.690	0.694	0.692
N	167	168	169	170	171	172	173	174
SER	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03

* $p<0.1$; ** $p<0.05$; *** $p<0.01$
Standard errors in parentheses

Figure 3 - First-differenced Log of Investment Over Time



APPENDIX 1 - CALCULATIONS

1. **Average quarterly growth rate of investment over the time period:** 1.387 + 0.040 * [2 * $\overline{time}$+1] = 7.47

2. **Test for Unit Root**

$$\Delta lnI_t = \alpha_0 + \theta lnI_{t-1} + \epsilon_t$$

$$H_0 : \theta = 0$$

$$H_1 : \theta < 0$$

$$Reject\ H_0\ if\ p - value\ \left(t = \frac{\hat{\theta}}{se(\widehat{\theta})}\right) < \alpha$$

2.1.Test for Unit Root of log(I)

```
Dickey-Fuller test for unit root                     Number of obs   =       175

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
-
 Z(t)             -0.241            -3.485            -2.885            -2.575
------------------------------------------------------------------------------
-
MacKinnon approximate p-value for Z(t) = 0.9335
```

2.2.Test for Unit Root of log(Y)

$$\Delta lnY_t = \alpha_0 + \theta lnY_{t-1} + \epsilon_t$$

$$H_0: \theta = 0$$

$$H_1: \theta < 0$$

$$Reject\ H_0\ if\ p - value\left(t = \frac{\hat{\theta}}{se(\widehat{\theta})}\right) < \alpha$$

```
Dickey-Fuller test for unit root                     Number of obs   =       175

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
-
 Z(t)             -0.034            -3.485            -2.885            -2.575
------------------------------------------------------------------------------
-
MacKinnon approximate p-value for Z(t) = 0.9556
```

2.3.Test for Unit Root of first-differenced log(I)

```
Dickey-Fuller test for unit root                     Number of obs   =       174

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
-
 Z(t)            -11.562            -3.485            -2.885            -2.575
------------------------------------------------------------------------------
-
MacKinnon approximate p-value for Z(t) = 0.0000
```

2.4. Test for Unit Root of first-differenced log(Y)

```
Dickey-Fuller test for unit root                   Number of obs   =       174

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
-
 Z(t)             -9.920            -3.485            -2.885            -2.575
------------------------------------------------------------------------------
-
MacKinnon approximate p-value for Z(t) = 0.0000
```

2.5. Test for Unit Root of Residual term

```
Dickey-Fuller test for unit root                   Number of obs   =       174

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
-
 Z(t)            -16.140            -3.485            -2.885            -2.575
------------------------------------------------------------------------------
-
MacKinnon approximate p-value for Z(t) = 0.0000
```

3. Test for Serial Correlation

3.1.1[st]-order Serial Correlation

$$H_0: \rho = 0$$

$$H_1: \rho \neq 0$$

$Reject\ H_0\ if\ |t_0| = \frac{\hat{\rho}}{se(\hat{\rho})} > z_{\alpha/2}$. $|t_0| = |\frac{-.044899}{.0777568}|$ = 0.58.

3.2.**4[th] -order Serial Correlation**

$$H_0: \rho_1 = \rho_2 = \cdots \rho_8 = 0$$
$$H_1: not\ (\rho_1 = \rho_2 = \cdots \rho_8 = 0)$$

Reject if F = $\frac{(R_u^2 - R_r^2)/q}{(1-R_u^2)/(n-2q-k-1)} > F_{n-2q-k-1,\alpha}$.

F(9, 153) = 0.19. Prob > F = 0.9948. P-value from F-test is 0.9948, which is not statistically significant.

4. Test for time trend

$$\Delta lnI_t = \alpha_0 + \theta time_t + \epsilon_t$$

$$H_0: \theta = 0$$

$$H_1: \theta \neq 0$$

$Reject\ H_0\ if\ |t_0| = \frac{\hat{\theta}}{se(\hat{\theta})} > z_{\alpha/2}.\ |t_0| = |\frac{-.0001359}{.0002508}| = 0.54.$

5. **Test for seasonality**

$$H_0: \beta_{q1} = \beta_{q2} = \beta_{q3} = \beta_{q4} = 0$$
$$H_1: not\ (\beta_{q1} = \beta_{q2} = \beta_{q3} = \beta_{q4} = 0)$$

Reject if F = $\frac{(R_u^2 - R_r^2)/4}{(1-R_u^2)/(n-k-1)} > F_{3,n-k-1,\alpha}$.

F(3, 171) = 0.63. Prob > F = 0.5989. P-value from F-test is 0.5989, which is not statistically significant.

6. **Test for lag length**

Note: only the test for the 8th lag length of the independent variable is shown, other lag length tests are similar.

$$H_0: \rho_8 = 0$$

$$H_1: \rho_8 \neq 0$$

$Reject\ H_0\ \ if\ |t_0| = \frac{\widehat{\rho_9}}{se(\widehat{\rho_8})} > z_{\alpha/2}.\ |t_0| = |\frac{-.4346998}{.3296194}| = 1.32$

7. **Calculate the long-run propensity**

$$LRP = \frac{\gamma_0}{1 - \pi_1} = \frac{3.2035105}{1 - .03556114} = 3.3216317$$

8. **Test for Predictive Accuracy**

PA = $\frac{\sum_{j=1}^{4} \hat{u}_{n+j|n}^2}{\hat{\sigma}^2} = \frac{-.0095508^2 + -.0288338^2 + -.029744^2 + -.0447044^2}{.00071593}$ = 5.3159027 < Chi-square value = 13.227.

APPENDIX 2 - DO & LOG FILE

2.1. DO FILE

```
log using empiricalproject02.txt, t replace

infile I Y using "/Users/baovinhnguyen/Desktop/invest2.txt"
```

```
gen time = q(1957q1) + _n - 1
format time %tq
tsset time


"""C. Section 2: Data Description"""
** 1. Summay Information
drop if time >= q(2001q1)
global var "I Y"
tabstat   $var,   columns(statistics)   statistics(mean   median   sd   min   max)
format(%8.2f)

**2. Trends
*Test for quadratic time trend

// gen time2 = time^2
// gen time3 = time^3

reg I time time2  //The  quarterly change investment over the period 1957:1 to
2001:4 was $(.9548261 + .0441438 * [2 * time+1]) billion (2005 dollars).
outreg   using   Table0,   bdec(3)   se   title("Regression")   summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER")   summdec(3   0   2)   starlevels   (10   5   1)
note("Standard errors in parentheses") replace

egen meantime = mean(time)
gen change = 1.387 + 0.040 * [2 * meantime+1]
 // The average quarterly change in consumption over the period 1957:1 to 2001:4
was $7.47 billion (2005 dollars).

*Graph for time trend
label var I "Investment"
label var time "Time"
graph twoway (tsline I, ms(o)) (qfit I time), title("Quadratic Time Trend for
Investment")       ytitle("Investment")       name(quadratic,       replace)
play(stata_gphformat)

**3. Test for Granger causality
reg I L(1/8).I L(1/8).Y
testparm l(1/8)Y // p-value =  0.0003
outreg   using   granger,   bdec(3)   se   title("Regression")   summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER")   summdec(3   0   2)   starlevels   (10   5   1)
note("Standard errors in parentheses") replace

reg Y L(1/8).I L(1/8).Y
testparm l(1/8)I // p-value =  0.7819
outreg   using   granger,   bdec(3)   se   title("Regression")   summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER")   summdec(3   0   2)   starlevels   (10   5   1)
note("Standard errors in parentheses") merge

// Y --> I
// Is the causal structure of the model consistent with your result? - Yes, the
model assumes that demand causes investment and my model results reflect that
relationship.

**4. Test for ARCH and GARCH
arch I L(1/4)I, arch(1/4) garch(1/4) iter(20)
```

```
outreg using arch, bdec(3) se title("ARCH/ GARCH Tests") summstat(r2\N\rmse) summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevels (10 5 1) note("Standard errors in parentheses") replace
arch I L(1/4)I, arch(1/3) garch(1/3) iter(20)
outreg using arch, bdec(3) se title("ARCH/ GARCH Tests") summstat(r2\N\rmse) summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevels (10 5 1) note("Standard errors in parentheses") merge
arch I L(1/4)I, arch(1/2) garch(1/2) iter(20)
outreg using arch, bdec(3) se title("ARCH/ GARCH Tests") summstat(r2\N\rmse) summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevels (10 5 1) note("Standard errors in parentheses") merge
arch I L(1/4)I, arch(1) garch(1) iter(20)
outreg using arch, bdec(3) se title("ARCH/ GARCH Tests") summstat(r2\N\rmse) summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevels (10 5 1) note("Standard errors in parentheses") merge

predict gvar, v // predict variance

label var time "Time"
graph twoway (line gvar time), title("GARCH Variances: 1957:1 - 2000:4") play(stata_gphformat) name(garchconvar, replace)

"""D. Section 3: Empirical Analysis"""
**1. Using Model 1, carry out A-F:

/*E. Test to see if the dependent variable or the independent variables should be first- differenced using the Dickey-Fuller test (only use “dfuller x” where “x” is the variable name, do not add a trend or lags to t his command).*/
gen lnI = log(I)
gen lnY = log(Y)
dfuller lnI // p-value = 0.8848 > 0.001 -> DO NOT reject
dfuller lnY // p-value = 0.9084 > 0..01 -> DO NOT reject
// DO NOT reject -> HAS evidence of unit root -> NEED TO DIFFERENCE.

gen I_fd = lnI - L.lnI
gen Y_fd = lnY - L.lnY
dfuller I_fd // p-value = 0.0000 -> DO reject
dfuller Y_fd // p-value = 0.0000 -> DO reject
// DO reject --> DON'T NEED to further difference.
// From now, we will use first-differenced variables. The model becomes I_fd L(0/8).Y_fd L(1/8).I_fd

/*F. Given that the data need to be first-differenced, test for cointegration and then determine if an error correction model is appropriate. Interpret the error correction parameter in Model 2.*/

// Check for resid cointegration
reg I_fd Y_fd
predict cresid, resid
dfuller cresid // p-value = 0.0000 -> I_fd - 3.210239 * Y_fd IS cointegrated -> NEED to do error correction term model.

// Error correction term model
gen ect = L.cresid
reg I_fd L(0/8).Y_fd L(1/8).I_fd ect
outreg using ect, bdec(3) se title("Regression") summstat(r2\N\rmse) summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevels (10 5 1) note("Standard errors in parentheses") replace
```

```
// From now, we need to include the error correction term in the model. The
model becomes I_fd L(0/8).Y_fd L(1/8).I_fd ect

/*B. Test for 1st -order and 4th-order serial correlation in the residuals using
Durbin’s Alternative Test*/
// First, re-run the updated model:
reg I_fd L(0/8).Y_fd L(1/8).I_fd ect
predict cresid2, resid

// 1st-order:
reg cresid2 L.cresid2, noc // p-value = 0.564 so we DO NOT reject the null
hypothesis at the 1% level --> there is NO 1st-order serial correlation
outreg using serialcorrelation, bdec(3) se title("Regression")
summstat(r2\N\rmse) summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevels
(10 5 1) note("Standard errors in parentheses") replace
// 4th-order:
reg cresid2 L(1/4).cresid2 L(0/4).Y_fd
testparm L(1/4).cresid2 L(0/4).Y_fd // p-value =  0.9948 so we DO NOT reject
the null hypothesis --> there is NO 4th-order serial correlation.
outreg using serialcorrelation, bdec(3) se title("Regression")
summstat(r2\N\rmse) summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevels
(10 5 1) note("Standard errors in parentheses") merge

/*D. Determine if a linear time trend should be included in the model (don’t
include a quadratic if the linear term is significant). */
reg I_fd time time2 // p-value = 0.965 , so we DO NOT need to include time trend
in the model.
outreg using timetrend, bdec(3) se title("Regression") summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevels (10 5 1)
note("Standard errors in parentheses") replace

/*C. Test for seasonality. If there is seasonality, include the seasonal
indicators in the model.*/
gen quarter = mod(time,4)+1
reg I_fd i.quarter
testparm i.quarter // p-value =  0.5780 - there is no evidence of seasonality

/* A. Test for lag length */
reg I_fd L(0/8).Y_fd L(1/8).I_fd ect
outreg using laglength, bdec(3) se title("Regression") summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevels (10 5 1)
note("Standard errors in parentheses") replace
reg I_fd L(0/7).Y_fd L(1/7).I_fd ect
outreg using laglength, bdec(3) se title("Regression") summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevels (10 5 1)
note("Standard errors in parentheses") merge
reg I_fd L(0/6).Y_fd L(1/6).I_fd ect
outreg using laglength, bdec(3) se title("Regression") summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevels (10 5 1)
note("Standard errors in parentheses") merge
reg I_fd L(0/5).Y_fd L(1/5).I_fd ect
outreg using laglength, bdec(3) se title("Regression") summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevels (10 5 1)
note("Standard errors in parentheses") merge
reg I_fd L(0/4).Y_fd L(1/4).I_fd ect
outreg using laglength, bdec(3) se title("Regression") summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevels (10 5 1)
note("Standard errors in parentheses") merge
```

```
reg I_fd L(0/3).Y_fd L(1/3).I_fd ect
outreg using laglength, bdec(3) se title("Regression") summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevels (10 5 1)
note("Standard errors in parentheses") merge
reg I_fd L(0/2).Y_fd L(1/2).I_fd ect
outreg using laglength, bdec(3) se title("Regression") summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevels (10 5 1)
note("Standard errors in parentheses") merge
reg I_fd L(0/1).Y_fd L(1/1).I_fd ect
outreg using laglength, bdec(3) se title("Regression") summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevels (10 5 1)
note("Standard errors in parentheses") merge

//The final model:
reg I_fd L.I_fd Y_fd ect
outreg using finalmodel, bdec(3) se title("Regression") summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevels (10 5 1)
note("Standard errors in parentheses") replace


**2. Calculate the short-run impact multiplier and the long-run propensity for
each independent variable included in Model 2

// Impact Multiplier:
gen IM = _b[Y_fd] // 3.20

// Long-run propensity:
gen LRP = _b[Y_fd] / (1- _b[L.I_fd])  // 3.3216317

**3. Include a graph of the actual values of the dependent variable and the
sample regression line.
predict yhat, xb

label var I_fd "First-differenced Log of Investment"
graph twoway (scatter I_fd time, ms(o)) (line yhat time), title("First-
differenced Log of Investment Over Time") ytitle("First-differenced Log of
Investment") subtitle("Quarterly, 1957-2000") play(stata_gphformat)

**4. Calculate dynamic forecasts for the last four periods.

arima Y_fd L(1/4).Y_fd if time < q(2001q1) // Estimate equation 9
predict xhatd, dynamic(q(2001q1)) // predict xhat
replace Y_fd = xhatd if time>=q(2001q1) //  replace the final four observations
for lnINC with xhatd
arima I_fd L.I_fd Y_fd ect if time < q(2001q1)
predict yhatd, dynamic(q(2001q1))
list time I_fd yhatd if time>=q(2001q1), noobs

**5. Carry out the Predictive Accuracy test.
gen uhat = I_fd - yhatd if time>=q(2001q1)
gen uhat2 = uhat^2

reg I_fd L.I_fd Y_fd ect
gen sigmahat = e(rmse)
gen sigmahat2 = sigmahat^2
di sigmahat2 // .00071593

egen sumuhat2 = sum(uhat2)
```

```
di sumuhat2 // .0038058

gen PA = (sumuhat2)/(sigmahat2)
di PA //5.3159027
```

2.2. LOG FILE

```
----------------------------------------------------------------------------
---------------------------------------------------------
      name:  <unnamed>
       log:    /Users/baovinhnguyen/Documents/1.  STUDY  /1.  EC  207/Homework
3/empiricalproject02.txt
  log type:  text
 opened on:  16 Dec 2019, 12:37:01

. infile I Y using "/Users/baovinhnguyen/Desktop/invest2.txt"
(180 observations read)

. gen time = q(1957q1) + _n - 1

. format time %tq

. tsset time
        time variable:  time, 1957q1 to 2001q4
                delta:  1 quarter

. """C. Section 2: Data Description"""
" is not a valid command name
r(199);

. ** 1. Summay Information

. drop if time >= q(2001q1)
(4 observations deleted)

. global var "I Y"

.  tabstat  $var,  columns(statistics)  statistics(mean  median  sd  min  max)
format(%8.2f)

    variable |      mean       p50        sd       min       max
-------------+--------------------------------------------------
           I |    778.63    699.20    406.63    229.30   1926.30
           Y |   4278.81   4091.70   1853.46   1705.60   8575.90
----------------------------------------------------------------

.
. **2. Trends

. *Test for quadratic time trend

. gen time2 = time^2

. reg I time time2

      Source |       SS           df       MS      Number of obs   =       176
```

```
-------------+----------------------------------   F(2, 173)       =   1245.22
       Model |  27055871.1         2  13527935.6   Prob > F        =    0.0000
    Residual |  1879448.95       173  10863.8668   R-squared       =    0.9350
-------------+----------------------------------   Adj R-squared   =    0.9343
       Total |  28935320.1       175  165344.686   Root MSE        =    104.23

-----------------------------------------------------------------------------
-
           I |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+---------------------------------------------------------------
-
        time |   1.387455     .53664     2.59   0.011     .3282506     2.44666
       time2 |   .0404482   .0034032    11.89   0.000     .0337311    .0471652
       _cons |   338.9097   17.62684    19.23   0.000     304.1184    373.7011
-----------------------------------------------------------------------------
-

. outreg using Table0, bdec(3) se title("Regression") summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevels (1
> 0 5 1) note("Standard errors in parentheses") replace

                                                                Regression
                                                     -----------------------
---
                                                                          I
                                                     -----------------------
---
                                                      time            1.387
                                                                   (0.537)**
                                                      time2           0.040
                                                                  (0.003)***
                                                      _cons          338.910

(17.627)***
                                                      R-Squared       0.935
                                                      N                176
                                                      SER            104.23
                                                     -----------------------
---
                                                   *  p<0.1;  **  p<0.05;  ***
p<0.01
                                                   Standard     errors     in
parentheses


. egen meantime = mean(time)

. gen change = 1.387 + 0.040 * [2 * meantime+1]

.  // The average quarterly change in consumption over the period 1957:1 to
2001:4 was $7.47 billion (2005 dollars).
/ is not a valid command name
r(199);

. *Graph for time trend

. label var I "Investment"
```

```
. label var time "Time"

. graph twoway (tsline I, ms(o)) (qfit I time), title("Quadratic Time Trend for
Investment") ytitle("Investment") name(quadratic, repla
> ce) play(stata_gphformat)
recording stata_gphformat not found in either PERSONAL or working directory
r(601);

. **3. Test for Granger causality

. reg I L(1/8).I L(1/8).Y

      Source |       SS           df       MS      Number of obs   =       168
-------------+----------------------------------   F(16, 151)      =   2034.22
       Model |  26527840.7        16  1657990.04   Prob > F        =    0.0000
    Residual |  123072.27        151  815.048147   R-squared       =    0.9954
-------------+----------------------------------   Adj R-squared   =    0.9949
       Total |    26650913       167  159586.305   Root MSE        =    28.549

------------------------------------------------------------------------------
-
           I |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
-
           I |
         L1. |   .6971081   .1237227     5.63   0.000      .452657    .9415593
         L2. |   .0935436   .1504443     0.62   0.535    -.2037041    .3907914
         L3. |   .2283944   .1520463     1.50   0.135    -.0720185    .5288074
         L4. |   -.194279   .1538323    -1.26   0.209    -.4982207    .1096627
         L5. |   .1405867   .1598976     0.88   0.381    -.1753388    .4565123
         L6. |   .1708438   .1611245     1.06   0.291    -.1475058    .4891933
         L7. |  -.1310879   .1599263    -0.82   0.414    -.4470701    .1848943
         L8. |  -.0571425   .1254491    -0.46   0.649    -.3050047    .1907197
             |
           Y |
         L1. |   .3538586    .078156     4.53   0.000     .1994381    .5082791
         L2. |  -.1339318   .1026334    -1.30   0.194    -.3367148    .0688512
         L3. |  -.2322235   .1073619    -2.16   0.032    -.4443489    -.020098
         L4. |   .1302026   .1141754     1.14   0.256    -.0953851    .3557903
         L5. |  -.2227242   .1216996    -1.83   0.069    -.4631782    .0177297
         L6. |   .0407378   .1239474     0.33   0.743    -.2041575     .285633
         L7. |  -.0322844   .1245514    -0.26   0.796     -.278373    .2138042
         L8. |   .1083901   .0925868     1.17   0.244    -.0745427    .2913229
             |
       _cons |  -13.17139   7.910805    -1.66   0.098    -28.80155    2.458774
------------------------------------------------------------------------------
-

. testparm l(1/8)Y // p-value =  0.0003
'/' not allowed in varlist
r(198);

. outreg using granger, bdec(3) se title("Regression") summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevels (
> 10 5 1) note("Standard errors in parentheses") replace

                                                         Regression
```

	I
L.I	0.697
	(0.124)***
L2.I	0.094
	(0.150)
L3.I	0.228
	(0.152)
L4.I	-0.194
	(0.154)
L5.I	0.141
	(0.160)
L6.I	0.171
	(0.161)
L7.I	-0.131
	(0.160)
L8.I	-0.057
	(0.125)
L.Y	0.354
	(0.078)***
L2.Y	-0.134
	(0.103)
L3.Y	-0.232
	(0.107)**
L4.Y	0.130
	(0.114)
L5.Y	-0.223
	(0.122)*
L6.Y	0.041
	(0.124)
L7.Y	-0.032
	(0.125)
L8.Y	0.108
	(0.093)
_cons	-13.171
	(7.911)*
R-Squared	0.995
N	168
SER	28.55

* p<0.1; ** p<0.05; *** p<0.01

Standard errors in parentheses

```
. reg Y L(1/8).I L(1/8).Y

      Source |       SS           df       MS      Number of obs   =       168
-------------+----------------------------------   F(16, 151)      =  16699.31
       Model |   547793219         16  34237076.2   Prob > F        =    0.0000
    Residual |  309581.507        151  2050.20865   R-squared       =    0.9994
```

```
-------------+------------------------------   Adj R-squared   =    0.9994
       Total |   548102801       167   3282052.7   Root MSE        =    45.279

------------------------------------------------------------------------------
-
           Y |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
-
           I |
         L1. |   .0131997   .1962261     0.07   0.946    -.3745036     .400903
         L2. |  -.2702161    .238607    -1.13   0.259    -.7416556    .2012234
         L3. |   .2208631   .2411478     0.92   0.361    -.2555964    .6973227
         L4. |  -.0421071   .2439804    -0.17   0.863    -.5241632    .4399491
         L5. |   .1350201   .2536001     0.53   0.595    -.3660428    .6360829
         L6. |    .241848   .2555459     0.95   0.345    -.2630593    .7467554
         L7. |  -.2500221   .2536456    -0.99   0.326    -.7511747    .2511305
         L8. |  -.0604384   .1989642    -0.30   0.762    -.4535516    .3326749
             |
           Y |
         L1. |   1.190348   .1239566     9.60   0.000     .9454344    1.435261
         L2. |    .108522   .1627782     0.67   0.506     -.213095    .4301389
         L3. |  -.2461862   .1702776    -1.45   0.150    -.5826205     .090248
         L4. |    .030327    .181084     0.17   0.867    -.3274586    .3881125
         L5. |  -.1821391   .1930174    -0.94   0.347    -.5635027    .1992246
         L6. |  -.0369066   .1965826    -0.19   0.851    -.4253142     .351501
         L7. |   -.023576   .1975405    -0.12   0.905    -.4138762    .3667243
         L8. |   .1695904    .146844     1.15   0.250    -.1205438    .4597247
             |
       _cons |  -2.322636   12.54666    -0.19   0.853    -27.11231    22.46704
------------------------------------------------------------------------------
-

. testparm l(1/8)I // p-value =  0.7819
'/' not allowed in varlist
r(198);

. outreg using granger, bdec(3) se title("Regression") summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevels (
> 10 5 1) note("Standard errors in parentheses") merge

                                                   Regression
                                             ----------------------------

---------
                                                        I          Y
                                             ----------------------------

---------
                                              L.I          0.697     0.013
                                                          (0.124)***
(0.196)
                                              L2.I          0.094        -

0.270
                                                           (0.150)
(0.239)
                                              L3.I          0.228     0.221
                                                           (0.152)

(0.241)
                                              L4.I         -0.194        -

0.042
```

(0.244)

(0.254)

(0.256)

0.250

(0.254)

0.060

(0.199)

(0.124)***

(0.163)

0.246

(0.170)

(0.181)

0.182

(0.193)

0.037

(0.197)

0.024

(0.198)

(0.147)

2.323

(12.547)

0.999

----

p<0.01

parentheses

	(0.154)	
L5.I	0.141	0.135
	(0.160)	
L6.I	0.171	0.242
	(0.161)	
L7.I	-0.131	-
	(0.160)	
L8.I	-0.057	-
	(0.125)	
L.Y	0.354	1.190
	(0.078)***	
L2.Y	-0.134	0.109
	(0.103)	
L3.Y	-0.232	-
	(0.107)**	
L4.Y	0.130	0.030
	(0.114)	
L5.Y	-0.223	-
	(0.122)*	
L6.Y	0.041	-
	(0.124)	
L7.Y	-0.032	-
	(0.125)	
L8.Y	0.108	0.170
	(0.093)	
_cons	-13.171	-
	(7.911)*	
R-Squared		0.995
N	168	168
SER	28.55	45.28

* p<0.1; ** p<0.05; ***

Standard errors in

```
. **4. Test for ARCH and GARCH

. arch I L(1/4)I, arch(1/4) garch(1/4) iter(20)

(setting optimization to BHHH)
Iteration 0:   log likelihood = -833.05802
Iteration 1:   log likelihood = -827.09586
Iteration 2:   log likelihood = -822.80119
Iteration 3:   log likelihood = -818.61032
Iteration 4:   log likelihood = -818.09343
(switching optimization to BFGS)
Iteration 5:   log likelihood = -817.47189
Iteration 6:   log likelihood = -816.15529
Iteration 7:   log likelihood = -816.02545  (backed up)
Iteration 8:   log likelihood = -815.63856
Iteration 9:   log likelihood = -815.56041  (backed up)
Iteration 10:  log likelihood = -815.31156
Iteration 11:  log likelihood = -815.06192
Iteration 12:  log likelihood = -815.04087  (backed up)
Iteration 13:  log likelihood = -814.93174
Iteration 14:  log likelihood = -814.83449
(switching optimization to BHHH)
Iteration 15:  log likelihood = -814.80548
Iteration 16:  log likelihood = -814.79981  (backed up)
Iteration 17:  log likelihood = -814.64371  (backed up)
Iteration 18:  log likelihood = -814.34158  (backed up)
Iteration 19:  log likelihood = -814.06632  (backed up)
(switching optimization to BFGS)
Iteration 20:  log likelihood = -813.61453  (backed up)
convergence not achieved

ARCH family regression

Sample: 1958q1 - 2000q4                         Number of obs   =        172
Distribution: Gaussian                          Wald chi2(4)    =   46545.47
Log likelihood = -813.6145                      Prob > chi2     =     0.0000

-----------------------------------------------------------------------------
-
             |                 OPG
           I |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+---------------------------------------------------------------
-
I            |
           I |
         L1. |   1.167333   .0777944    15.01   0.000     1.014858    1.319807
         L2. |  -.0760843   .1087901    -0.70   0.484     -.289309    .1371404
         L3. |  -.0938417   .0881654    -1.06   0.287    -.2666427    .0789593
         L4. |   .0158818   .0666499     0.24   0.812    -.1147496    .1465131
             |
       _cons |  -1.480626   4.018424    -0.37   0.713    -9.356592     6.39534
-------------+---------------------------------------------------------------
-
ARCH         |
        arch |
         L1. |       .257   .1300882     1.98   0.048     .0020317    .5119683
```

```
        L2. |  -.0971101   .2017355    -0.48   0.630    -.4925044    .2982841
        L3. |   -.394563   .1281523    -3.08   0.002    -.6457369    -.143389
        L4. |   .2300496   .1527516     1.51   0.132     -.069338    .5294371
            |
      garch |
        L1. |   .8090278   .6660582     1.21   0.224    -.4964224    2.114478
        L2. |   .9225303   .3870574     2.38   0.017     .1639116    1.681149
        L3. |  -.4503995   .4496755    -1.00   0.317    -1.331747    .4309484
        L4. |  -.2763097   .4041264    -0.68   0.494    -1.068383    .5157634
            |
      _cons |  -.3476376   36.07243    -0.01   0.992    -71.04829    70.35302
------------------------------------------------------------------------------
-

. outreg using arch, bdec(3) se title("ARCH/ GARCH Tests") summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starleve
> ls (10 5 1) note("Standard errors in parentheses") replace

                                                        ARCH/ GARCH Tests
                                                  ---------------------------

--------
                                                   I         L.I         1.167

(0.078)***
                                                              L2.I           -
0.076

(0.109)
                                                              L3.I           -
0.094

(0.088)
                                                              L4.I       0.016

(0.067)
                                                              _cons          -
1.481

(4.018)
                                                   ARCH      L.arch      0.257

(0.130)**
                                                              L2.arch        -
0.097

(0.202)
                                                              L3.arch        -
0.395

(0.128)***
                                                              L4.arch
0.230

(0.153)
                                                              L.garch
0.809

(0.666)
```

L2.garch
0.923

(0.387)**
L3.garch -
0.450

(0.450)
L4.garch -
0.276

(0.404)
_cons -
0.348

(36.072)
R-Squared .
N 172
SER .

----
* p<0.1; ** p<0.05; ***
p<0.01
Standard errors in
parentheses

```
. arch I L(1/4)I, arch(1/3) garch(1/3) iter(20)

(setting optimization to BHHH)
Iteration 0:   log likelihood = -833.37608
Iteration 1:   log likelihood = -833.18781
Iteration 2:   log likelihood = -823.96114
Iteration 3:   log likelihood = -818.85302
Iteration 4:   log likelihood = -817.42037
(switching optimization to BFGS)
Iteration 5:   log likelihood = -816.77912
Iteration 6:   log likelihood = -816.22659
Iteration 7:   log likelihood = -815.67374  (backed up)
Iteration 8:   log likelihood = -815.64736  (backed up)
Iteration 9:   log likelihood =  -815.5753
Iteration 10:  log likelihood = -815.50344
Iteration 11:  log likelihood = -815.50064
Iteration 12:  log likelihood = -815.50064  (backed up)
Iteration 13:  log likelihood = -815.36148
Iteration 14:  log likelihood = -815.36148  (backed up)
(switching optimization to BHHH)
Iteration 15:  log likelihood = -815.26582
Iteration 16:  log likelihood = -814.59395
Iteration 17:  log likelihood = -814.54513
Iteration 18:  log likelihood = -814.33885
Iteration 19:  log likelihood = -814.22119
(switching optimization to BFGS)
Iteration 20:  log likelihood =   -814.078
convergence not achieved

ARCH family regression
```

```
Sample: 1958q1 - 2000q4                         Number of obs   =        172
Distribution: Gaussian                          Wald chi2(4)    =   47461.35
Log likelihood =  -814.078                      Prob > chi2     =     0.0000

-----------------------------------------------------------------------------
-
             |                 OPG
           I |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+---------------------------------------------------------------
-
I            |
           I |
         L1. |   1.164965   .0854851    13.63   0.000     .9974174    1.332513
         L2. |  -.0892048    .126013    -0.71   0.479    -.3361858    .1577762
         L3. |   -.079365   .1028537    -0.77   0.440    -.2809546    .1222246
         L4. |   .0183923   .0786078     0.23   0.815    -.1356762    .1724608
             |
       _cons |  -2.349661   4.175558    -0.56   0.574     -10.5336    5.834282
-------------+---------------------------------------------------------------
-
ARCH         |
        arch |
         L1. |   .2773826   .1350589     2.05   0.040     .0126719    .5420932
         L2. |   .2190909    .089457     2.45   0.014     .0437583    .3944235
         L3. |  -.2111917   .1549176    -1.36   0.173    -.5148247    .0924413
             |
       garch |
         L1. |  -.2698223    .342731    -0.79   0.431    -.9415627    .4019181
         L2. |   .6728628   .0852249     7.90   0.000      .505825    .8399005
         L3. |   .2924548   .2756612     1.06   0.289    -.2478312    .8327408
             |
       _cons |   49.14073   47.20096     1.04   0.298    -43.37145    141.6529
-----------------------------------------------------------------------------
-

. outreg using arch, bdec(3) se title("ARCH/ GARCH Tests") summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starleve
> ls (10 5 1) note("Standard errors in parentheses") merge

                                                           ARCH/ GARCH Tests
                                             ---------------------------------

--------------
                                              I             L.I             1.167
1.165
                                                                     (0.078)***
(0.085)***
                                                          L2.I            -0.076
-0.089
                                                                      (0.109)
(0.126)
                                                          L3.I            -0.094
-0.079
                                                                      (0.088)
(0.103)
                                                          L4.I             0.016
0.018
                                                                      (0.067)
(0.079)
```

	_cons	-1.481	-2.350
		(4.018)	(4.176)
ARCH	L.arch	0.257	0.277
		(0.130)**	(0.135)**
	L2.arch	-0.097	0.219
		(0.202)	(0.089)**
	L3.arch	-0.395	-0.211
		(0.128)***	(0.155)
	L4.arch	0.230	
		(0.153)	
	L.garch	0.809	-0.270
		(0.666)	(0.343)
	L2.garch	0.923	0.673
		(0.387)**	(0.085)***
	L3.garch	-0.450	0.292
		(0.450)	(0.276)
	L4.garch	-0.276	
		(0.404)	
	_cons	-0.348	49.141
		(36.072)	(47.201)
R-Squared		.	.
N		172	172
SER		.	.

* p<0.1; ** p<0.05; *** p<0.01

Standard errors in parentheses

```
. arch I L(1/4)I, arch(1/2) garch(1/2) iter(20)

(setting optimization to BHHH)
Iteration 0:   log likelihood = -829.55709
Iteration 1:   log likelihood = -822.12074
Iteration 2:   log likelihood = -821.15222
Iteration 3:   log likelihood = -819.75662
Iteration 4:   log likelihood = -819.70336
```

```
(switching optimization to BFGS)
Iteration 5:   log likelihood = -819.62313
Iteration 6:   log likelihood = -819.48152
BFGS stepping has contracted, resetting BFGS Hessian (0)
Iteration 7:   log likelihood = -819.45228
Iteration 8:   log likelihood = -819.45225  (backed up)
Iteration 9:   log likelihood = -819.45017  (backed up)
Iteration 10:  log likelihood = -819.44713  (backed up)
Iteration 11:  log likelihood = -819.44551  (backed up)
Iteration 12:  log likelihood = -819.44526
Iteration 13:  log likelihood =  -819.4437
Iteration 14:  log likelihood = -819.44268
(switching optimization to BHHH)
Iteration 15:  log likelihood = -819.44108
Iteration 16:  log likelihood = -819.43878
Iteration 17:  log likelihood = -819.43809
Iteration 18:  log likelihood = -819.43793
Iteration 19:  log likelihood =  -819.4342
(switching optimization to BFGS)
Iteration 20:  log likelihood =  -819.4342
convergence not achieved

ARCH family regression

Sample: 1958q1 - 2000q4                         Number of obs   =        172
Distribution: Gaussian                          Wald chi2(4)    =   44246.04
Log likelihood = -819.4342                      Prob > chi2     =     0.0000

-----------------------------------------------------------------------------
-
             |                 OPG
           I |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+---------------------------------------------------------------
-
I            |
           I |
         L1. |     1.0959    .084402    12.98   0.000     .9304754    1.261325
         L2. |   .0384566   .1439935     0.27   0.789    -.2437655    .3206787
         L3. |   -.114007   .1448829    -0.79   0.431    -.3979722    .1699582
         L4. |  -.0064911    .101605    -0.06   0.949    -.2056331     .192651
             |
       _cons |  -.7802429   4.535202    -0.17   0.863    -9.669076     8.10859
-------------+---------------------------------------------------------------
-
ARCH         |
        arch |
         L1. |   .1399264    .097268     1.44   0.150    -.0507153    .3305681
         L2. |   .2136591   .0905534     2.36   0.018     .0361777    .3911405
             |
       garch |
         L1. |  -.0090347   .4281303    -0.02   0.983    -.8481546    .8300852
         L2. |   .5680319   .4162285     1.36   0.172    -.2477609    1.383825
             |
       _cons |   102.0891   91.01313     1.12   0.262    -76.29336    280.4716
-----------------------------------------------------------------------------
-
```

```
. outreg using arch, bdec(3) se title("ARCH/ GARCH Tests") summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starleve
> ls (10 5 1) note("Standard errors in parentheses") merge

                                                  ARCH/ GARCH Tests
                                        ---------------------------------------
--------------------
                                         I          L.I          1.167      1.165
1.096
                                                                (0.078)***
(0.085)***  (0.084)***
                                                    L2.I           -0.076       -
0.089      0.038
                                                                 (0.109)
(0.126)     (0.144)
                                                    L3.I           -0.094       -
0.079      -0.114
                                                                 (0.088)
(0.103)     (0.145)
                                                    L4.I          0.016      0.018
-0.006
                                                                 (0.067)
(0.079)     (0.102)
                                                    _cons          -1.481       -
2.350      -0.780
                                                                 (4.018)
(4.176)     (4.535)
                                         ARCH       L.arch        0.257      0.277
0.140
                                                                (0.130)**
(0.135)**    (0.097)
                                                    L2.arch      -0.097      0.219
0.214
                                                                 (0.202)
(0.089)**   (0.091)**
                                                    L3.arch        -0.395       -
0.211
                                                                (0.128)***
(0.155)
                                                    L4.arch        0.230
                                                                 (0.153)
                                                    L.garch        0.809        -
0.270      -0.009
                                                                 (0.666)
(0.343)     (0.428)
                                                    L2.garch      0.923      0.673
0.568
                                                                (0.387)**
(0.085)***   (0.416)
                                                    L3.garch     -0.450      0.292
                                                                 (0.450)
(0.276)
                                                    L4.garch      -0.276
                                                                 (0.404)
                                                    _cons        -0.348     49.141
102.089
                                                                 (36.072)
(47.201)    (91.013)
```

```
                                       R-Squared                    .        .
.
                                       N                          172      172
172
                                       SER                          .        .
.
                                      --------------------------------------
--------------------
                                                   *  p<0.1;  **  p<0.05;  ***
p<0.01
                                                   Standard     errors     in
parentheses

. arch I L(1/4)I, arch(1) garch(1) iter(20)

(setting optimization to BHHH)
Iteration 0:   log likelihood = -827.89443
Iteration 1:   log likelihood = -824.81799
Iteration 2:   log likelihood = -821.00987
Iteration 3:   log likelihood = -820.03245
Iteration 4:   log likelihood = -819.94187
(switching optimization to BFGS)
Iteration 5:   log likelihood = -819.92524
Iteration 6:   log likelihood = -819.90521
Iteration 7:   log likelihood = -819.90409
Iteration 8:   log likelihood = -819.90365
Iteration 9:   log likelihood = -819.90357
Iteration 10:  log likelihood = -819.90356
Iteration 11:  log likelihood = -819.90356

ARCH family regression

Sample: 1958q1 - 2000q4                           Number of obs   =        172
Distribution: Gaussian                            Wald chi2(4)    =   42420.35
Log likelihood = -819.9036                        Prob > chi2     =     0.0000

-----------------------------------------------------------------------------
-
             |                 OPG
           I |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+---------------------------------------------------------------
-
I            |
           I |
         L1. |   1.078732   .0848873    12.71   0.000     .9123558    1.245108
         L2. |   .0708052   .1431755     0.49   0.621    -.2098136     .351424
         L3. |  -.1263202   .1393596    -0.91   0.365    -.3994601    .1468197
         L4. |  -.0099881   .1014887    -0.10   0.922    -.2089023    .1889261
             |
       _cons |  -.5945724   4.662975    -0.13   0.899    -9.733836    8.544691
-------------+---------------------------------------------------------------
-
ARCH         |
        arch |
         L1. |   .1544529   .0698861     2.21   0.027     .0174786    .2914271
             |
       garch |
```

```
         L1. |   .8129311    .085807     9.47   0.000     .6447525    .9811097
             |
       _cons |    37.9188   37.82445     1.00   0.316    -36.21576    112.0533
------------------------------------------------------------------------------
-

. outreg using arch, bdec(3) se title("ARCH/ GARCH Tests") summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starleve
> ls (10 5 1) note("Standard errors in parentheses") merge

                                                           ARCH/ GARCH Tests
                                --------------------------------------------
--------------------------
                                 I           L.I           1.167        1.165
1.096        1.079
                                                      (0.078)***   (0.085)***
(0.084)***   (0.085)***
                                             L2.I         -0.076       -0.089
0.038        0.071
                                                       (0.109)      (0.126)
(0.144)      (0.143)
                                             L3.I         -0.094       -0.079
-0.114       -0.126
                                                       (0.088)      (0.103)
(0.145)      (0.139)
                                             L4.I          0.016        0.018
-0.006       -0.010
                                                       (0.067)      (0.079)
(0.102)      (0.101)
                                             _cons        -1.481       -2.350
-0.780       -0.595
                                                       (4.018)      (4.176)
(4.535)      (4.663)
                                 ARCH        L.arch        0.257        0.277
0.140        0.154
                                                      (0.130)**     (0.135)**
(0.097)     (0.070)**
                                             L2.arch      -0.097        0.219
0.214
                                                       (0.202)      (0.089)**
(0.091)**
                                             L3.arch     -0.395      -0.211
                                                      (0.128)***   (0.155)
                                             L4.arch     0.230
                                                       (0.153)
                                             L.garch       0.809       -0.270
-0.009       0.813
                                                       (0.666)      (0.343)
(0.428)     (0.086)***
                                             L2.garch      0.923        0.673
0.568
                                                      (0.387)**    (0.085)***
(0.416)
                                             L3.garch    -0.450       0.292
                                                       (0.450)     (0.276)
                                             L4.garch    -0.276
                                                       (0.404)
```

```
                                                _cons          -0.348       49.141
102.089      37.919
                                                              (36.072)     (47.201)
(91.013)    (37.824)
                                    R-Squared                      .            .
.           .
                                    N                            172          172
172         172
                                    SER                            .            .
.           .
                                   ---------------------------------------------
-------------------------
                                                        * p<0.1; ** p<0.05; ***
p<0.01
                                                        Standard    errors    in
parentheses


.
. predict gvar, v

. label var time "Time"

. graph twoway (line gvar time), title("GARCH Variances: 1957:1 - 2000:4")
play(stata_gphformat) name(garchconvar, replace)
recording stata_gphformat not found in either PERSONAL or working directory
r(601);

. **** D. Section 3: Empirical Analysis

. gen lnI = log(I)

. gen lnY = log(Y)

. dfuller lnI

Dickey-Fuller test for unit root                   Number of obs   =       175

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
-
 Z(t)             -0.241            -3.485            -2.885            -2.575
------------------------------------------------------------------------------
-
MacKinnon approximate p-value for Z(t) = 0.9335

. dfuller lnY

Dickey-Fuller test for unit root                   Number of obs   =       175

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
-
 Z(t)             -0.034            -3.485            -2.885            -2.575
```

```
------------------------------------------------------------------------------
-
MacKinnon approximate p-value for Z(t) = 0.9556

. gen I_fd = lnI - L.lnI
(1 missing value generated)

. gen Y_fd = lnY - L.lnY
(1 missing value generated)

. dfuller I_fd

Dickey-Fuller test for unit root                   Number of obs   =       174

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
-
 Z(t)            -11.562            -3.485            -2.885            -2.575
------------------------------------------------------------------------------
-
MacKinnon approximate p-value for Z(t) = 0.0000

. dfuller Y_fd

Dickey-Fuller test for unit root                   Number of obs   =       174

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
-
 Z(t)             -9.920            -3.485            -2.885            -2.575
------------------------------------------------------------------------------
-
MacKinnon approximate p-value for Z(t) = 0.0000

. reg I_fd Y_fd

      Source |       SS           df       MS      Number of obs   =       175
-------------+----------------------------------   F(1, 173)       =    360.80
       Model |  .266015344         1  .266015344   Prob > F        =    0.0000
    Residual |  .127550048       173  .000737284   R-squared       =    0.6759
-------------+----------------------------------   Adj R-squared   =    0.6740
       Total |  .393565391       174   .00226187   Root MSE        =    .02715

------------------------------------------------------------------------------
-
        I_fd |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
-
        Y_fd |   3.234851   .1703014    18.99   0.000     2.898715    3.570987
       _cons |  -.0178262   .0025594    -6.97   0.000    -.0228778   -.0127746
------------------------------------------------------------------------------
-

. predict cresid, resid
```

```
(1 missing value generated)

. dfuller cresid

Dickey-Fuller test for unit root                   Number of obs   =       174

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
-
 Z(t)            -16.140            -3.485            -2.885            -2.575
------------------------------------------------------------------------------
-
MacKinnon approximate p-value for Z(t) = 0.0000

. gen ect = L.cresid
(2 missing values generated)

. reg I_fd L(0/8).Y_fd L(1/8).I_fd ect
note: L.Y_fd omitted because of collinearity

      Source |       SS           df       MS      Number of obs   =       167
-------------+----------------------------------   F(17, 149)      =     23.27
       Model |  .263180661        17  .015481215   Prob > F        =    0.0000
    Residual |  .099134495       149  .000665332   R-squared       =    0.7264
-------------+----------------------------------   Adj R-squared   =    0.6952
       Total |  .362315156       166  .002182621   Root MSE        =    .02579

------------------------------------------------------------------------------
-
        I_fd |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
-
        Y_fd |
         --. |   3.040279    .194724    15.61   0.000     2.655502    3.425056
         L1. |          0  (omitted)
         L2. |   .2533246   .3265832     0.78   0.439    -.3920081    .8986573
         L3. |   .0726045   .3287765     0.22   0.826    -.5770621    .7222711
         L4. |    .785034   .3321703     2.36   0.019     .1286611    1.441407
         L5. |  -.2274536   .3244434    -0.70   0.484     -.868558    .4136508
         L6. |  -.0045289   .3247762    -0.01   0.989     -.646291    .6372332
         L7. |  -.2117834   .3257483    -0.65   0.517    -.8554663    .4318994
         L8. |  -.4346998   .3296194    -1.32   0.189    -1.086032    .2166326
             |
        I_fd |
         L1. |   .0336483   .0591367     0.57   0.570    -.0832066    .1505031
         L2. |  -.0969644   .0810282    -1.20   0.233    -.2570773    .0631484
         L3. |  -.0807527   .0811315    -1.00   0.321    -.2410696    .0795641
         L4. |  -.1818905   .0798491    -2.28   0.024    -.3396733   -.0241076
         L5. |  -.0636355   .0796243    -0.80   0.425    -.2209742    .0937033
         L6. |   .0436412   .0791553     0.55   0.582    -.1127707    .2000531
         L7. |   -.001038   .0792908    -0.01   0.990    -.1577176    .1556416
         L8. |  -.0432127   .0796399    -0.54   0.588    -.2005822    .1141568
             |
         ect |  -.2689016   .0973058    -2.76   0.006    -.4611793    -.076624
       _cons |  -.0144616   .0060017    -2.41   0.017     -.026321   -.0026022
```

```
-----------------------------------------------------------------------------
-

. outreg using ect, bdec(3) se title("Regression") summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevels (10 5
> 1) note("Standard errors in parentheses") replace

                                                              Regression
                                                        ----------------------
---
                                                                  I_fd
                                                        ----------------------
---
                                                         Y_fd          3.040

(0.195)***
                                                         oL.Y_fd       0.000
                                                                      (0.000)
                                                         L2.Y_fd       0.253
                                                                      (0.327)
                                                         L3.Y_fd       0.073
                                                                      (0.329)
                                                         L4.Y_fd       0.785
                                                                     (0.332)**
                                                         L5.Y_fd      -0.227
                                                                      (0.324)
                                                         L6.Y_fd      -0.005
                                                                      (0.325)
                                                         L7.Y_fd      -0.212
                                                                      (0.326)
                                                         L8.Y_fd      -0.435
                                                                      (0.330)
                                                         L.I_fd        0.034
                                                                      (0.059)
                                                         L2.I_fd      -0.097
                                                                      (0.081)
                                                         L3.I_fd      -0.081
                                                                      (0.081)
                                                         L4.I_fd      -0.182
                                                                     (0.080)**
                                                         L5.I_fd      -0.064
                                                                      (0.080)
                                                         L6.I_fd       0.044
                                                                      (0.079)
                                                         L7.I_fd      -0.001
                                                                      (0.079)
                                                         L8.I_fd      -0.043
                                                                      (0.080)
                                                         ect          -0.269

(0.097)***
                                                         _cons        -0.014
                                                                     (0.006)**
                                                         R-Squared     0.726
                                                         N              167
                                                         SER            0.03
                                                        ----------------------
---
```

* p<0.1; ** p<0.05; *** p<0.01

Standard errors in parentheses

```
. reg I_fd L(0/8).Y_fd L(1/8).I_fd ect
note: L.Y_fd omitted because of collinearity

      Source |       SS           df       MS      Number of obs   =       167
-------------+----------------------------------   F(17, 149)      =     23.27
       Model |  .263180661        17  .015481215   Prob > F        =    0.0000
    Residual |  .099134495       149  .000665332   R-squared       =    0.7264
-------------+----------------------------------   Adj R-squared   =    0.6952
       Total |  .362315156       166  .002182621   Root MSE        =    .02579

------------------------------------------------------------------------------
        I_fd |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        Y_fd |
         --. |   3.040279    .194724    15.61   0.000     2.655502    3.425056
         L1. |          0  (omitted)
         L2. |   .2533246   .3265832     0.78   0.439    -.3920081    .8986573
         L3. |   .0726045   .3287765     0.22   0.826    -.5770621    .7222711
         L4. |    .785034   .3321703     2.36   0.019     .1286611    1.441407
         L5. |  -.2274536   .3244434    -0.70   0.484     -.868558    .4136508
         L6. |  -.0045289   .3247762    -0.01   0.989     -.646291    .6372332
         L7. |  -.2117834   .3257483    -0.65   0.517    -.8554663    .4318994
         L8. |  -.4346998   .3296194    -1.32   0.189    -1.086032    .2166326
             |
        I_fd |
         L1. |   .0336483   .0591367     0.57   0.570    -.0832066    .1505031
         L2. |  -.0969644   .0810282    -1.20   0.233    -.2570773    .0631484
         L3. |  -.0807527   .0811315    -1.00   0.321    -.2410696    .0795641
         L4. |  -.1818905   .0798491    -2.28   0.024    -.3396733   -.0241076
         L5. |  -.0636355   .0796243    -0.80   0.425    -.2209742    .0937033
         L6. |   .0436412   .0791553     0.55   0.582    -.1127707    .2000531
         L7. |   -.001038   .0792908    -0.01   0.990    -.1577176    .1556416
         L8. |  -.0432127   .0796399    -0.54   0.588    -.2005822    .1141568
             |
         ect |  -.2689016   .0973058    -2.76   0.006    -.4611793    -.076624
       _cons |  -.0144616   .0060017    -2.41   0.017     -.026321   -.0026022
------------------------------------------------------------------------------

. predict cresid2, resid
(9 missing values generated)

. reg cresid2 L.cresid2, noc

      Source |       SS           df       MS      Number of obs   =       166
-------------+----------------------------------   F(1, 165)       =      0.33
       Model |  .000199763         1  .000199763   Prob > F        =    0.5644
    Residual |  .098855772       165  .000599126   R-squared       =    0.0020
-------------+----------------------------------   Adj R-squared   =   -0.0040
       Total |  .099055535       166   .00059672   Root MSE        =    .02448
```

```
------------------------------------------------------------------------------
-
     cresid2 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
-
     cresid2 |
         L1. |   -.044899   .0777568    -0.58   0.564    -.1984256    .1086276
------------------------------------------------------------------------------
-

.   outreg   using   serialcorrelation,   bdec(3)   se   title("Regression")
summstat(r2\N\rmse) summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) st
> arlevels (10 5 1) note("Standard errors in parentheses") replace

                                                              Regression
                                                        ---------------------
-
                                                                     cresid2
                                                        ---------------------
-
                                                         L.cresid2   -0.045
                                                                     (0.078)
                                                         R-Squared    0.002
                                                         N             166
                                                         SER          0.02
                                                        ---------------------
-
                                                    *  p<0.1;  **  p<0.05;  ***
p<0.01
                                                    Standard     errors     in
parentheses


. reg cresid2 L(1/4).cresid2 L(0/4).Y_fd

      Source |       SS           df       MS      Number of obs   =       163
-------------+----------------------------------   F(9, 153)       =      0.19
       Model |  .001061004         9  .000117889   Prob > F        =    0.9948
    Residual |  .094153134       153   .00061538   R-squared       =    0.0111
-------------+----------------------------------   Adj R-squared   =   -0.0470
       Total |  .095214138       162  .000587742   Root MSE        =    .02481

------------------------------------------------------------------------------
-
     cresid2 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
-
     cresid2 |
         L1. |  -.0511693   .0807366    -0.63   0.527    -.2106717    .1083332
         L2. |   .0013739   .0808483     0.02   0.986    -.1583491     .161097
         L3. |   .0181298   .0802303     0.23   0.822    -.1403724    .1766319
         L4. |  -.0757422   .0808303    -0.94   0.350    -.2354298    .0839454
             |
        Y_fd |
         --. |  -.0884294   .1817337    -0.49   0.627    -.4474608     .270602
         L1. |   .1047302   .1837289     0.57   0.569    -.2582427    .4677032
         L2. |   .0284626    .185326     0.15   0.878    -.3376655    .3945908
```

```
         L3. |   -.048501   .1832487    -0.26   0.792    -.4105253    .3135233
         L4. |  -.0062691   .1761332    -0.04   0.972    -.3542361    .3416979
             |
       _cons |   4.25e-06   .0033474     0.00   0.999    -.0066089    .0066174
------------------------------------------------------------------------------
-

. testparm L(1/4).cresid2 L(0/4).Y_fd

 ( 1)  L.cresid2 = 0
 ( 2)  L2.cresid2 = 0
 ( 3)  L3.cresid2 = 0
 ( 4)  L4.cresid2 = 0
 ( 5)  Y_fd = 0
 ( 6)  L.Y_fd = 0
 ( 7)  L2.Y_fd = 0
 ( 8)  L3.Y_fd = 0
 ( 9)  L4.Y_fd = 0

       F(  9,   153) =    0.19
            Prob > F =    0.9948

.  outreg  using  serialcorrelation,  bdec(3)  se  title("Regression")
summstat(r2\N\rmse) summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) st
> arlevels (10 5 1) note("Standard errors in parentheses") merge

                                                     Regression
                                                  --------------------------
------
                                                        cresid2
cresid2
                                                  --------------------------
------
                                                   L.cresid2      -0.045    -
0.051
                                                                 (0.078)
(0.081)
                                                   L2.cresid2          0.001

(0.081)
                                                   L3.cresid2          0.018

(0.080)
                                                   L4.cresid2              -
0.076

(0.081)
                                                   Y_fd                    -
0.088

(0.182)
                                                   L.Y_fd              0.105

(0.184)
                                                   L2.Y_fd             0.028

(0.185)
```

```
                                          L3.Y_fd                 -
0.049

(0.183)
                                          L4.Y_fd                 -
0.006

(0.176)
                                          _cons               0.000

(0.003)
                                          R-Squared    0.002   0.011
                                          N              166     163
                                          SER           0.02    0.02
                                          -------------------------
------
                                          *  p<0.1;  **  p<0.05;  ***
p<0.01
                                          Standard     errors     in
parentheses

. reg I_fd time time2

      Source |       SS           df       MS      Number of obs   =       175
-------------+----------------------------------   F(2, 172)       =      0.27
       Model |  .001246402         2  .000623201   Prob > F        =    0.7613
    Residual |   .39231899       172  .002280924   R-squared       =    0.0032
-------------+----------------------------------   Adj R-squared   =   -0.0084
       Total |  .393565391       174   .00226187   Root MSE        =    .04776

-----------------------------------------------------------------------------
-
        I_fd |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+---------------------------------------------------------------
-
        time |  -.0001359   .0002508    -0.54   0.589     -.000631    .0003592
       time2 |   1.05e-06   1.58e-06     0.66   0.508    -2.07e-06    4.17e-06
       _cons |   .0128122   .0082788     1.55   0.124    -.0035289    .0291533
-----------------------------------------------------------------------------
-

. outreg using timetrend, bdec(3) se title("Regression") summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevels
>  (10 5 1) note("Standard errors in parentheses") replace

                                                          Regression
                                                     ---------------------
-
                                                              I_fd
                                                     ---------------------
-
                                                      time        -0.000
                                                                  (0.000)
                                                      time2        0.000
                                                                  (0.000)
                                                      _cons        0.013
                                                                  (0.008)
```

```
                                                         R-Squared    0.003
                                                         N             175
                                                         SER          0.05
                                                        ---------------------
-
                                                     *  p<0.1;  **  p<0.05;  ***
p<0.01
                                                     Standard     errors     in
parentheses

. gen quarter = mod(time,4)+1

. reg I_fd i.quarter

      Source |       SS           df       MS      Number of obs   =       175
-------------+----------------------------------   F(3, 171)       =      0.63
       Model |  .004278061         3   .00142602   Prob > F        =    0.5989
    Residual |   .38928733       171  .002276534   R-squared       =    0.0109
-------------+----------------------------------   Adj R-squared   =   -0.0065
       Total |  .393565391       174   .00226187   Root MSE        =    .04771

----------------------------------------------------------------------------
-
        I_fd |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+--------------------------------------------------------------
-
     quarter |
          2  |  -.0069712   .0102314    -0.68   0.497    -.0271673     .013225
          3  |  -.0087589   .0102314    -0.86   0.393    -.0289551    .0114373
          4  |  -.0138567   .0102314    -1.35   0.177    -.0340528    .0063395
             |
       _cons |   .0186524   .0072762     2.56   0.011     .0042897     .033015
----------------------------------------------------------------------------
-

. testparm i.quarter

 ( 1)  2.quarter = 0
 ( 2)  3.quarter = 0
 ( 3)  4.quarter = 0

       F(  3,   171) =    0.63
            Prob > F =    0.5989

. reg I_fd L(0/8).Y_fd L(1/8).I_fd ect
note: L.Y_fd omitted because of collinearity

      Source |       SS           df       MS      Number of obs   =       167
-------------+----------------------------------   F(17, 149)      =     23.27
       Model |  .263180661        17  .015481215   Prob > F        =    0.0000
    Residual |  .099134495       149  .000665332   R-squared       =    0.7264
-------------+----------------------------------   Adj R-squared   =    0.6952
       Total |  .362315156       166  .002182621   Root MSE        =    .02579

----------------------------------------------------------------------------
-
        I_fd |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
```

```
-------------+----------------------------------------------------------------
-
        Y_fd |
         --. |   3.040279    .194724    15.61   0.000     2.655502    3.425056
         L1. |          0  (omitted)
         L2. |   .2533246   .3265832     0.78   0.439    -.3920081    .8986573
         L3. |   .0726045   .3287765     0.22   0.826    -.5770621    .7222711
         L4. |    .785034   .3321703     2.36   0.019     .1286611    1.441407
         L5. |  -.2274536   .3244434    -0.70   0.484     -.868558    .4136508
         L6. |  -.0045289   .3247762    -0.01   0.989     -.646291    .6372332
         L7. |  -.2117834   .3257483    -0.65   0.517    -.8554663    .4318994
         L8. |  -.4346998   .3296194    -1.32   0.189    -1.086032    .2166326
             |
        I_fd |
         L1. |   .0336483   .0591367     0.57   0.570    -.0832066    .1505031
         L2. |  -.0969644   .0810282    -1.20   0.233    -.2570773    .0631484
         L3. |  -.0807527   .0811315    -1.00   0.321    -.2410696    .0795641
         L4. |  -.1818905   .0798491    -2.28   0.024    -.3396733   -.0241076
         L5. |  -.0636355   .0796243    -0.80   0.425    -.2209742    .0937033
         L6. |   .0436412   .0791553     0.55   0.582    -.1127707    .2000531
         L7. |   -.001038   .0792908    -0.01   0.990    -.1577176    .1556416
         L8. |  -.0432127   .0796399    -0.54   0.588    -.2005822    .1141568
             |
         ect |  -.2689016   .0973058    -2.76   0.006    -.4611793    -.076624
       _cons |  -.0144616   .0060017    -2.41   0.017     -.026321   -.0026022
------------------------------------------------------------------------------
-

. outreg using laglength, bdec(3) se title("Regression") summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevels
>  (10 5 1) note("Standard errors in parentheses") replace

                                                            Regression
                                                       ----------------------
---
                                                                I_fd
                                                       ----------------------
---
                                                        Y_fd          3.040

(0.195)***
                                                        oL.Y_fd       0.000
                                                                     (0.000)
                                                        L2.Y_fd       0.253
                                                                     (0.327)
                                                        L3.Y_fd       0.073
                                                                     (0.329)
                                                        L4.Y_fd       0.785
                                                                    (0.332)**
                                                        L5.Y_fd      -0.227
                                                                     (0.324)
                                                        L6.Y_fd      -0.005
                                                                     (0.325)
                                                        L7.Y_fd      -0.212
                                                                     (0.326)
                                                        L8.Y_fd      -0.435
                                                                     (0.330)
                                                        L.I_fd        0.034
```

	(0.059)
L2.I_fd	-0.097
	(0.081)
L3.I_fd	-0.081
	(0.081)
L4.I_fd	-0.182
	(0.080)**
L5.I_fd	-0.064
	(0.080)
L6.I_fd	0.044
	(0.079)
L7.I_fd	-0.001
	(0.079)
L8.I_fd	-0.043
	(0.080)
ect	-0.269
	(0.097)***
_cons	-0.014
	(0.006)**
R-Squared	0.726
N	167
SER	0.03

* p<0.1; ** p<0.05; *** p<0.01

Standard errors in parentheses

```
. reg I_fd L(0/7).Y_fd L(1/7).I_fd ect
note: L.Y_fd omitted because of collinearity

      Source |       SS           df       MS      Number of obs   =       168
-------------+----------------------------------   F(15, 152)      =     24.63
       Model |  .258053428        15  .017203562   Prob > F        =    0.0000
    Residual |  .106149368       152  .000698351   R-squared       =    0.7085
-------------+----------------------------------   Adj R-squared   =    0.6798
       Total |  .364202796       167  .002180855   Root MSE        =    .02643

-------------------------------------------------------------------------------
-
        I_fd |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+-----------------------------------------------------------------
-
        Y_fd |
         --. |   3.085734    .192218    16.05   0.000      2.70597    3.465498
         L1. |          0  (omitted)
         L2. |   .2189948   .3338783     0.66   0.513    -.4406466    .8786362
         L3. |  -.0347283   .3351161    -0.10   0.918    -.6968151    .6273586
         L4. |   .7259044   .3232242     2.25   0.026     .0873124    1.364496
         L5. |  -.3284977   .3308438    -0.99   0.322    -.9821437    .3251484
         L6. |  -.0377947   .3322129    -0.11   0.910    -.6941457    .6185562
         L7. |  -.3910401   .3249227    -1.20   0.231    -1.032988    .2509077
             |
        I_fd |
         L1. |   .0538621   .0601201     0.90   0.372    -.0649168     .172641
```

```
         L2. |  -.0904312   .0825159    -1.10   0.275    -.2534573    .0725949
         L3. |  -.0243251   .0810972    -0.30   0.765    -.1845484    .1358982
         L4. |  -.1648775   .0799499    -2.06   0.041     -.322834   -.006921
         L5. |  -.0296092   .0807777    -0.37   0.714    -.1892013     .129983
         L6. |   .0525083   .0809126     0.65   0.517    -.1073503    .2123668
         L7. |   .0081161   .0793656     0.10   0.919     -.148686    .1649182
             |
         ect |  -.2474393   .0992815    -2.49   0.014    -.4435893   -.0512893
       _cons |  -.0163138   .0056179    -2.90   0.004     -.027413   -.0052146
------------------------------------------------------------------------------
-

. outreg using laglength, bdec(3) se title("Regression") summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevels
>  (10 5 1) note("Standard errors in parentheses") merge
```

```
                                                          Regression
                                                 ----------------------------
---------
                                                             I_fd
I_fd
                                                 ----------------------------
---------
                                                  Y_fd          3.040      3.086
                                                             (0.195)***
(0.192)***
                                                  oL.Y_fd        0.000      0.000
                                                              (0.000)
(0.000)
                                                  L2.Y_fd        0.253      0.219
                                                              (0.327)
(0.334)
                                                  L3.Y_fd          0.073         -
0.035
                                                              (0.329)
(0.335)
                                                  L4.Y_fd        0.785      0.726
                                                             (0.332)**
(0.323)**
                                                  L5.Y_fd          -0.227        -
0.328
                                                              (0.324)
(0.331)
                                                  L6.Y_fd          -0.005        -
0.038
                                                              (0.325)
(0.332)
                                                  L7.Y_fd          -0.212        -
0.391
                                                              (0.326)
(0.325)
                                                  L8.Y_fd         -0.435
                                                              (0.330)
                                                  L.I_fd         0.034      0.054
                                                              (0.059)
(0.060)
                                                  L2.I_fd          -0.097        -
0.090
```

```
                                                       (0.081)
(0.083)
                                          L3.I_fd        -0.081        -
0.024
                                                       (0.081)
(0.081)
                                          L4.I_fd        -0.182        -
0.165
                                                      (0.080)**
(0.080)**
                                          L5.I_fd        -0.064        -
0.030
                                                       (0.080)
(0.081)
                                          L6.I_fd      0.044       0.053
                                                       (0.079)
(0.081)
                                          L7.I_fd     -0.001       0.008
                                                       (0.079)
(0.079)
                                          L8.I_fd       -0.043
                                                       (0.080)
                                          ect            -0.269        -
0.247
                                                      (0.097)***
(0.099)**
                                          _cons          -0.014        -
0.016
                                                      (0.006)**
(0.006)***
                                          R-Squared                0.726
0.709
                                          N               167        168
                                          SER            0.03       0.03
                                         ----------------------------
---------
                                            *  p<0.1;  **  p<0.05;  ***
p<0.01
                                            Standard     errors      in
parentheses


. reg I_fd L(0/6).Y_fd L(1/6).I_fd ect
note: L.Y_fd omitted because of collinearity

      Source |       SS           df       MS      Number of obs   =       169
-------------+----------------------------------   F(13, 155)      =     28.50
       Model |  .260692459        13  .020053266   Prob > F        =    0.0000
    Residual |  .109060957       155  .000703619   R-squared       =    0.7050
-------------+----------------------------------   Adj R-squared   =    0.6803
       Total |  .369753415       168  .002200913   Root MSE        =    .02653

-----------------------------------------------------------------------------
-
        I_fd |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+---------------------------------------------------------------
-
        Y_fd |
```

```
         --. |   3.137651     .19099    16.43   0.000     2.760372     3.51493
         L1. |          0  (omitted)
         L2. |    .159292   .3337068     0.48   0.634    -.4999081    .8184922
         L3. |  -.1129391   .3204387    -0.35   0.725    -.7459296    .5200514
         L4. |   .6762557   .3234599     2.09   0.038     .0372971    1.315214
         L5. |  -.3577797   .3313736    -1.08   0.282    -1.012371    .2968115
         L6. |  -.1525259   .3246796    -0.47   0.639    -.7938938     .488842
             |
        I_fd |
         L1. |   .0598896   .0595826     1.01   0.316    -.0578091    .1775882
         L2. |  -.0565543   .0810875    -0.70   0.487    -.2167335    .1036248
         L3. |  -.0133882    .079555    -0.17   0.867    -.1705402    .1437638
         L4. |  -.1485876   .0796729    -1.86   0.064    -.3059724    .0087972
         L5. |  -.0243046    .080944    -0.30   0.764    -.1842003    .1355911
         L6. |   .0558661   .0794501     0.70   0.483    -.1010787    .2128109
             |
         ect |  -.2528969   .0994602    -2.54   0.012    -.4493694   -.0564244
       _cons |  -.0179883   .0051984    -3.46   0.001    -.0282571   -.0077195
------------------------------------------------------------------------------
-

. outreg using laglength, bdec(3) se title("Regression") summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevels
>  (10 5 1) note("Standard errors in parentheses") merge

                                                  Regression
                                    ----------------------------------

---------------
                                                 I_fd           I_fd
I_fd
                                    ----------------------------------
---------------
                                     Y_fd           3.040          3.086
3.138
                                                 (0.195)***  (0.192)***
(0.191)***
                                     oL.Y_fd        0.000          0.000
0.000
                                                  (0.000)        (0.000)
(0.000)
                                     L2.Y_fd        0.253          0.219
0.159
                                                  (0.327)        (0.334)
(0.334)
                                     L3.Y_fd        0.073         -0.035
-0.113
                                                  (0.329)        (0.335)
(0.320)
                                     L4.Y_fd        0.785          0.726
0.676
                                                 (0.332)**      (0.323)**
(0.323)**
                                     L5.Y_fd       -0.227         -0.328
-0.358
                                                  (0.324)        (0.331)
(0.331)
                                     L6.Y_fd       -0.005         -0.038
-0.153
```

	(0.325)	(0.332)	(0.325)
L7.Y_fd	-0.212	-0.391	
	(0.326)	(0.325)	
L8.Y_fd	-0.435		
	(0.330)		
L.I_fd	0.034	0.054	0.060
	(0.059)	(0.060)	(0.060)
L2.I_fd	-0.097	-0.090	-0.057
	(0.081)	(0.083)	(0.081)
L3.I_fd	-0.081	-0.024	-0.013
	(0.081)	(0.081)	(0.080)
L4.I_fd	-0.182	-0.165	-0.149
	(0.080)**	(0.080)**	(0.080)*
L5.I_fd	-0.064	-0.030	-0.024
	(0.080)	(0.081)	(0.081)
L6.I_fd	0.044	0.053	0.056
	(0.079)	(0.081)	(0.079)
L7.I_fd	-0.001	0.008	
	(0.079)	(0.079)	
L8.I_fd	-0.043		
	(0.080)		
ect	-0.269	-0.247	-0.253
	(0.097)***	(0.099)**	(0.099)**
_cons	-0.014	-0.016	-0.018
	(0.006)**	(0.006)***	(0.005)***
R-Squared	0.726	0.709	0.705
N	167	168	169
SER	0.03	0.03	0.03

* p<0.1; ** p<0.05; *** p<0.01

Standard errors in parentheses

```
. reg I_fd L(0/5).Y_fd L(1/5).I_fd ect
note: L.Y_fd omitted because of collinearity
```

```
      Source |       SS           df       MS      Number of obs   =       170
-------------+----------------------------------   F(11, 158)      =     34.74
       Model |  .264753745        11  .024068522   Prob > F        =    0.0000
    Residual |  .109472744       158  .000692865   R-squared       =    0.7075
-------------+----------------------------------   Adj R-squared   =    0.6871
       Total |   .37422649       169  .002214358   Root MSE        =    .02632

------------------------------------------------------------------------------
-
        I_fd |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
-
        Y_fd |
         --. |   3.153785    .186528    16.91   0.000     2.785375    3.522195
         L1. |          0  (omitted)
         L2. |   .1481697   .3157765     0.47   0.640    -.4755179    .7718574
         L3. |  -.1075455   .3172349    -0.34   0.735    -.7341137    .5190226
         L4. |    .683043   .3200498     2.13   0.034     .0509152    1.315171
         L5. |  -.3240154   .3196482    -1.01   0.312      -.95535    .3073193
             |
        I_fd |
         L1. |   .0594143   .0585093     1.02   0.311     -.056147    .1749757
         L2. |  -.0616691   .0786421    -0.78   0.434    -.2169945    .0936563
         L3. |  -.0157896    .078436    -0.20   0.841    -.1707078    .1391286
         L4. |  -.1518748   .0788677    -1.93   0.056    -.3076458    .0038962
         L5. |  -.0342023   .0784842    -0.44   0.664    -.1892158    .1208113
             |
         ect |  -.2567986   .0983626    -2.61   0.010    -.4510739   -.0625233
       _cons |  -.0189131   .0046712    -4.05   0.000    -.0281391    -.009687
------------------------------------------------------------------------------
-

. outreg using laglength, bdec(3) se title("Regression") summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevels
>  (10 5 1) note("Standard errors in parentheses") merge

                                                      Regression
                                     ----------------------------------------
---------------------
                                                   I_fd       I_fd       I_fd
I_fd
                                     ----------------------------------------
---------------------
                                      Y_fd        3.040      3.086      3.138
3.154
                                                (0.195)***          (0.192)***
(0.191)***  (0.187)***
                                      oL.Y_fd      0.000      0.000      0.000
0.000
                                                 (0.000)               (0.000)
(0.000)     (0.000)
                                      L2.Y_fd      0.253      0.219      0.159
0.148
                                                 (0.327)               (0.334)
(0.334)     (0.316)
                                      L3.Y_fd      0.073     -0.035          -
0.113      -0.108
```

(0.320)	(0.317)
0.683	
(0.323)**	(0.320)**
0.358	-0.324
(0.331)	(0.320)
0.153	
(0.325)	
0.059	
(0.060)	(0.059)
0.057	-0.062
(0.081)	(0.079)
0.013	-0.016
(0.080)	(0.078)
0.149	-0.152
(0.080)*	(0.079)*
0.024	-0.034
(0.081)	(0.078)
(0.079)	
0.253	-0.257
(0.099)**	(0.098)***
0.018	-0.019
(0.005)***	(0.005)***
0.707	
170	

	(0.329)		(0.335)
L4.Y_fd	0.785	0.726	0.676
	(0.332)**		(0.323)**
L5.Y_fd	-0.227	-0.328	-
	(0.324)		(0.331)
L6.Y_fd	-0.005	-0.038	-
	(0.325)		(0.332)
L7.Y_fd	-0.212	-0.391	
	(0.326)	(0.325)	
L8.Y_fd	-0.435		
	(0.330)		
L.I_fd	0.034	0.054	0.060
	(0.059)		(0.060)
L2.I_fd	-0.097	-0.090	-
	(0.081)		(0.083)
L3.I_fd	-0.081	-0.024	-
	(0.081)		(0.081)
L4.I_fd	-0.182	-0.165	-
	(0.080)**		(0.080)**
L5.I_fd	-0.064	-0.030	-
	(0.080)		(0.081)
L6.I_fd	0.044	0.053	0.056
	(0.079)		(0.081)
L7.I_fd	-0.001	0.008	
	(0.079)	(0.079)	
L8.I_fd	-0.043		
	(0.080)		
ect	-0.269	-0.247	-
	(0.097)***		(0.099)**
_cons	-0.014	-0.016	-
	(0.006)**		(0.006)***
R-Squared	0.726	0.709	0.705
N	167	168	169

```
                                          SER           0.03        0.03        0.03
0.03
                                         ----------------------------------------
---------------------
                                                         *  p<0.1;  **  p<0.05;  ***
p<0.01
                                                         Standard     errors     in
parentheses


. reg I_fd L(0/4).Y_fd L(1/4).I_fd ect
note: L.Y_fd omitted because of collinearity

      Source |       SS           df       MS      Number of obs   =       171
-------------+----------------------------------   F(9, 161)       =     41.11
       Model |  .261675648         9  .029075072   Prob > F        =    0.0000
    Residual |  .113855215       161  .000707175   R-squared       =    0.6968
-------------+----------------------------------   Adj R-squared   =    0.6799
       Total |  .375530863       170  .002209005   Root MSE        =    .02659

------------------------------------------------------------------------------
-
        I_fd |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
-
        Y_fd |
         --. |    3.21922    .185753    17.33   0.000     2.852394    3.586047
         L1. |          0  (omitted)
         L2. |   .0975636    .318343     0.31   0.760    -.5311027    .7262299
         L3. |  -.1618133   .3192828    -0.51   0.613    -.7923357     .468709
         L4. |   .5493323   .3151804     1.74   0.083    -.0730885    1.171753
             |
        I_fd |
         L1. |    .059694   .0564403     1.06   0.292    -.0517648    .1711528
         L2. |  -.0435832    .079004    -0.55   0.582     -.199601    .1124345
         L3. |   -.008251   .0790304    -0.10   0.917    -.1643209    .1478189
         L4. |   -.146152   .0779462    -1.88   0.063    -.3000808    .0077768
             |
         ect |  -.2540617   .0952492    -2.67   0.008    -.4421606   -.0659627
       _cons |  -.0209986   .0042436    -4.95   0.000     -.029379   -.0126183
------------------------------------------------------------------------------
-

. outreg using laglength, bdec(3) se title("Regression") summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevels
>  (10 5 1) note("Standard errors in parentheses") merge

                                                              Regression
                                ----------------------------------------------
---------------------------
                                               I_fd          I_fd          I_fd
I_fd         I_fd
                                ----------------------------------------------
---------------------------
                                 Y_fd           3.040         3.086         3.138
3.154        3.219
                                            (0.195)***   (0.192)***   (0.191)***
(0.187)***  (0.186)***
```

0.000	0.000
(0.000)	(0.000)
0.148	0.098
(0.316)	(0.318)
-0.108	-0.162
(0.317)	(0.319)
0.683	0.549
(0.320)**	(0.315)*
-0.324	
(0.320)	
0.059	0.060
(0.059)	(0.056)
-0.062	-0.044
(0.079)	(0.079)
-0.016	-0.008
(0.078)	(0.079)
-0.152	-0.146
(0.079)*	(0.078)*
-0.034	
(0.078)	
-0.257	-0.254
(0.098)***	(0.095)***
-0.019	-0.021

oL.Y_fd	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
L2.Y_fd	0.253	0.219	0.159
	(0.327)	(0.334)	(0.334)
L3.Y_fd	0.073	-0.035	-0.113
	(0.329)	(0.335)	(0.320)
L4.Y_fd	0.785	0.726	0.676
	(0.332)**	(0.323)**	(0.323)**
L5.Y_fd	-0.227	-0.328	-0.358
	(0.324)	(0.331)	(0.331)
L6.Y_fd	-0.005	-0.038	-0.153
	(0.325)	(0.332)	(0.325)
L7.Y_fd	-0.212	-0.391	
	(0.326)	(0.325)	
L8.Y_fd	-0.435		
	(0.330)		
L.I_fd	0.034	0.054	0.060
	(0.059)	(0.060)	(0.060)
L2.I_fd	-0.097	-0.090	-0.057
	(0.081)	(0.083)	(0.081)
L3.I_fd	-0.081	-0.024	-0.013
	(0.081)	(0.081)	(0.080)
L4.I_fd	-0.182	-0.165	-0.149
	(0.080)**	(0.080)**	(0.080)*
L5.I_fd	-0.064	-0.030	-0.024
	(0.080)	(0.081)	(0.081)
L6.I_fd	0.044	0.053	0.056
	(0.079)	(0.081)	(0.079)
L7.I_fd	-0.001	0.008	
	(0.079)	(0.079)	
L8.I_fd	-0.043		
	(0.080)		
ect	-0.269	-0.247	-0.253
	(0.097)***	(0.099)**	(0.099)**
_cons	-0.014	-0.016	-0.018

```
                                    (0.006)**   (0.006)***  (0.005)***
(0.005)***  (0.004)***
                     R-Squared      0.726         0.709         0.705
0.707       0.697
                     N                167           168           169
170         171
                     SER               0.03          0.03          0.03
0.03        0.03
                    -----------------------------------------------
--------------------------
                                          *  p<0.1;  **  p<0.05;  ***
p<0.01
                                          Standard     errors     in
parentheses

. reg I_fd L(0/3).Y_fd L(1/3).I_fd ect
note: L.Y_fd omitted because of collinearity

      Source |       SS           df       MS      Number of obs   =       172
-------------+----------------------------------   F(7, 164)       =     52.19
       Model |  .264704742         7  .037814963   Prob > F        =    0.0000
    Residual |   .11883008       164  .000724574   R-squared       =    0.6902
-------------+----------------------------------   Adj R-squared   =    0.6769
       Total |  .383534822       171  .002242894   Root MSE        =    .02692

-----------------------------------------------------------------------------
-
        I_fd |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+---------------------------------------------------------------
-
        Y_fd |
         --. |   3.161152   .1801162    17.55   0.000     2.805506    3.516797
         L1. |          0  (omitted)
         L2. |   .1393297   .3207498     0.43   0.665    -.4940019    .7726613
         L3. |  -.3058147   .3149064    -0.97   0.333    -.9276084    .3159789
             |
        I_fd |
         L1. |   .0516347    .056969     0.91   0.366    -.0608526     .164122
         L2. |  -.0354157   .0798075    -0.44   0.658    -.1929983     .122167
         L3. |   .0346821   .0780132     0.44   0.657    -.1193576    .1887217
             |
         ect |  -.2642588   .0962501    -2.75   0.007    -.4543079   -.0742097
       _cons |  -.0164163   .0037962    -4.32   0.000     -.023912   -.0089205
-----------------------------------------------------------------------------
-

. outreg using laglength, bdec(3) se title("Regression") summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevels
>  (10 5 1) note("Standard errors in parentheses") merge

                                                    Regression
                         ---------------------------------------------------
--------------------------------
                                    I_fd       I_fd       I_fd       I_fd
I_fd        I_fd
                         ---------------------------------------------------
--------------------------------
```

Y_fd	3.040	3.086	3.138	3.154	3.219	3.161
	(0.195)***	(0.192)***	(0.191)***	(0.187)***	(0.186)***	(0.180)***
oL.Y_fd	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
L2.Y_fd	0.253	0.219	0.159	0.148	0.098	0.139
	(0.327)	(0.334)	(0.334)	(0.316)	(0.318)	(0.321)
L3.Y_fd	0.073	-0.035	-0.113	-0.108	-0.162	-0.306
	(0.329)	(0.335)	(0.320)	(0.317)	(0.319)	(0.315)
L4.Y_fd	0.785	0.726	0.676	0.683	0.549	
	(0.332)**	(0.323)**	(0.323)**	(0.320)**	(0.315)*	
L5.Y_fd	-0.227	-0.328	-0.358	-0.324		
	(0.324)	(0.331)	(0.331)	(0.320)		
L6.Y_fd	-0.005	-0.038	-0.153			
	(0.325)	(0.332)	(0.325)			
L7.Y_fd	-0.212	-0.391				
	(0.326)	(0.325)				
L8.Y_fd	-0.435					
	(0.330)					
L.I_fd	0.034	0.054	0.060	0.059	0.060	0.052
	(0.059)	(0.060)	(0.060)	(0.059)	(0.056)	(0.057)
L2.I_fd	-0.097	-0.090	-0.057	-0.062	-0.044	-0.035
	(0.081)	(0.083)	(0.081)	(0.079)	(0.079)	(0.080)
L3.I_fd	-0.081	-0.024	-0.013	-0.016	-0.008	0.035
	(0.081)	(0.081)	(0.080)	(0.078)	(0.079)	(0.078)
L4.I_fd	-0.182	-0.165	-0.149	-0.152	-0.146	
	(0.080)**	(0.080)**	(0.080)*	(0.079)*	(0.078)*	
L5.I_fd	-0.064	-0.030	-0.024	-0.034		
	(0.080)	(0.081)	(0.081)	(0.078)		
L6.I_fd	0.044	0.053	0.056			
	(0.079)	(0.081)	(0.079)			
L7.I_fd	-0.001	0.008				
	(0.079)	(0.079)				
L8.I_fd	-0.043					
	(0.080)					
ect	-0.269	-0.247	-0.253	-0.257	-0.254	-0.264

```
                                  (0.097)***    (0.099)**      (0.099)**
(0.098)***  (0.095)***  (0.096)***
                           _cons           -0.014       -0.016       -0.018       -
0.019       -0.021       -0.016
                                  (0.006)**      (0.006)***    (0.005)***
(0.005)***  (0.004)***  (0.004)***
                           R-Squared     0.726      0.709      0.705      0.707
0.697       0.690
                           N              167        168        169        170
171         172
                           SER            0.03       0.03       0.03       0.03
0.03        0.03
                          ----------------------------------------------------
--------------------------------
                                                  *  p<0.1;  **  p<0.05;  ***
p<0.01
                                                  Standard     errors     in
parentheses
```

```
. reg I_fd L(0/2).Y_fd L(1/2).I_fd ect
note: L.Y_fd omitted because of collinearity

      Source |       SS           df       MS      Number of obs   =       173
-------------+----------------------------------   F(5, 167)       =     75.74
       Model |  .272913643         5  .054582729   Prob > F        =    0.0000
    Residual |  .120351557       167  .000720668   R-squared       =    0.6940
-------------+----------------------------------   Adj R-squared   =    0.6848
       Total |    .3932652       172  .002286426   Root MSE        =    .02685

-----------------------------------------------------------------------------
-
        I_fd |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+---------------------------------------------------------------
-
        Y_fd |
         --. |   3.187889   .1779045    17.92   0.000     2.836657    3.539121
         L1. |          0  (omitted)
         L2. |   .1561123   .3112981     0.50   0.617    -.4584745    .7706992
             |
        I_fd |
         L1. |   .0399229    .056125     0.71   0.478    -.0708831    .1507289
         L2. |  -.0522363   .0774184    -0.67   0.501    -.2050813    .1006087
             |
         ect |   -.256366   .0957521    -2.68   0.008    -.4454066   -.0673254
       _cons |  -.0189763   .0031335    -6.06   0.000    -.0251626     -.01279
-----------------------------------------------------------------------------
-

. outreg using laglength, bdec(3) se title("Regression") summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevels
>  (10 5 1) note("Standard errors in parentheses") merge

                                                             Regression
                    -----------------------------------------------------------
---------------------------------------
                                 I_fd         I_fd         I_fd         I_fd
I_fd        I_fd        I_fd
```

Y_fd	3.040	3.086	3.138	3.154	3.219	3.161	3.188
	(0.195)***	(0.192)***	(0.191)***	(0.187)***	(0.186)***	(0.180)***	(0.178)***
oL.Y_fd	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
L2.Y_fd	0.253	0.219	0.159	0.148	0.098	0.139	0.156
	(0.327)	(0.334)	(0.334)	(0.316)	(0.318)	(0.321)	(0.311)
L3.Y_fd	0.073	-0.035	-0.113	-0.108	-0.162	-0.306	
	(0.329)	(0.335)	(0.320)	(0.317)	(0.319)	(0.315)	
L4.Y_fd	0.785	0.726	0.676	0.683	0.549		
	(0.332)**	(0.323)**	(0.323)**	(0.320)**	(0.315)*		
L5.Y_fd	-0.227	-0.328	-0.358	-0.324			
	(0.324)	(0.331)	(0.331)	(0.320)			
L6.Y_fd	-0.005	-0.038	-0.153				
	(0.325)	(0.332)	(0.325)				
L7.Y_fd	-0.212	-0.391					
	(0.326)	(0.325)					
L8.Y_fd	-0.435						
	(0.330)						
L.I_fd	0.034	0.054	0.060	0.059	0.060	0.052	0.040
	(0.059)	(0.060)	(0.060)	(0.059)	(0.056)	(0.057)	(0.056)
L2.I_fd	-0.097	-0.090	-0.057	-0.062	-0.044	-0.035	-0.052
	(0.081)	(0.083)	(0.081)	(0.079)	(0.079)	(0.080)	(0.077)
L3.I_fd	-0.081	-0.024	-0.013	-0.016	-0.008	0.035	
	(0.081)	(0.081)	(0.080)	(0.078)	(0.079)	(0.078)	
L4.I_fd	-0.182	-0.165	-0.149	-0.152	-0.146		
	(0.080)**	(0.080)**	(0.080)*	(0.079)*	(0.078)*		
L5.I_fd	-0.064	-0.030	-0.024	-0.034			
	(0.080)	(0.081)	(0.081)	(0.078)			
L6.I_fd	0.044	0.053	0.056				
	(0.079)	(0.081)	(0.079)				
L7.I_fd	-0.001	0.008					
	(0.079)	(0.079)					
L8.I_fd	-0.043						
	(0.080)						
ect	-0.269	-0.247	-0.253	-0.257	-0.254	-0.264	-0.256
	(0.097)***	(0.099)**	(0.099)**	(0.098)***	(0.095)***	(0.096)***	(0.096)***

```
                    _cons          -0.014       -0.016       -0.018       -0.019
-0.021      -0.016      -0.019
                                 (0.006)**   (0.006)***  (0.005)***  (0.005)***
(0.004)***  (0.004)***  (0.003)***
                    R-Squared      0.726        0.709        0.705        0.707
0.697       0.690       0.694
                    N                167          168          169          170
171         172         173
                    SER             0.03         0.03         0.03         0.03
0.03        0.03        0.03
                   ----------------------------------------------------------
---------------------------------------
                                                    *  p<0.1;  **  p<0.05;  ***
p<0.01
                                                    Standard     errors     in
parentheses
```

```
. reg I_fd L(0/1).Y_fd L(1/1).I_fd ect
note: L.Y_fd omitted because of collinearity

      Source |       SS           df       MS      Number of obs   =       174
-------------+----------------------------------   F(3, 170)       =    127.52
       Model |  .272373414         3  .090791138   Prob > F        =    0.0000
    Residual |   .12103926       170  .000711996   R-squared       =    0.6923
-------------+----------------------------------   Adj R-squared   =    0.6869
       Total |  .393412674       173  .002274062   Root MSE        =    .02668

-----------------------------------------------------------------------------
-
        I_fd |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+---------------------------------------------------------------
-
        Y_fd |
         --. |   3.203511   .1749742    18.31   0.000     2.858109    3.548913
         L1. |          0  (omitted)
             |
        I_fd |
         L1. |   .0355611   .0538544     0.66   0.510    -.0707484    .1418706
             |
         ect |  -.2365331   .0926482    -2.55   0.012    -.4194221   -.0536441
       _cons |   -.018135   .0025375    -7.15   0.000    -.0231441   -.0131259
-----------------------------------------------------------------------------
-

. outreg using laglength, bdec(3) se title("Regression") summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevels
>  (10 5 1) note("Standard errors in parentheses") merge

                                                              Regression
             ----------------------------------------------------------------
---------------------------------------------
                             I_fd        I_fd        I_fd        I_fd        I_fd
I_fd        I_fd        I_fd
             ----------------------------------------------------------------
---------------------------------------------
             Y_fd          3.040       3.086       3.138       3.154       3.219
3.161       3.188       3.204
```

	(0.195)***	(0.192)***	(0.191)***	(0.187)***	(0.186)***	(0.180)***	(0.178)***	(0.175)***
oL.Y_fd	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
L2.Y_fd	0.253	0.219	0.159	0.148	0.098	0.139	0.156	
	(0.327)	(0.334)	(0.334)	(0.316)	(0.318)	(0.321)	(0.311)	
L3.Y_fd	0.073	-0.035	-0.113	-0.108	-0.162	-0.306		
	(0.329)	(0.335)	(0.320)	(0.317)	(0.319)	(0.315)		
L4.Y_fd	0.785	0.726	0.676	0.683	0.549			
	(0.332)**	(0.323)**	(0.323)**	(0.320)**	(0.315)*			
L5.Y_fd	-0.227	-0.328	-0.358	-0.324				
	(0.324)	(0.331)	(0.331)	(0.320)				
L6.Y_fd	-0.005	-0.038	-0.153					
	(0.325)	(0.332)	(0.325)					
L7.Y_fd	-0.212	-0.391						
	(0.326)	(0.325)						
L8.Y_fd	-0.435							
	(0.330)							
L.I_fd	0.034	0.054	0.060	0.059	0.060	0.052	0.040	0.036
	(0.059)	(0.060)	(0.060)	(0.059)	(0.056)	(0.057)	(0.056)	(0.054)
L2.I_fd	-0.097	-0.090	-0.057	-0.062	-0.044	-0.035	-0.052	
	(0.081)	(0.083)	(0.081)	(0.079)	(0.079)	(0.080)	(0.077)	
L3.I_fd	-0.081	-0.024	-0.013	-0.016	-0.008	0.035		
	(0.081)	(0.081)	(0.080)	(0.078)	(0.079)	(0.078)		
L4.I_fd	-0.182	-0.165	-0.149	-0.152	-0.146			
	(0.080)**	(0.080)**	(0.080)*	(0.079)*	(0.078)*			
L5.I_fd	-0.064	-0.030	-0.024	-0.034				
	(0.080)	(0.081)	(0.081)	(0.078)				
L6.I_fd	0.044	0.053	0.056					
	(0.079)	(0.081)	(0.079)					
L7.I_fd	-0.001	0.008						
	(0.079)	(0.079)						
L8.I_fd	-0.043							
	(0.080)							
ect	-0.269	-0.247	-0.253	-0.257	-0.254	-0.264	-0.256	-0.237
	(0.097)***	(0.099)**	(0.099)**	(0.098)***	(0.095)***	(0.096)***	(0.096)***	(0.093)**
_cons	-0.014	-0.016	-0.018	-0.019	-0.021	-0.016	-0.019	-0.018
	(0.006)**	(0.006)***	(0.005)***	(0.005)***	(0.004)***	(0.004)***	(0.003)***	(0.003)***

```
             R-Squared    0.726       0.709       0.705       0.707       0.697
0.690        0.694        0.692
             N              167         168         169         170         171
172          173          174
             SER           0.03        0.03        0.03        0.03        0.03
0.03         0.03         0.03
             ----------------------------------------------------------------
---------------------------------------------
                                                  * p<0.1; ** p<0.05; ***
p<0.01
                                                  Standard    errors    in
parentheses


.
. reg  I_fd L.I_fd L.Y_fd ect
note: L.Y_fd omitted because of collinearity

      Source |       SS           df       MS      Number of obs   =       174
-------------+----------------------------------   F(2, 171)       =      8.01
       Model |  .033712357         2  .016856179   Prob > F        =    0.0005
    Residual |  .359700317       171  .002103511   R-squared       =    0.0857
-------------+----------------------------------   Adj R-squared   =    0.0750
       Total |  .393412674       173  .002274062   Root MSE        =    .04586

------------------------------------------------------------------------------
-
        I_fd |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
-
        I_fd |
         L1. |   .3086692   .0889449     3.47   0.001     .1330979    .4842406
             |
        Y_fd |
         L1. |          0  (omitted)
             |
         ect |  -.5650673   .1562312    -3.62   0.000    -.8734574   -.2566771
       _cons |   .0077988   .0036187     2.16   0.033     .0006556    .0149419
------------------------------------------------------------------------------
-

. outreg using finalmodel, bdec(3) se title("Regression") summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevel
> s (10 5 1) note("Standard errors in parentheses") replace
(note: file finalmodel.doc not found)
                                                        Regression
                                                 ----------------------
---
                                                               I_fd
                                                 ----------------------
---
                                                  L.I_fd       0.309

(0.089)***
                                                  oL.Y_fd      0.000
                                                              (0.000)
                                                  ect          -0.565
```

```
(0.156)***
                                                               _cons         0.008
                                                                           (0.004)**
                                                               R-Squared     0.086
                                                               N              174
                                                               SER            0.05
                                                              ----------------------
---
                                                          *  p<0.1;  **  p<0.05;  ***
p<0.01
                                                          Standard     errors     in
parentheses

. gen IM = _b[Y_fd]
[Y_fd] not found
r(111);

. reg I_fd L.I_fd Y_fd ect

      Source |       SS           df       MS      Number of obs   =       174
-------------+----------------------------------   F(3, 170)       =    127.52
       Model |  .272373414         3  .090791138   Prob > F        =    0.0000
    Residual |   .12103926       170  .000711996   R-squared       =    0.6923
-------------+----------------------------------   Adj R-squared   =    0.6869
       Total |  .393412674       173  .002274062   Root MSE        =    .02668

------------------------------------------------------------------------------
-
        I_fd |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
-
        I_fd |
         L1. |   .0355611   .0538544     0.66   0.510    -.0707484    .1418706
             |
        Y_fd |   3.203511   .1749742    18.31   0.000     2.858109    3.548913
         ect |  -.2365331   .0926482    -2.55   0.012    -.4194221   -.0536441
       _cons |   -.018135   .0025375    -7.15   0.000    -.0231441   -.0131259
------------------------------------------------------------------------------
-

. outreg using finalmodel, bdec(3) se title("Regression") summstat(r2\N\rmse)
summtitle("R-Squared"\"N"\"SER") summdec(3 0 2) starlevel
> s (10 5 1) note("Standard errors in parentheses") replace

                                                                     Regression
                                                              ----------------------
---
                                                                              I_fd
                                                              ----------------------
---
                                                               L.I_fd        0.036
                                                                            (0.054)
                                                               Y_fd          3.204

(0.175)***
                                                               ect           -0.237
```

```
                                                     (0.093)**
                                           _cons        -0.018

(0.003)***
                                           R-Squared     0.692
                                           N              174
                                           SER            0.03
                                          ----------------------
---
                                        *  p<0.1;  **  p<0.05;  ***
p<0.01
                                        Standard     errors     in
parentheses

. gen IM = _b[Y_fd]

. di IM
3.2035105

. gen LRP = _b[Y_fd] / (1- _b[L.I_fd])

. di LRP
3.3216317

. di _b[L.I_fd]
.03556114

. predict yhat, xb
(2 missing values generated)

. label var I_fd "First-differenced Log of Investment"

.  graph  twoway  (scatter  I_fd  time,  ms(o))  (line  yhat  time),  title("First-
differenced Log of Investment Over Time") ytitle("First-differ
>    enced    Log    of    Investment")    subtitle("Quarterly,    1957-2000")
play(stata_gphformat)
recording stata_gphformat not found in either PERSONAL or working directory
r(601);

. arima Y_fd L(1/4).Y_fd if time < q(2001q1)

(setting optimization to BHHH)
Iteration 0:   log likelihood =  527.30294
Iteration 1:   log likelihood =  527.30294

ARIMA regression

Sample:  1958q2 - 2000q4                        Number of obs     =        171
                                                Wald chi2(4)      =      16.49
Log likelihood =  527.3029                      Prob > chi2       =     0.0024

------------------------------------------------------------------------------
-
             |                 OPG
        Y_fd |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
-
```

```
Y_fd         |
        Y_fd |
         L1. |   .2238327   .0729687     3.07   0.002     .0808166    .3668488
         L2. |   .1036935   .0633934     1.64   0.102    -.0205553    .2279423
         L3. |  -.0611831   .0742126    -0.82   0.410    -.2066371    .0842709
         L4. |  -.0138248   .0613896    -0.23   0.822    -.1341462    .1064965
             |
       _cons |    .007116   .0011784     6.04   0.000     .0048064    .0094256
-------------+----------------------------------------------------------------
-
      /sigma |   .0110804   .0004932    22.46   0.000     .0101136    .0120471
------------------------------------------------------------------------------
-
Note: The test of the variance against zero is one sided, and the two-sided
      confidence interval is truncated at zero.

. predict xhatd, dynamic(q(2001q1))
(option xb assumed; predicted values)
(5 missing values generated)

. replace Y_fd = xhatd if time>=q(2001q1)
(0 real changes made)

. use "/Users/baovinhnguyen/Documents/1. STUDY /1. EC 207/Empirical Project
02/invest2.dta", clear

. arima Y_fd L(1/4).Y_fd if time < q(2001q1)

(setting optimization to BHHH)
Iteration 0:   log likelihood =  527.30294
Iteration 1:   log likelihood =  527.30294

ARIMA regression

Sample:  1958q2 - 2000q4                        Number of obs     =        171
                                                Wald chi2(4)      =      16.49
Log likelihood =  527.3029                      Prob > chi2       =     0.0024

------------------------------------------------------------------------------
-
             |                 OPG
        Y_fd |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
-
Y_fd         |
        Y_fd |
         L1. |   .2238327   .0729687     3.07   0.002     .0808166    .3668488
         L2. |   .1036935   .0633934     1.64   0.102    -.0205553    .2279423
         L3. |  -.0611831   .0742126    -0.82   0.410    -.2066371    .0842709
         L4. |  -.0138248   .0613896    -0.23   0.822    -.1341462    .1064965
             |
       _cons |    .007116   .0011784     6.04   0.000     .0048064    .0094256
-------------+----------------------------------------------------------------
-
      /sigma |   .0110804   .0004932    22.46   0.000     .0101136    .0120471
------------------------------------------------------------------------------
-
Note: The test of the variance against zero is one sided, and the two-sided
```

```
      confidence interval is truncated at zero.

. predict xhatd, dynamic(q(2001q1))
variable xhatd already defined
r(110);

. drop xhatd

. predict xhatd, dynamic(q(2001q1))
(option xb assumed; predicted values)
(5 missing values generated)

. replace Y_fd = xhatd if time>=q(2001q1)
(0 real changes made)

. arima I_fd L.I_fd Y_fd ect if time < q(2001q1)

(setting optimization to BHHH)
Iteration 0:   log likelihood =  385.65521
Iteration 1:   log likelihood =  385.65521

ARIMA regression

Sample:  1957q3 - 2000q4                        Number of obs      =       174
                                                Wald chi2(3)       =    738.26
Log likelihood =  385.6552                      Prob > chi2        =    0.0000

------------------------------------------------------------------------------
-
             |                 OPG
        I_fd |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
-
I_fd         |
        I_fd |
         L1. |   .0356087    .050579     0.70   0.481    -.0635242    .1347417
             |
        Y_fd |   3.203511    .129634    24.71   0.000     2.949433    3.457589
         ect |  -.2365807   .0854749    -2.77   0.006    -.4041084    -.069053
       _cons |  -.0180033   .0024564    -7.33   0.000    -.0228178   -.0131887
-------------+----------------------------------------------------------------
-
      /sigma |   .0263748   .0013083    20.16   0.000     .0238106     .028939
------------------------------------------------------------------------------
-
Note: The test of the variance against zero is one sided, and the two-sided
      confidence interval is truncated at zero.

. predict yhatd, dynamic(q(2001q1))
variable yhatd already defined
r(110);

. drop yhatd

. predict yhatd, dynamic(q(2001q1))
(option xb assumed; predicted values)
(2 missing values generated)
```

```
. list time I_fd yhatd if time>=q(2001q1), noobs

  +------------------------------+
  |   time        I_fd     yhatd |
  |------------------------------|
  | 2001q1   -.0059357   .0036152 |
  | 2001q2   -.0157375   .0130963 |
  | 2001q3   -.0106668   .0190771 |
  | 2001q4   -.0256343   .0190701 |
  +------------------------------+

. gen uhat = I_fd - yhatd if time>=q(2001q1)
variable uhat already defined
r(110);

. gen uhat2 = uhat^2
(176 missing values generated)

. drop uhat

. drop uhat2

. gen uhat = I_fd - yhatd if time>=q(2001q1)
(176 missing values generated)

. gen uhat2 = uhat^2
(176 missing values generated)

. drop sigmahat sigmahat2
variable sigmahat not found
r(111);

. reg I_fd L.I_fd Y_fd ect

      Source |       SS           df       MS      Number of obs   =       178
-------------+----------------------------------   F(3, 174)       =    126.48
       Model |  .271653278         3  .090551093   Prob > F        =    0.0000
    Residual |  .124571192       174  .000715926   R-squared       =    0.6856
-------------+----------------------------------   Adj R-squared   =    0.6802
       Total |   .39622447       177  .002238556   Root MSE        =    .02676

-----------------------------------------------------------------------------
-
        I_fd |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+---------------------------------------------------------------
-
        I_fd |
         L1. |   .0364286   .0539998     0.67   0.501    -.0701504    .1430076
             |
        Y_fd |   3.203537    .175452    18.26   0.000     2.857249    3.549825
         ect |  -.2216194   .0925934    -2.39   0.018    -.4043703   -.0388686
       _cons |  -.0186359   .0025239    -7.38   0.000    -.0236172   -.0136546
-----------------------------------------------------------------------------
-

. gen sigmahat = e(rmse)

. gen sigmahat2 = sigmahat^2
```

```
. di sigmahat2
.00071593

. egen sumuhat2 = sum(uhat2)

. di sumuhat2
.0038058

. gen PA = (sumuhat2)/(sigmahat2)
variable PA already defined
r(110);

. di PA
.

. drop PA

. gen PA = (sumuhat2)/(sigmahat2)

. di PA
5.3159027
```