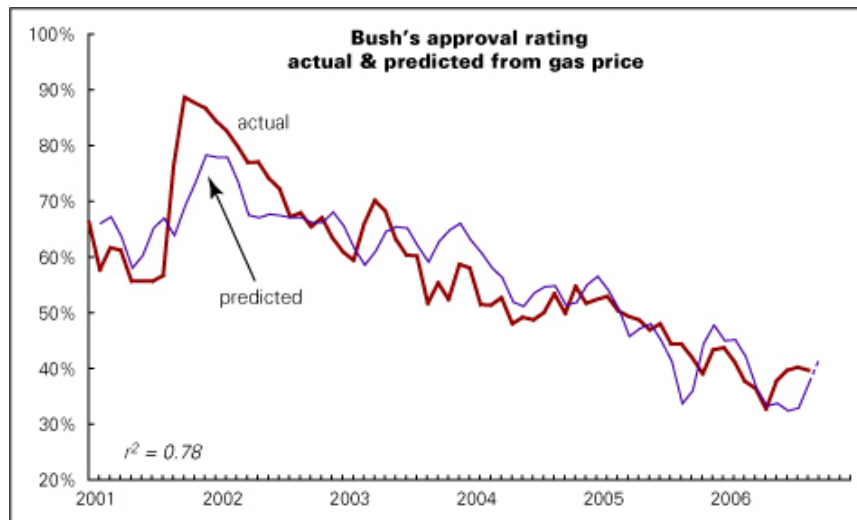
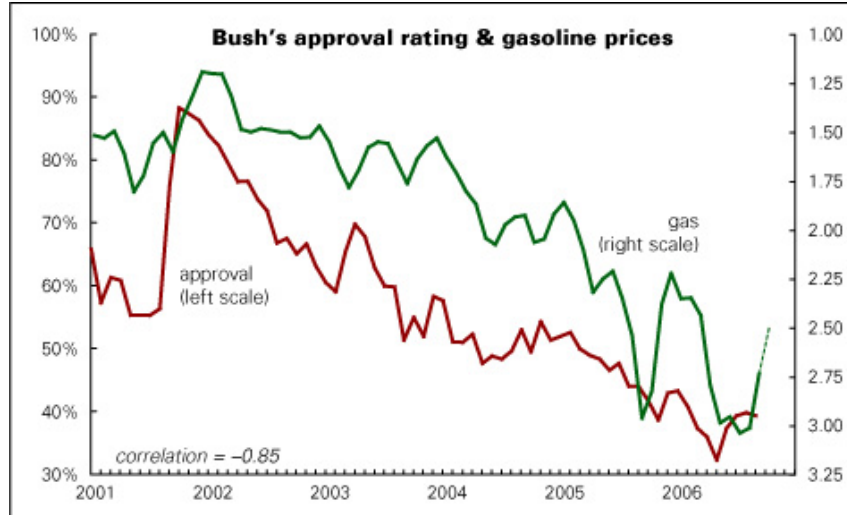


6.1.1 – SAS: Time Series

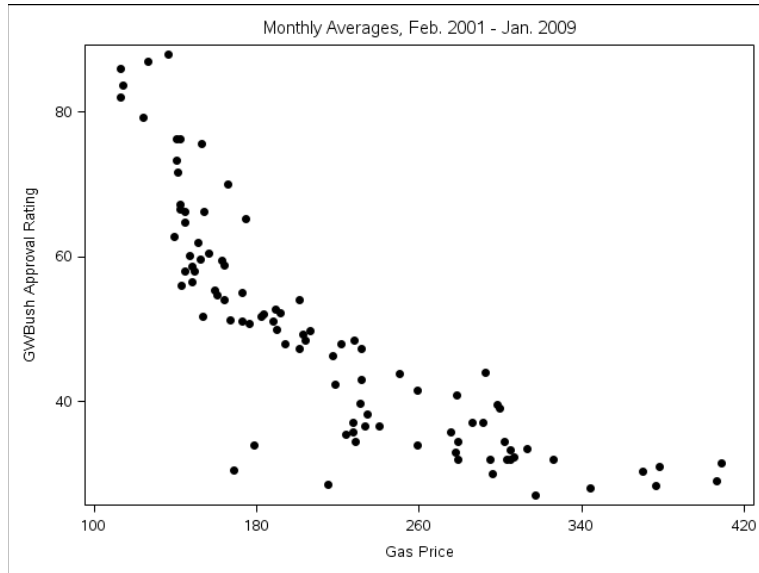
Example 1: “Bush and the price of gas”

- <http://www.leftbusinessobserver.com/BushNGas.html>
- “...no occupant of the White House has ever seen his popularity so closely tied to the price of gas.”
- “There's no precedent for this tight relationship.”



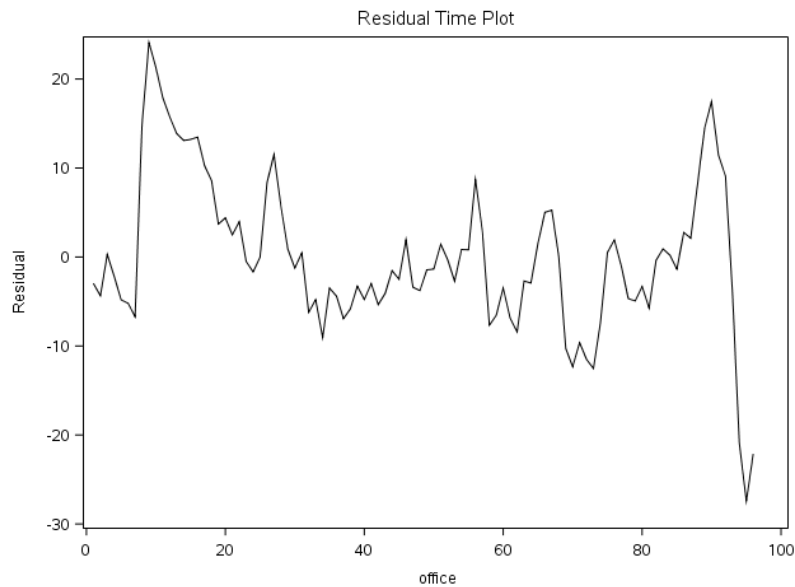
But – can we justify a conclusion that gas price significantly affects approval rating?
(HW 7 will address this more completely)

Presidential Approval Ratings and Gas Price



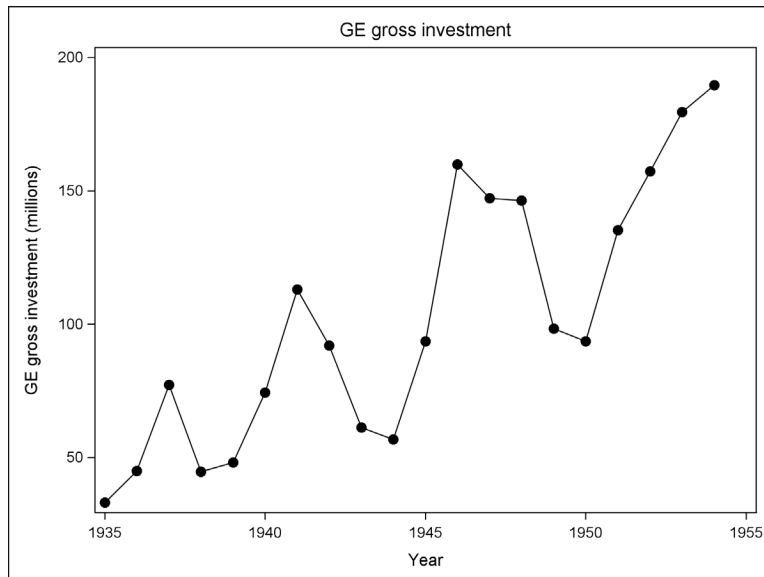
Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	88.80015	2.82573	31.43	<.0001
price	1	-0.18281	0.01242	-14.72	<.0001

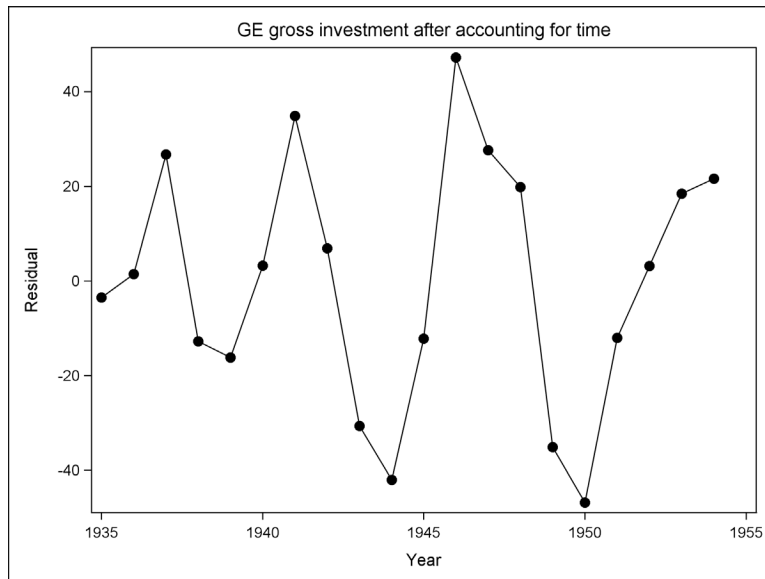


Example 2: General Electric's gross investment (in millions of dollars) for years 1935 – 1954. Originally presented in Grunfeld, Y. (1958), "The Determinants of Corporate Investment," Ph.D. dissertation, University of Chicago; discussed in Boot, J.C.G. (1960), "Investment Demand: An Empirical Contribution to the Aggregation Problem," International Economic Review, 1, 3-30. See also Damodar N. Gujarati, Basic Econometrics, Third Edition, 1995, McGraw-Hill, [1995, pp. 522-525].

```
data GE; input year GEinv @@; cards;
  1935 33.1 1936 45.0 1937 77.2 1938 44.6 1939 48.1
  1940 74.4 1941 113.0 1942 91.9 1943 61.3 1944 56.8
  1945 93.6 1946 159.9 1947 147.2 1948 146.3 1949 98.3
  1950 93.5 1951 135.2 1952 157.3 1953 179.5 1954 189.6
;
proc sgplot data=GE noautolegend;
  scatter y=GEinv x=year /
    markerattrs=(symbol=CIRCLEFILLED size=8pt);
  series y=GEinv x=year / lineattrs=(pattern=solid);
  xaxis label='Year';
  yaxis label='GE gross investment (millions)';
  title1 'GE gross investment';
run;
```



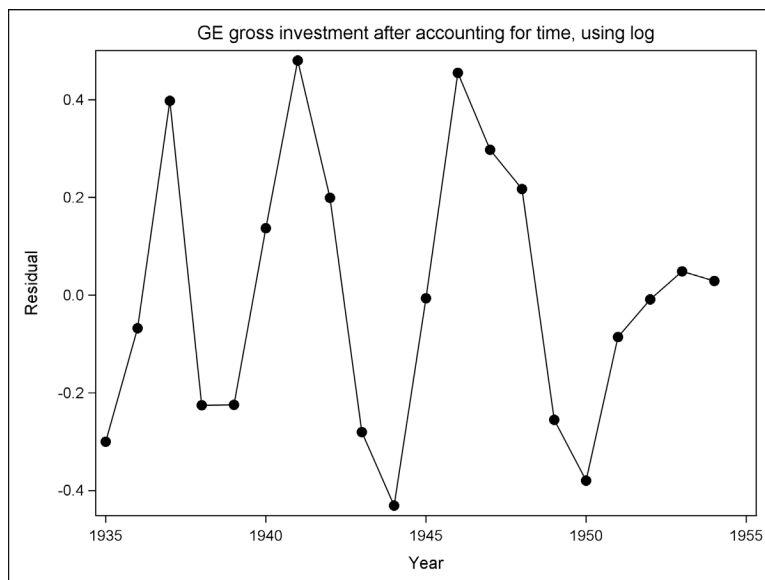
```
/* 1. Make data stationary */
proc reg data=GE noprint;
  model GEinv=year; output out=a1 r=resid;
  title1 'simple regression on time';
proc sgplot data=a1 noautolegend;
  scatter y=resid x=year /
    markerattrs=(symbol=CIRCLEFILLED size=8pt);
  series y=resid x=year / lineattrs=(pattern=solid);
  xaxis label='Year'; yaxis label='Residual';
  title1 'GE gross investment after accounting for time';
run;
```



```

data GE; set GE; logGEinv=log(GEinv);
proc reg data=GE noprint;
  model logGEinv=year; output out=a2 r=resid;
  title1 'simple regression on time, using log';
proc sgplot data=a2 noautolegend;
  scatter y=resid x=year /
    markerattrs=(symbol=CIRCLEFILLED size=8pt);
  series y=resid x=year / lineattrs=(pattern=solid);
  xaxis label='Year'; yaxis label='Residual';
  title1 'GE gross investment after accounting for time,
using log';
run;

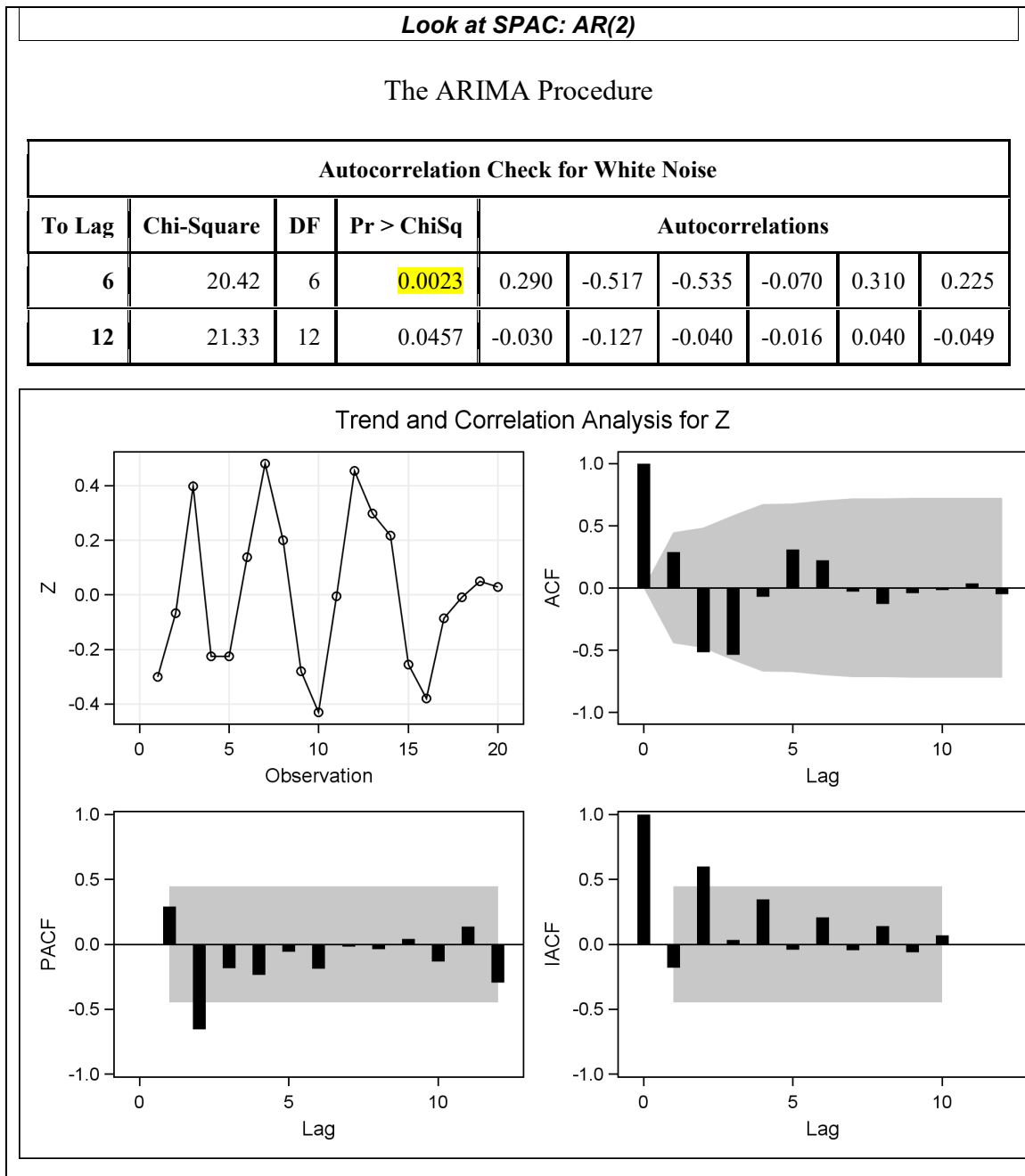
```



```

/* 2. Test for independence and
   3. Investigate potential dependence structures */
data newuse; set a2;
  Z = resid;
proc arima data=newuse;
  identify var=Z nlag=12 ;
  title1 'Look at SPAC: AR(2)';
run;

```



```

/* 4. Fit dependence structure and assess model adequacy */
proc arima data=newuse;
  identify var=logGEinv crosscorr=(year) nlag=12;
  estimate p=2 input=(year) method=uls plot;
  title1 'AR(2) model fit to log of GE data';
run;

```

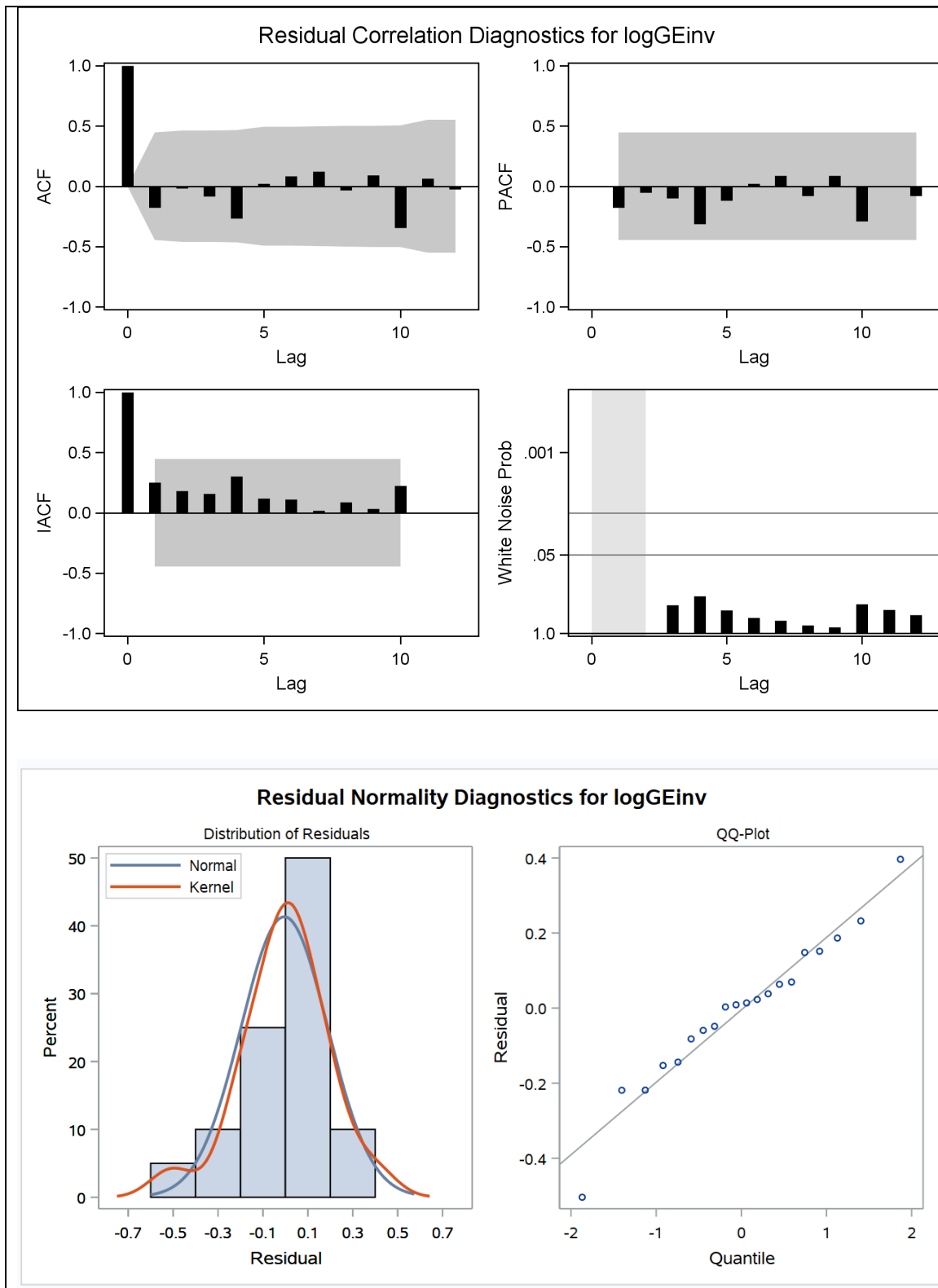
AR(2) model fit to log of GE data

Unconditional Least Squares Estimation							
Parameter	Estimate	Standard Error	t Value	Approx Pr > t	Lag	Variable	Shift
MU	-135.17006	14.84188	-9.11	<.0001	0	logGEinv	0
AR1,1	0.51014	0.18639	2.74	0.0146	1	logGEinv	0
AR1,2	-0.71635	0.17516	-4.09	0.0009	2	logGEinv	0
NUM1	0.07183	0.0076327	9.41	<.0001	0	year	0

Constant Estimate	-163.042
Variance Estimate	0.044281
Std Error Estimate	0.210431

Autocorrelation Check of Residuals

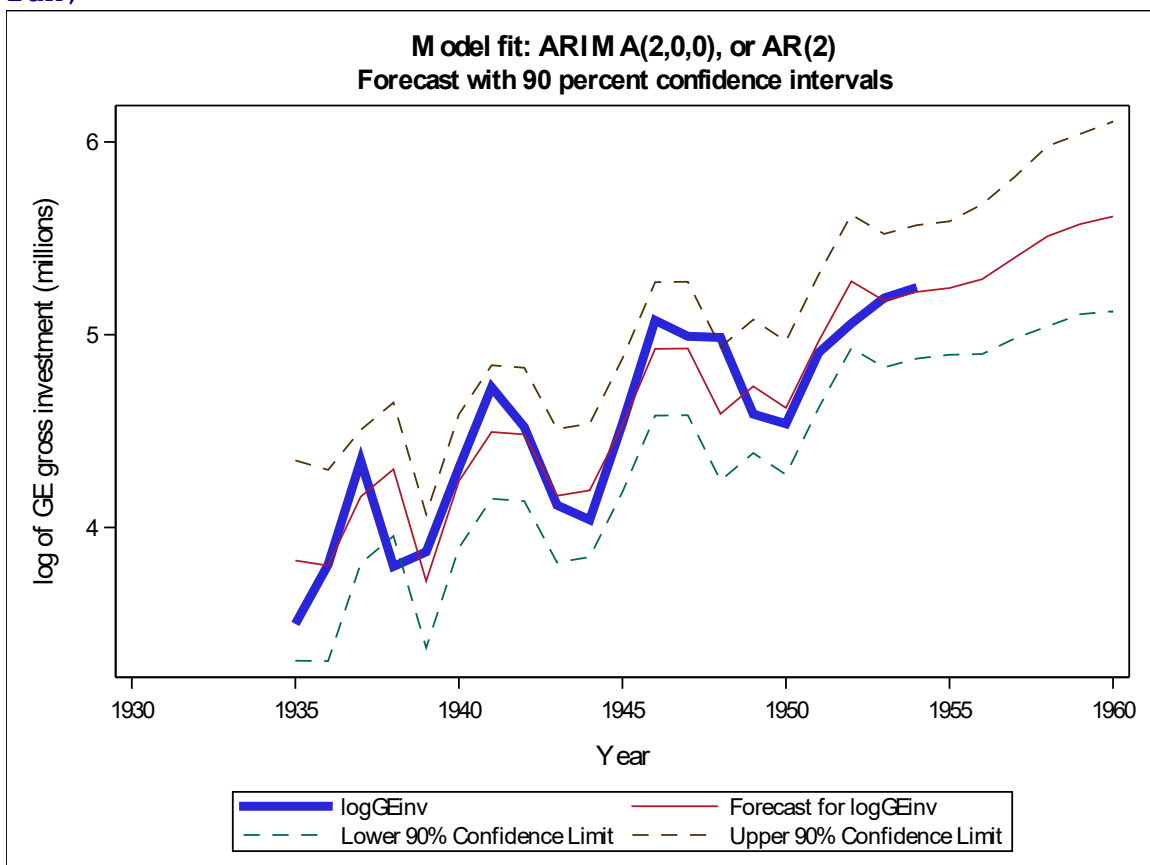
To Lag	Chi-Square	DF	Pr > ChiSq	Autocorrelations					
6	3.11	4	0.5395	-0.176	-0.019	-0.086	-0.269	0.018	0.078
12	9.44	10	0.4910	0.122	-0.032	0.094	-0.343	0.065	-0.026
18	14.23	16	0.5815	-0.140	0.189	-0.037	0.005	0.074	-0.004



```

/* 5. Forecast */
data fout1; set fout1;
  time = _n_ + 1934;
proc sgplot data=fout1;
  series x=time y=logGEinv /
    lineattrs=(pattern=solid thickness=5);
  series x=time y=forecast / lineattrs=(pattern=solid);
  series x=time y=190 / lineattrs=(pattern=dash);
  series x=time y=u90 / lineattrs=(pattern=dash);
  xaxis label='Year' values=(1930 to 1960 by 5);
  yaxis label='log of GE gross investment (millions)';
  title1 'Model fit: ARIMA(2,0,0), or AR(2)';
  title2 'Forecast with 90 percent confidence intervals';
run;

```



```

proc arima data=newuse;
  identify var=logGEinv crosscorr=(year) nlag=12;
  estimate p=1 q=1 input=(year) method=uls plot;
  title1 'ARMA(1,1) model fit to log of GE data';
  title2 '(for comparison)';
run;

```


**ARMA(1,1) model fit to log of GE data
(for comparison)**

Unconditional Least Squares Estimation							
Parameter	Estimate	Standard Error	t Value	Approx Pr > t	Lag	Variable	Shift
MU	-136.13361	27.32905	-4.98	0.0001	0	logGEinv	0
MA1,1	-0.99998	0.50174	-1.99	0.0636	1	logGEinv	0
AR1,1	-0.26677	0.25864	-1.03	0.3177	1	logGEinv	0
NUM1	0.07233	0.01405	5.15	<.0001	0	year	0

Constant Estimate	-172.45
Variance Estimate	0.057055
Std Error Estimate	0.238861

Autocorrelation Check of Residuals									
To Lag	Chi-Square	DF	Pr > ChiSq	Autocorrelations					
6	9.31	4	0.0537	-0.031	-0.243	-0.476	0.032	0.182	0.177
12	10.60	10	0.3893	-0.026	-0.100	0.016	-0.084	0.088	-0.062

