\* This is SAS code file;

\* Can be used for empirical analysis and simulation analysis;

\* Input data;

**DATA** testdata;

INPUT year temp;

Datalines;

1850 -0.435

1851 -0.302

1852 -0.305

1853 -0.338

1854 -0.296

1855 -0.337

1856 -0.41

1857 -0.48

1858 -0.487

1859 -0.353

1860 -0.385

1861 -0.411

1862 -0.518

1863 -0.315

1864 -0.491

1865 -0.296

1866 -0.295

1867 -0.315

1868 -0.268

1869 -0.287

1870 -0.282

1871 -0.335

1872 -0.277

1873 -0.335

1874 -0.377

1875 -0.406

1876 -0.372

1877 -0.127

1878 -0.014

1879 -0.258

1880 -0.247

1881 -0.251

1882 -0.256

1883 -0.308

1884 -0.373

1885 -0.363

1886 -0.289

1887 -0.374

1888 -0.34

1889 -0.223

1890 -0.423

1891 -0.386

1892 -0.481

1893 -0.503

1894 -0.436

1895 -0.418

1896 -0.239

1897 -0.26

1898 -0.402

1899 -0.322

1900 -0.254

1901 -0.317

1902 -0.429

1903 -0.496

1904 -0.539

1905 -0.425

1906 -0.35

1907 -0.518

1908 -0.554

1909 -0.559

1910 -0.544

1911 -0.573

1912 -0.497

1913 -0.486

1914 -0.319

1915 -0.247

1916 -0.434

1917 -0.494

1918 -0.387

1919 -0.332

1920 -0.327

1921 -0.268

1922 -0.378

1923 -0.346

1924 -0.358

1925 -0.274

1926 -0.179

1927 -0.258

1928 -0.254

1929 -0.358

1930 -0.17

1931 -0.138

1932 -0.162

1933 -0.282

1934 -0.161

1935 -0.184

1936 -0.149

1937 -0.041

1938 0.002

1939 -0.002

1940 0.01

1941 0.063

1942 -0.02

1943 -0.019

1944 0.1

1945 -0.024

1946 -0.189

1947 -0.194

1948 -0.196

1949 -0.206

1950 -0.294

1951 -0.169

1952 -0.096

1953 -0.046

1954 -0.246

1955 -0.269

1956 -0.335

1957 -0.085

1958 -0.021

1959 -0.075

1960 -0.119

1961 -0.032

1962 -0.034

1963 -0.01

1964 -0.278

1965 -0.211

1966 -0.151

1967 -0.147

1968 -0.16

1969 -0.026

1970 -0.073

1971 -0.18

1972 -0.066

1973 0.059

1974 -0.207

1975 -0.161

1976 -0.241

1977 0.004

1978 -0.061

1979 0.046

1980 0.069

1981 0.11

1982 0.015

1983 0.171

1984 -0.019

1985 -0.037

1986 0.034

1987 0.178

1988 0.175

1989 0.109

1990 0.248

1991 0.203

1992 0.071

1993 0.105

1994 0.169

1995 0.269

1996 0.139

1997 0.349

1998 0.529

1999 0.304

2000 0.278

2001 0.407

2002 0.455

2003 0.467

2004 0.444

2005 0.474

2006 0.425

2007 0.397

2008 0.329

2009 0.436

2010 0.47

2011 0.341

2012 0.403

;

**Run**;

\* Check data;

**PROC** **PRINT** data=testdata; **RUN**;

\* Prepare variables;

**data** testdata1;

set testdata;

\*if (year< 1950 and year > 1849) then output;

**Run**;

**data** testdata1;

set testdata1;

DL1 =**0**; DT1 =**0**;

Time = year-**1899**;

if (year > **1912**) then DL1= **1**;

if (year > **1912**) then DT1= (year-**1912**)\*DL1;

**run**;

\* Plot data;

**proc** **gplot** data=testdata1;

plot temp\*year;

symbol i=join;

**run**;

\* Running regression analysis;

**proc** **reg** data=testdata1;

\*Model temp = year;

Model temp = year DL1 DT1;

output out=regdata residual=res;

**run**;

\*To get robust t-stats (Newey and West);

\*To perform Newey-West standard error correction, PROC MODEL is run again specifying the

GMM estimation method in the FIT statement. KERNEL=(BART, 5, 0) is also specified which requests

the Bartlett kernel with a lag length of 4.

The VARDEF=n option is specified to be consistent with the original Newey-West formula;

**proc** **model** data=testdata1;

instruments year;

parms b0 b1 ;

temp =b0 + b1\*year;

fit temp / gmm kernel=(bart,**5**,**0**) vardef=n;

**run**;

**quit**;

**proc** **model** data=testdata1;

instruments year DL1 DT1;

parms b0 b1 b2 b3;

temp =b0 + b1\*year +b2\*DL1 +b3\*DT1;

fit temp / gmm kernel=(bart,**5**,**0**) vardef=n;

**run**;

**quit**;

**proc** **arima** data=regdata;

\*identify var= res minic p=(1:10) q=(1:5);

identify var= res scan p=(**1**:**10**) q=(**1**:**5**);

\*identify var= res esacf p=(1:10) q=(1:5);

**run**;

**proc** **arima** data=regdata;

identify var=res stationarity=(adf=(**1**,**2**,**3**,**4**,**5**));

**run**;

\* Test for heteroscedasticity, the White test.

The White test tests the null hypothesis that the variance of the residuals is homogenous.

Therefore, if the p-value is very small, we would have to reject the hypothesis and accept

the alternative hypothesis that the variance is not homogenous.

We use the / spec option on the model statement to obtain the White test.

This test does not account for autocorrelations;

**proc** **reg** data=testdata1;

model temp = year / spec;

**run**;

**quit**;

\* Running GLS-ARMA;

**proc** **arima** data=testdata1 plots(only)=(residual(smooth) forecast(forecasts));

identify var= temp crosscorr=(year) ;

estimate p=**6** q=**0** input=( year) method=ml ;

outlier maxnum=3 alpha=0.05 id=year;

**run**;

**proc** **arima** data=testdata1 plots(only)=(residual(smooth));

identify var= temp crosscorr=(year DL1 DT1) ;

estimate p=**1** q=**0** input=( year DL1 DT1) method=ml ;

forecast id=year PRINTALL out=forecasts;

**run**;

\* Running GLS-AR analysis;

**Proc** **autoreg** data =testdata1;

model temp = year / nlag=**6** method=ml chow = (**64**);

**run**;

**Proc** **autoreg** data =testdata1;

model temp = year DL1 DT1 / nlag=**6** method=ml;

\*test x1 + x2 = 0;

\*test intercept = 1, x1 + x2 = 0;

**run**;

\*If the CROSSCORR= option is specified on the IDENTIFY statement, then

the results of the STATIONARITY, MINIC, ESACF and/or SCAN options are

incorrect；

\*To circumvent the problem, include two IDENTIFY statements in the PROC

ARIMA step: one with the CROSSCORR= option, and the other with the

STATIONARITY, MINIC, ESACF and/or SCAN options；