```
* MSBA 635 - Data Analytics II;

* print data;
*Time Series Example 2 - Nonstationarity Tests
*Phillips-Perron unit root (nonstationarity) test on federal funds rate and change in federal funds rate
*time series test for stationarity or nonstationary

proc print data=tmp1.usa (obs=10);
run;
```

The SAS System 17:16 Tuesday, January 22, 2019 1

Obs	gdp	inf	f	b
1	3807.4	9.47	9.69	11.19
2	3906.3	10.03	10.56	12.64
3	3976.0	10.83	11.39	12.64
4	4034.0	11.51	9.27	11.10
5	4117.2	10.51	8.48	10.68
6	4175.7	9.24	7.92	9.76
7	4258.3	8.37	7.90	9.29
8	4318.7	7.00	8.10	8.84
9	4382.4	6.16	7.83	7.94
10	4423.2	5.90	6.92	7.18

```
* display data attributes;

proc contents data=tmp1.usa;
run;
```


The CONTENTS Procedure

Data Set Name	TMP1.USA	Observations	104
Member Type	DATA	Variables	4
Engine	V9	Indexes	0
Created	11/13/2010 11:53:41	Observation Length	32
Last Modified	11/13/2010 11:53:41	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label			
Data Representation	WINDOWS_32		
Encoding	wlatin1 Western (Windows)		

Engine/Host Dependent Information

Data Set Page Size	4096
Number of Data Set Pages	2
First Data Page	1
Max Obs per Page	126
Obs in First Data Page	80
Number of Data Set Repairs	0
Filename	C:\Users\nxnguy01\Desktop\usa.sas7bdat
Release Created	9.0202M3
Host Created	W32_VSPRO

Alphabetic List of Variables and Attributes

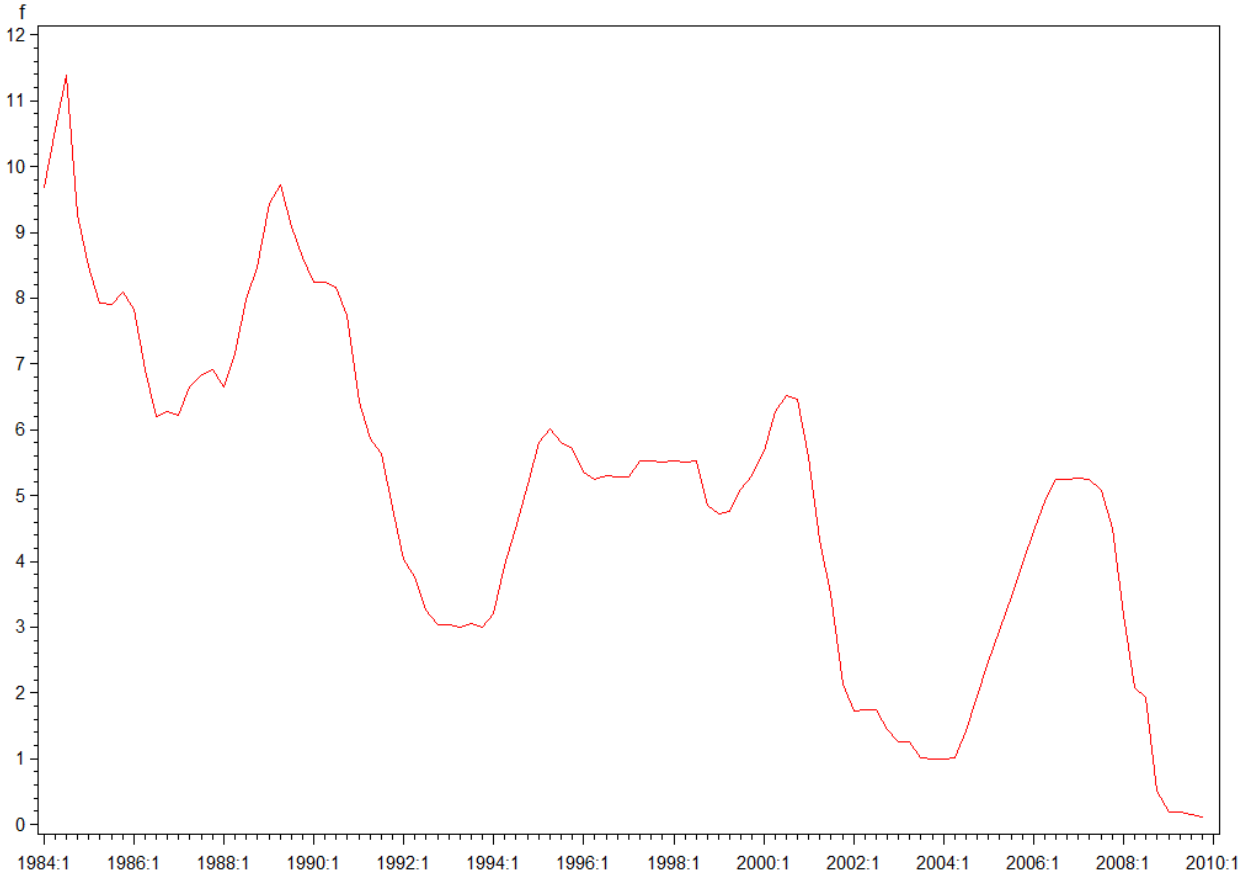
#	Variable	Type	Len	Label
4	b	Num	8	3-year Bond rate
3	f	Num	8	federal funds rate
1	gdp	Num	8	real US gross domestic product
2	inf	Num	8	annual inflation rate

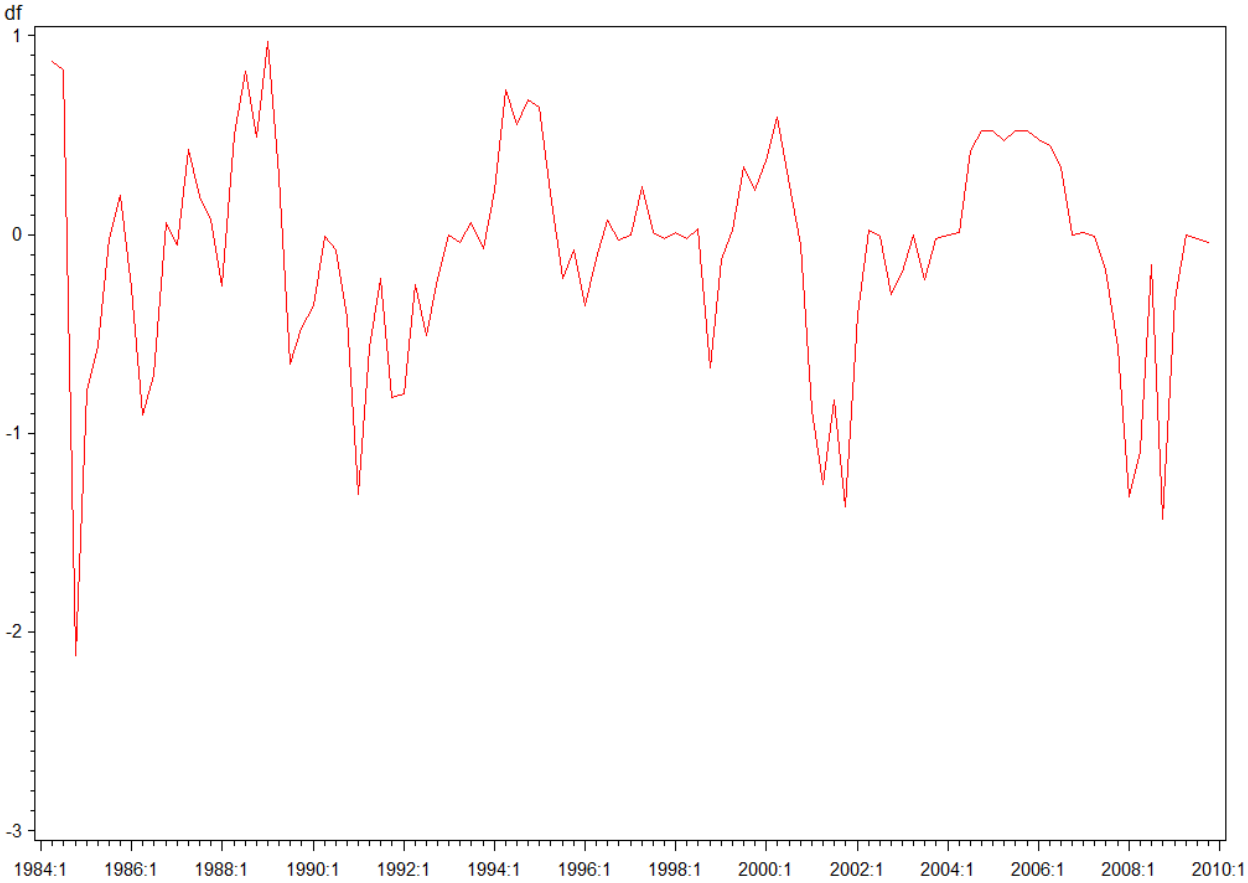
```
* construct new variables;
*legacy code to construct variables, differences, lags, working with dates

data usadata;
set tmp1.usa;
df = dif(f);
ddf = dif(df);
f1 = lag(f);
df1 = dif(f1);
retain date '1oct83'd;
date = intnx('qtr',date,1);
format date yyqc.;
year = 1984 + int((_n_-1)/4);
qtr = mod((_n_-1),4) + 1;
run;

* print data;
*we started with 4 series then we added on all this other stuff
*every time you take a difference you lose an observation
proc print data=work.usadata (obs=10);
run;
```

The SAS System 17:16 Tuesday, January 22, 2019 3

Obs	gdp	inf	f	b	df	ddf	f1	df1	date	year	qtr
1	3807.4	9.47	9.69	11.19	.	.	.	.	1984:1	1984	1
2	3906.3	10.03	10.56	12.64	0.87	.	9.69	.	1984:2	1984	2
3	3976.0	10.83	11.39	12.64	0.83	-0.04	10.56	0.87	1984:3	1984	3
4	4034.0	11.51	9.27	11.10	-2.12	-2.95	11.39	0.83	1984:4	1984	4
5	4117.2	10.51	8.48	10.68	-0.79	1.33	9.27	-2.12	1985:1	1985	1
6	4175.7	9.24	7.92	9.76	-0.56	0.23	8.48	-0.79	1985:2	1985	2
7	4258.3	8.37	7.90	9.29	-0.02	0.54	7.92	-0.56	1985:3	1985	3
8	4318.7	7.00	8.10	8.84	0.20	0.22	7.90	-0.02	1985:4	1985	4
9	4382.4	6.16	7.83	7.94	-0.27	-0.47	8.10	0.20	1986:1	1986	1
10	4423.2	5.90	6.92	7.18	-0.91	-0.64	7.83	-0.27	1986:2	1986	2

```
* plot data;
*federal funds rate (graph 1) and change in federal funds rate (graph 2) is plotted here
*first graph is nonstationary, nonmean reverting
*second graph the trend is flat as a pancake. Did this quarter vs last quarter here
*df=difference in federal funds rate.
*these are quarterly data.
*in graph 1 it is downward sloping, its nonstationary
*graph 2 you get rid of that, it tells you its stationary. Use the first difference, you
have to model the stationary series
*downward trend on the first graph means its non-mean reverting

options nolabel;
symbol1 value=none interpol=join color=red;
proc gplot data=work.usadata;
plot f*date;
plot df*date;
run;
quit;
```




df
1
0
-1
-2
-3
1984:1
1986:1
1988:1
1990:1
1992:1
1994:1
1996:1
1998:1
2000:1
2002:1
2004:1
2006:1
2008:1
2010:1

```
* estimate model using proc autoreg;
*statistical test here will tell is if its stationary or not
*the phillips-perron test-hypothesis is the data series is nonstationary. So do you
reject the null hypothesis or fail to reject the null hypothesis? Look at the p-values,
you fail to reject the hypothesis. Its not mean reverting. So it is nonstationary. Fail
to reject the null of non-stationary
*zero mean = no constant no trend in the model
*single mean = constant but no trend in the model
*trend = constant and trend in the model
*you fail to reject at every level except for the alpha 0.0714 but that's weak.
options nolabel;
proc autoreg data=work.usadata;
model f = / stationarity=(phillips);
run;
quit;
```


The AUTOREG Procedure

Dependent Variable f

Ordinary Least Squares Estimates

SSE	679.513462	DFE	103
MSE	6.59722	Root MSE	2.56851
SBC	494.990165	AIC	492.345774
MAE	2.03236686	AICC	492.38499
MAPE	186.25642	HQC	493.417094
Durbin-Watson	0.0464	Total R-Square	0.0000

Phillips-Perron Unit Root Test

Type	Lags	Rho	Pr < Rho	Tau	Pr < Tau
Zero Mean	2	-2.4090	**0.2849**	-1.7804	**0.0714**
Single Mean	2	-4.4283	**0.4856**	-1.4650	**0.5478**
Trend	2	-10.5791	**0.3779**	-2.2891	**0.4356**

Parameter Estimates

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	4.9838	0.2519	19.79	<.0001

```
* estimate model using proc autoreg;
*the phillips test will tell us
*the only thing that is changed here is you are running the test on df and not f. you are
going to reject null that it is nonstationary. Since it is statistically significant you
reject the null hypothesis that the data series is nonstationary. It is in fact
stationary.
*its called an I(1) series- the time series is integrated of order 1. Which means you
have to first difference f (federal funds rate) to make it stationary.
options nolabel;
proc autoreg data=work.usadata;
model df = / stationarity=(phillips);
run;
quit;
```


The AUTOREG Procedure

Dependent Variable df

Ordinary Least Squares Estimates

SSE	30.6673262	DFE	102
MSE	0.30066	Root MSE	0.54832
SBC	172.148354	AIC	169.513625
MAE	0.40051277	AICC	169.553229
MAPE	189.597982	HQC	170.58078
Durbin-Watson	0.8952	Total R-Square	0.0000

Phillips-Perron Unit Root Test

Type	Lags	Rho	Pr < Rho	Tau	Pr < Tau
Zero Mean	2	-46.6819	**<.0001**	-5.5314	**<.0001**
Single Mean	2	-48.4380	**0.0010**	-5.6564	**<.0001**
Trend	2	-48.3618	**0.0003**	-5.6275	**<.0001**

Parameter Estimates

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	-0.0929	0.0540	-1.72	0.0885