

Business Cycle Facts

TA Session 1

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SciencesPo

January 2018

Objective of this first TA session

At the end of this session you should be able to :

Part I :

- ▶ Download series from the fred database, either manually or using Stata
- ▶ Plot a serie and customize a graph using Excel and Stata
- ▶ Detrend a serie using the Hodrick Prescott Filter and understand the role of its key parameter
- ▶ Understand the notions of procyclical and countercyclical behavior of a serie
- ▶ Use the Baxter-King filter and understand its main differences with the HP filter

Part II :

- ▶ Understand the two ways to state the "centralized problem"

Part I

The Fred Database : <https://fred.stlouisfed.org/>

Objective : be able to look for specific data and to download them

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ECONOMIC DATA & ST. LOUIS FED

ECONOMIC RESEARCH
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AT A GLANCE


POPULAR SERIES

LATEST RELEASES


TOOLS

NEED HELP?


Consumer Price Index for All Urban Consumers: All Items
+2.1 % Chg. from Yr. Ago on Dec 2017




Real Gross Domestic Product
2.6 % Chg. from Preceding Period on Q4 2017




Industrial Production Index
+0.9 % Chg. on Dec 2017




10-Year Treasury Constant Maturity Rate
2.63 % on 2018-01-25




U.S. / Euro Foreign Exchange Rate
1.2238 U.S. \$ to 1 Euro on 2018-01-19




Civilian Unemployment Rate
4.1 % on Dec 2017



All Employees: Total Nonfarm Payrolls
+148 Chg., Thous. of Persons on Dec 2017



4-Week Moving Average of Initial Claims
240000 on 2018-01-20



The Fred Database

Looking for the real GDP serie

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AT A GLANCE | POPULAR SERIES | LATEST RELEASES | TOOLS | NEED HELP?


Consumer Price Index for All Urban Consumers: All Items
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The Fred Database

Or just Search for "GDP" and select : Billions of Chained 2009 Dollars, Quarterly, Seasonally Adjusted Annual Rate

Search Results

Displaying About 46,000 series for **GDP**

Gross Domestic Product ✕

Reset

☐ Add to Data List

☐ Add to Graph

Sort by Search Rank ▾

Real Gross Domestic Product

☐ Billions of Chained 2009 Dollars, Quarterly, Seasonally Adjusted Annual Rate

Q1 1947 to Q4 2017 (3 days ago)

☐ Percent Change from Preceding Period, Quarterly, Seasonally Adjusted Annual Rate

Q2 1947 to Q4 2017 (3 days ago)

☐ Billions of Chained 2009 Dollars, Annual, Not Seasonally Adjusted

1929 to 2017 (3 days ago)

☐ Percent Change from Preceding Period, Annual, Not Seasonally Adjusted

1930 to 2017 (3 days ago)

☐ Percent Change from Quarter One Year Ago, Quarterly, Seasonally Adjusted

Q1 1948 to Q4 2017 (3 days ago)

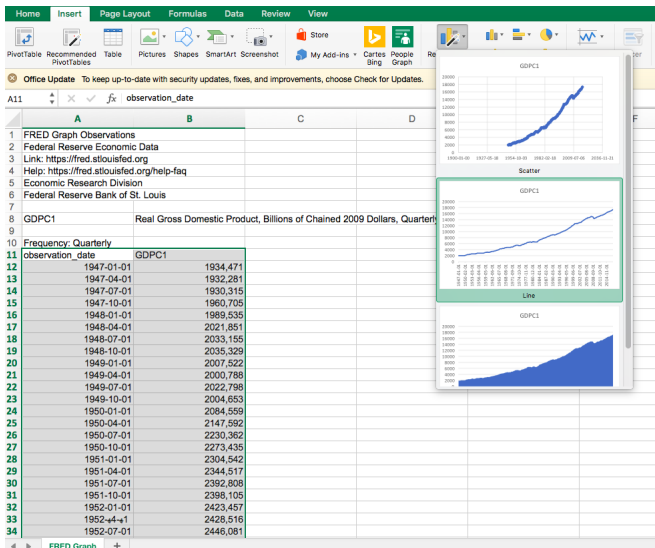
The Fred Database

Then download the serie using Excel



You can change the frequency, unit, axis, time window, etc. using "Edit Graph"

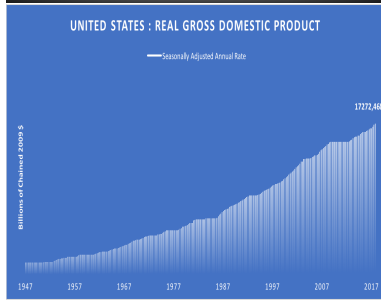
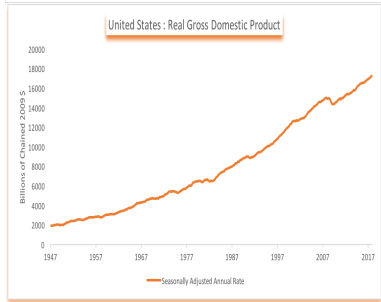
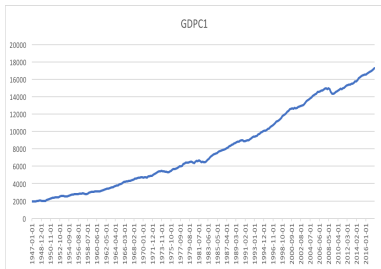
On the Art of Plotting Data



Select "Insert" and choose the kind of graph that you want to plot

On the Art of Plotting Data

And customise it : add axis label (unit), title, and whatever you like



The Hodrick Prescott Filter

Excel Plugin : http://www.web-reg.de/hp_addin.html

"Download" and follow the instruction "Extract the zip-file and declare HPFilter.xla as an add-in (Tools - Add-Ins Manager - Browse").

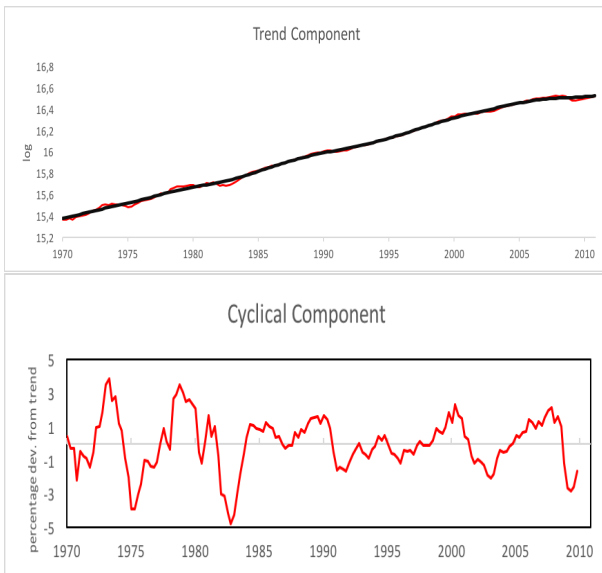
LN		A	B	C	D	E	F
1		FRED Graph Observations					
2		Federal Reserve Economic Data					
3		Link: https://fred.stlouisfed.org					
4		Help: https://fred.stlouisfed.org/help-faq					
5		Economic Research Division					
6		Federal Reserve Bank of St. Louis					
7							
8		GDPC1	Real Gross Domestic Product, Billions of Chained 2009 Dollars, Quarterly, Seasonally Adjusted Annual Rate				
9							
10		Frequency: Quarterly					
11		observation_date	Seasonally Adjusted Annual Rate				
12		1947-01-01	1934,471	12,17279937	HP(C12:C295;1600)		
13		1947-04-01	1932,281	12,17162669			
14		1947-07-01	1930,315	12,17060867			
15		1947-10-01	1960,705	12,18622957			
16		1948-01-01	1989,535	12,20082641			
17		1948-04-01	2021,851	12,21650889			
18		1948-07-01	2033,155	12,22251424			
19		1948-10-01	2035,329	12,22358294			
20		1949-01-01	2007,522	12,20982659			
21		1949-04-01	2000,788	12,20646657			
22		1949-07-01	2022,798	12,21140717			
23		1949-10-01	2004,653	12,20839644			
24		1950-01-01	2084,559	12,24748279			
25		1950-04-01	2147,592	12,27727268			
26		1950-07-01	2230,362	12,31508937			
27		1950-10-01	2273,435	12,33421737			
28		1951-01-01	2304,542	12,34780742			
29		1951-04-01	2344,517	12,36500488			
30		1951-07-01	2392,808	12,38539304			
31		1951-10-01	2398,105	12,38760431			
32		1952-01-01	2423,457	12,3981205			
33		1952-04-01	2428,516	12,40020584			
34		1952-07-01	2446,081	12,40741262			
35		1952-10-01	2526,359	12,4397046			
36		1953-01-01	2573,372	12,45814257			
37		1953-04-01	2593,456	12,46591681			
38		1953-07-01	2578,922	12,46029695			
39		1953-10-01	2630,768	12,47440404			
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HP(timeseries as Range,lambda as Double).

Lambda : 100 for yearly data, 1600 for quarterly data and 14400 for monthly data.

The Hodrick Prescott Filter

Plot them as your Prof.



Do it with Stata

Install Freduse

```
clear
```

```
findit freduse
```

```
/*-----
```

```
To Do:
```

```
1.select "st010"
```

```
2."click here to install"
```

```
3. close the window
```

```
-----*/
```

Do it with Stata

Load the data and plot the serie

```
freduse GDPC1
```

```
generate time = q(1947q1) + _n -1
```

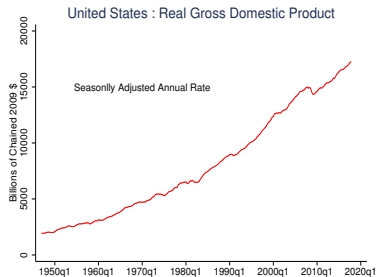
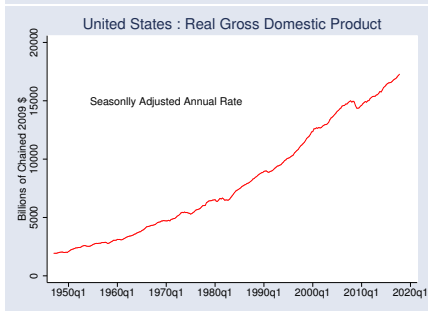
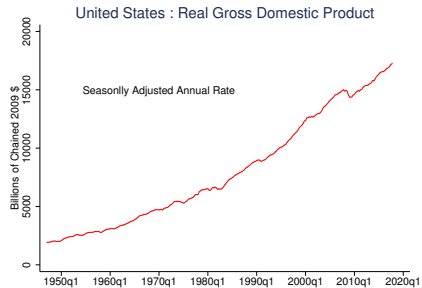
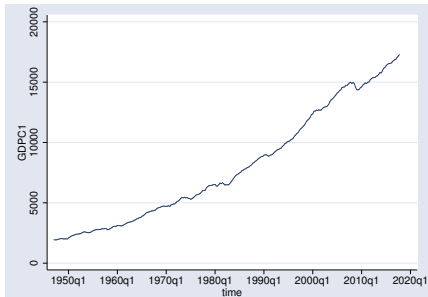
```
format time %tq
```

```
tsset time
```

```
twoway tsline GDPC1
```

```
twoway tsline GDPC1, title(United States : Real Gross  
    Domestic Product) ytitle(Billions of Chained  
    2009 $) xtitle("") lcolor(red) ttext( 15000 1970  
    q1 "Seasonally Adjusted Annual Rate" ) ylab(  
    nogrid)
```

Do it with Stata



Do it with Stata

Detrend the serie and plot

```
gen ln_gdp = ln(GDPC1*1000) if time >= tq(1970q1) &
    time < tq(2010q1)

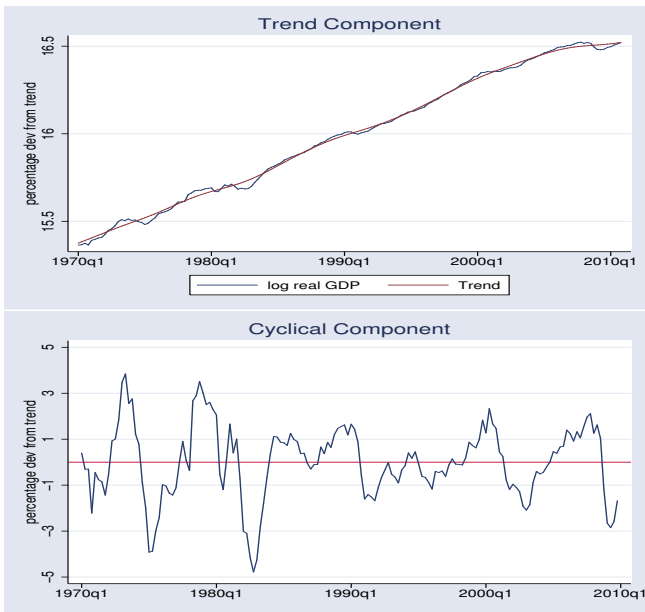
tsfilter hp gdp_cycle =ln_gdp, trend(gdp_trend) smooth
    (1600)

gen Cyclical_Component = gdp_cycle * 100
label var ln_gdp "log_real_GDP"
label var gdp_trend "Trend"

twoway tsline Cyclical_Component if time >= tq(1970q1)
    & time < tq(2010q1), title(Cyclical Component)
    ytitle(percentage dev from trend) xtitle("")
    ylabel(-5(2)5) yline(0)

twoway tsline ln_gdp gdp_trend if time >= tq(1970q1) &
    time < tq(2010q1), title(Trend Component) ytitle(
    percentage dev from trend) xtitle("")
```

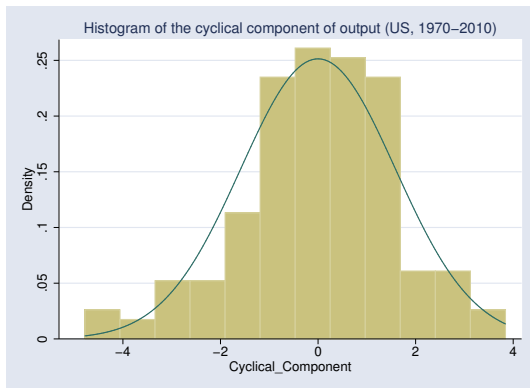
Do it with Stata



Do it with Stata

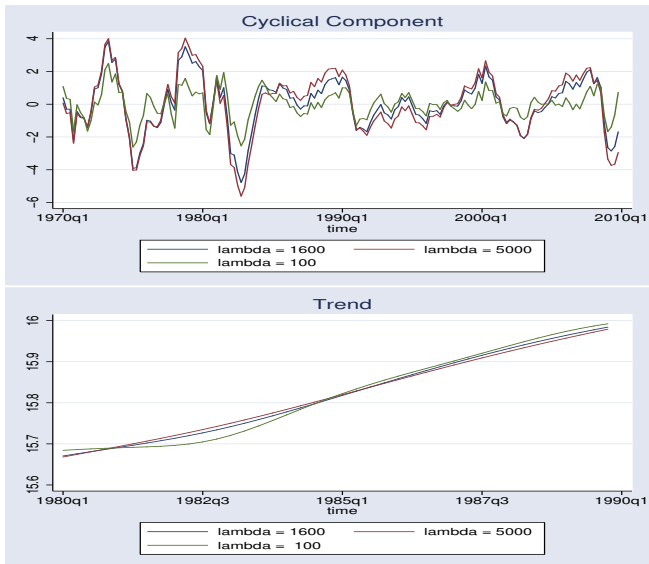
```
hist Cyclical_Component, normal title("Histogram of  
the cyclical component of output (US, 1970-2010)",  
size(medium))
```

```
egen sd = sd(Cyclical_Component)  
mean = mean(Cyclical_Component)
```



The Hodrick Prescott Filter

The dependence on lambda



The Hodrick Prescott Filter

Why ?

The Hodrick Prescott Filter

Why ?

$$\min_{\tau} \left(\sum_{t=1}^T (y_t - \tau_t)^2 + \lambda \sum_{t=2}^{T-1} [(\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1})]^2 \right)$$

The second term is a multiple λ of the sum of the squares of the trend component's second differences. This second term penalizes variations in the growth rate of the trend component. The larger the value of λ , the higher is the penalty.

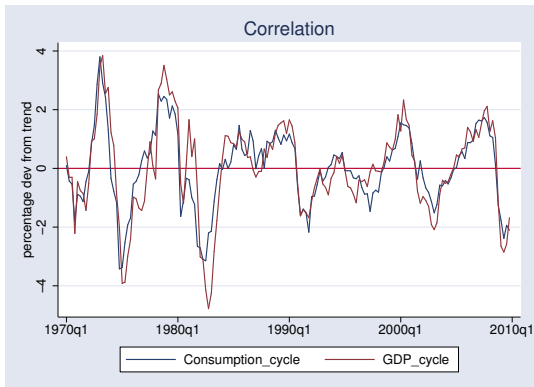
With y_t the serie, τ the trend component,

Correlation between variables

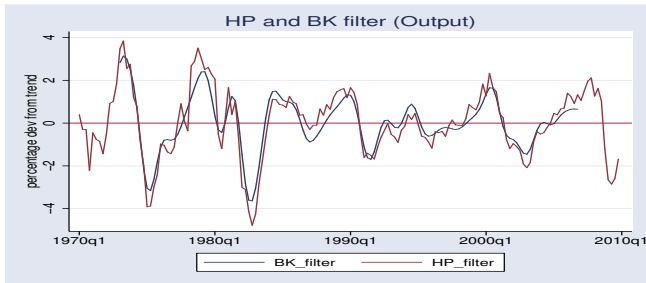
Real Personal Consumption Expenditures

Cross correlation with output

L.Consumption	Consumption	F.Consumption
0.8882	0.8778	0.7229



The Baxter-King filter



Part II

The centralized problem

The common notation

Let's copy and past the problem of your lecture :

The planner chooses $\{C_{t+i}, S_{t+i}, K_{t+i+1}\}_{i=0}^{\infty}$ to maximize :

$$\mathbb{E}_t \left[\sum_{i=0}^{\infty} \beta^i U(C_{t+i}) \right]$$

subject to

$$C_{t+i} + S_{t+i} \leq Z_{t+i} F(K_{t+i}, 1)$$

$$K_{t+i+1} = (1 - \delta) K_{t+i} + S_{t+i}$$

$$K_{t+i+1} \geq 0 ; K_t > 0 \text{ given}$$

The centralized problem

A problem of notation

This notation is widely use in macroeconomics but is not really precise and can lead you to misunderstand what is really going on with this optimization program.

This notation can lead you to think that the planner chooses at time t every C , S and K from now to infinity when what it does it to choose a *plan* for those variables conditional on what happens in the economy (and so here on the history of z).

Let's restate it in a different way !

The centralized problem

A problem of notation

Define the history z^t of the random variable Z by :

$$z^t \equiv [Z_t, Z_{t-1}, \dots, Z_0]$$

And define Π^{t+i} as the probability of the history $t + i$

The centralized problem

Let's restate the centralized problem

With these notations :

The planner chooses $\{C(z^{t+i}), S(z^{t+i}), K'(z^{t+i})\}_{i=0}^{\infty}$ to maximize :

$$\sum_{i=0}^{\infty} \sum_{z^{t+i}} \beta^i \pi^{t+i} U(C(z^{t+i}))$$

subject to

$$C(z^{t+i}) + S(z^{t+i}) \leq Z(z^{t+i}) F(K'(z^{t+i-1}), 1)$$

$$K'(z^{t+i}) = (1 - \delta) K'(z^{t+i-1}) + S(z^{t+i})$$

$$K'(z^{t+i}) \geq 0 ; K(z^t) > 0 \text{ given}$$

The first order conditions

- ▶ As in the lecture, we combine the two constraints :

$$K'(z^{t+i}) = (1 - \delta)K'(z^{t+i-1}) + Z(z^{t+i})F(K'(z^{t+i-1}), 1) - C(z^{t+i})$$

There is one constraint for each period and for each state of the world possible

- ▶ And write the Lagrangian :

$$\begin{aligned}\mathcal{L} = & \sum_{i=0}^{\infty} \sum_{z^{t+i}} \beta^i \pi^{t+i} U(C(z^{t+i})) \\ & + \sum_{i=0}^{\infty} \sum_{z^{t+i}} \beta^i \pi^{t+i} \lambda(z^{t+i}) [(1 - \delta)K'(z^{t+i-1}) \\ & + Z(z^{t+i})F(K'(z^{t+i-1}), 1) - C(z^{t+i}) - K'(z^{t+i})]\end{aligned}$$

The first order conditions

- ▶ Take the derivative with respect to $C(z^{t+i})$:

$$\begin{aligned}\frac{\partial \mathcal{L}}{\partial C(z^{t+i})} &= \beta^i \Pi^{t+i} U' (C(z^{t+i})) - \beta^i \Pi^{t+i} \lambda(z^{t+i}) = 0 \\ \iff U' (C(z^{t+i})) &= \lambda(z^{t+i})\end{aligned}$$

- ▶ Take the derivative with respect to $K'(z^{t+i})$ (★) :

$$\begin{aligned}\frac{\partial \mathcal{L}}{\partial K'(z^{t+i})} &= -\beta^i \Pi^{t+i} \lambda(z^{t+i}) + \sum_{z^{t+i+1}} \beta^{i+1} \Pi^{t+i+1} \lambda(z^{t+i+1}) R(z^{t+i+1}) = 0 \\ \iff \beta \mathbb{E}(\lambda(z^{t+i+1}) R(z^{t+i+1}) | z^{t+i}) &= \lambda(z^{t+i})\end{aligned}$$

Remember : $R(z^{t+i}) = (1 - \delta) + Z(z^{t+i}) F_1(K'(z^{t+i-1}), 1)$

(★) There is a sum because $K'(z^{t+i})$ appears in all histories z^{t+i+1} that start with the same history z^{t+i}

The first order conditions

Take the two first order conditions :

$$\beta \mathbb{E}(\lambda(z^{t+i+1})R(z^{t+i+1})| z^{t+i}) = \lambda(z^{t+i})$$

$$U'(C(z^{t+i})) = \lambda(z^{t+i})$$

Combine them to get the **Euler equation**

$$U'(C(z^{t+i})) = \beta \mathbb{E}(U'(C(z^{t+i+1})) R(z^{t+i+1})| z^{t+i})$$