Business Cycles: Main Stylized Facts

— Week 1-2 —

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What are we going to talk about

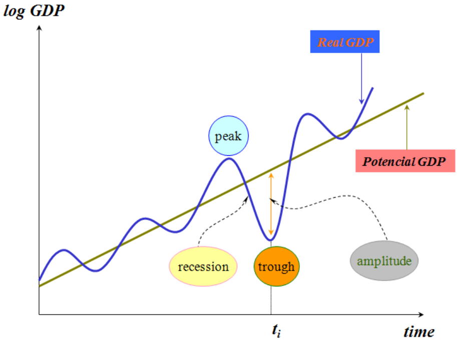
1. What are Business Cycles?
2. Comovement
3. Behavior of Key Macroeconomic Variables
4. Filters
5. A more recent view of cycles
6. Reading required

I - What are business cycles?

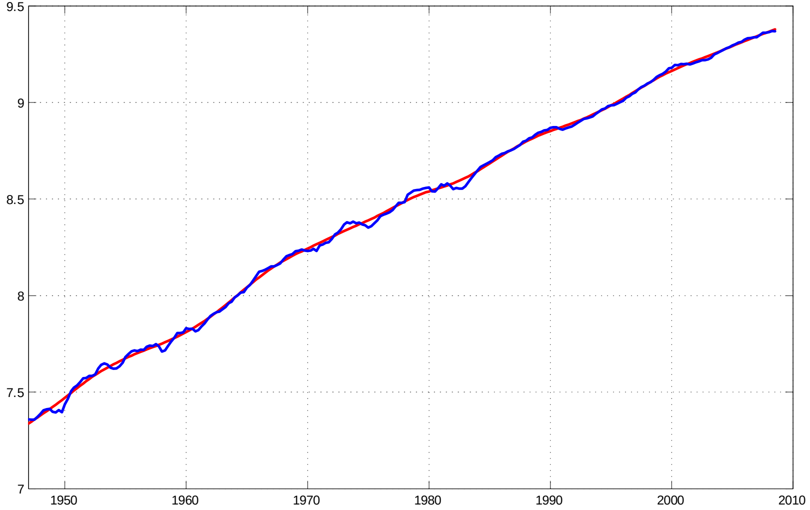
Business cycles: a figure

Definition

Business cycles are the recurrent short-run movements around a smooth long-run trend in endogenous economic variables, like production, investment, consumption, employment, price level, real wage, average labor productivity, money supply, among others.



Business cycles: GDP and its trend (USA)



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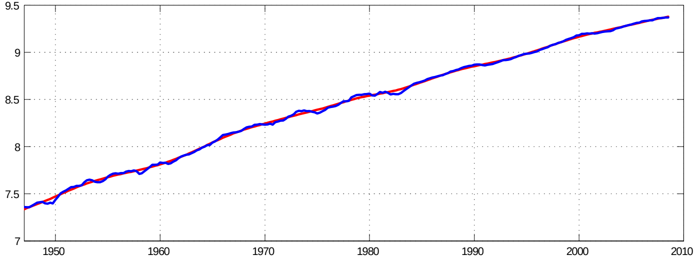
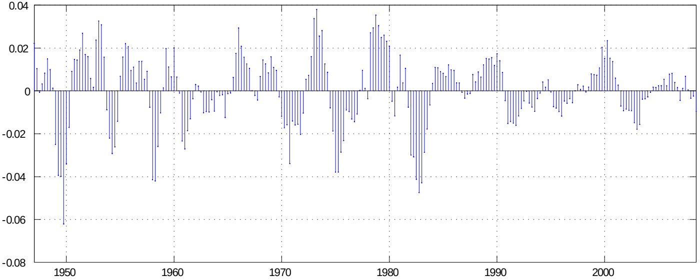




Key words

1. **Business Cycles**: fluctuations around a long term *trend*
2. **Turning points**: *peaks (booms)* and *troughs (crises)*
3. **Boom**: Persistent positive deviations from trend are **booms**
4. **Crisis/recession**: Persistent negative deviations from trend are **recessions**
5. **Percentage deviations from trend:** in macroeconomics business cycle measurement is done always with: percentage deviations from trend.

Press, politics ... and the economists

1. **"Dating the cycles"**. This is a crucial issue for everybody, mainly for the press and... for politics
2. **In the press, in politics**: a recession starts with two consecutive quarters of negative growth in real GDP
3. **Controversy:** for obvious reasons, if an economy is (or is not) in recession is a matter that brings controversy
4. **NBER** (National Bureau of Economic Research). In the US it is this institution that has the task of dating the turning points

Press, politics ... and the economists (cont.)

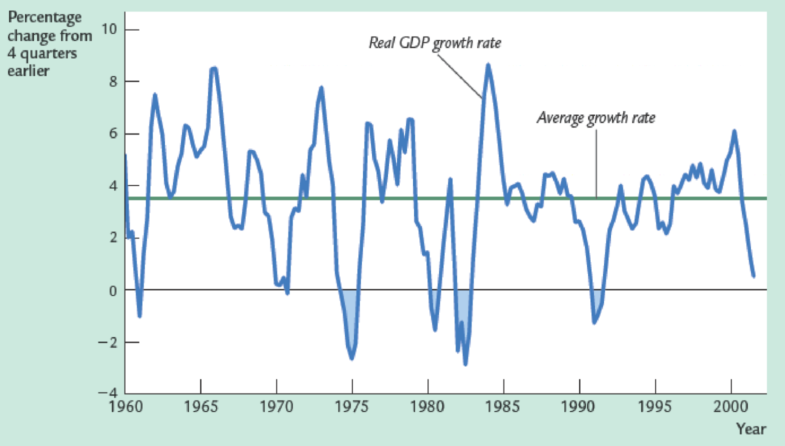
1. **Two consecutive quarters of negative growth: recession?**
2. **For NBER:** its not just like that:

NBER's answer

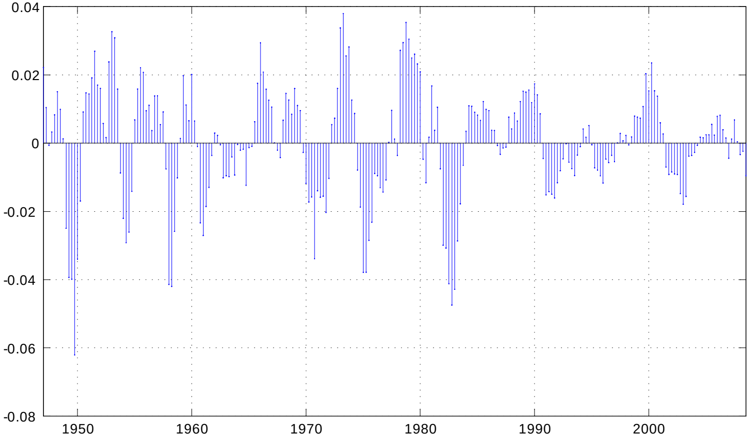
"**Q**: The financial press often states the definition of a recession as two consecutive quarters of decline in real GDP. How does that relate to the NBER's recession dating procedure?
A: Most of the recessions identified by our procedures do consist of two or more quarters of declining real GDP, **but not all of them**. As an example, the last recession, in 2001, did not include two consecutive quarters of decline. As of the date of the committee's meeting, the economy had not yet experienced two consecutive quarters of decline."

NBER (December 2008). "Determination of the December 2007 Peak in Economic Activity", Cambridge, Mass.

Negative growth and recessions (US)



% deviations from trend and recessions (US)



Irregular vs regular behavior

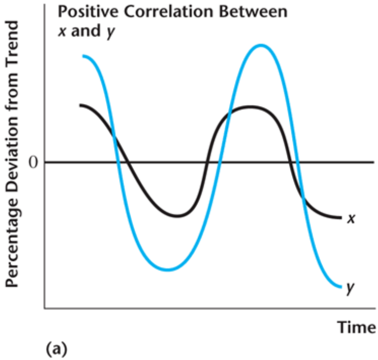
1. The fluctuations in GDP about trend are quite choppy
2. There is no regularity in the **amplitude** of fluctuations in real GDP about trend.
3. There is no regularity in the **frequency** of fluctuations in real GDP about trend.
4. However, there are regularities about:
    1. **comovements**
    2. **leading and lagging** behavior
    3. **volatility**

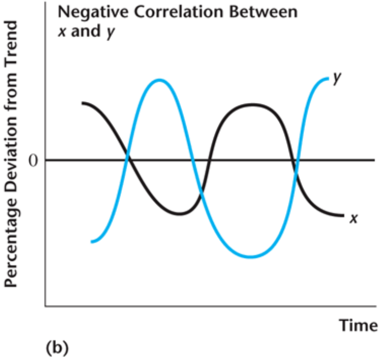
II - Comovement

Correlation

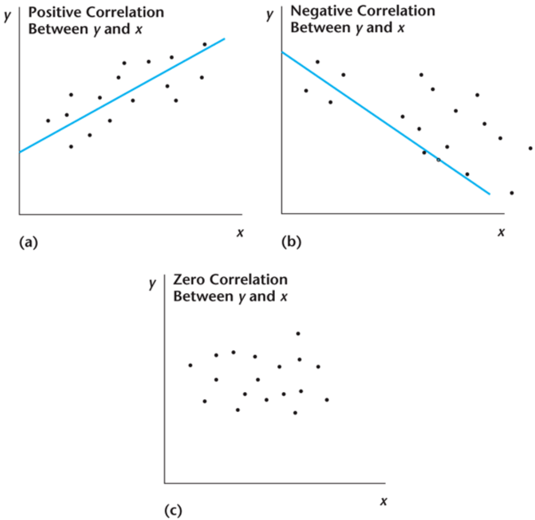
- Correlation is important because it tells us whether variables are:
  - Procyclical
  - Countercyclical
  - Acyclical
- If deviations from trend in a certain macroeconomic variable are correlated with the deviations from trend in real GDP:
  - positive correlation: that variable is **procyclical**
  - negative correlation: that variable is **countercyclical**.
- If a macroeconomic variable is neither procyclical nor countercyclical, it is **acyclical**.

Positive and negative correlation

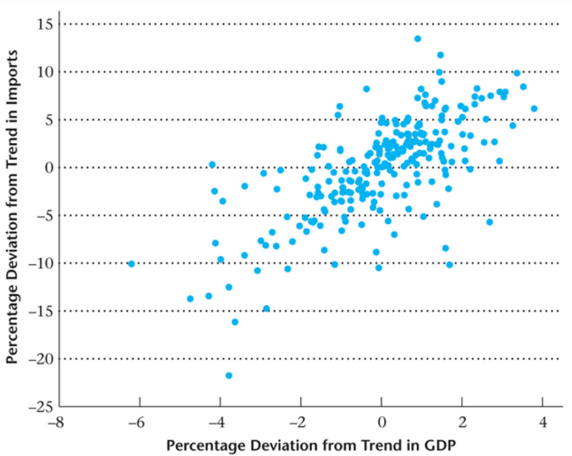




Positive and negative correlation (Cont.)



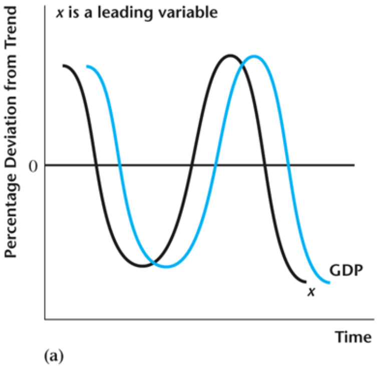
Positive correlation: an example (scatter plot)



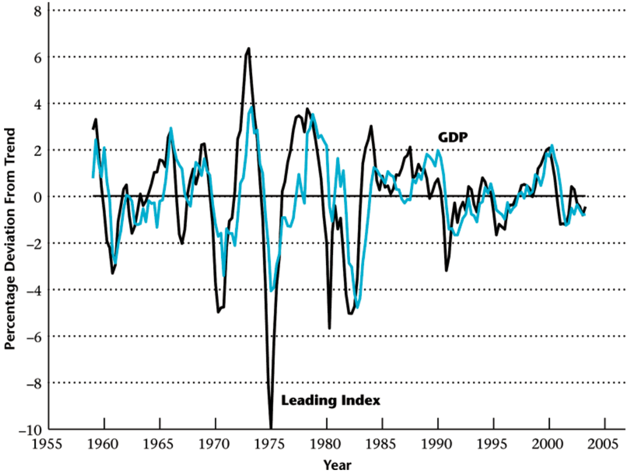
Leads and lags

1. A variable is leading if its peaks and troughs tend to **precede** those of real GDP
2. A variable is lagging if its ....
3. A **coincident** variable is one that neither leads nor lags real GDP
4. Importance: if we have relevant information about a leading variable we may anticipate what is expected to happen to real GDP (and overall economic activity).
5. **The leading index**: a set of variables that are good predictors of the expected future evolution of real GDP

Leading and lagging variables

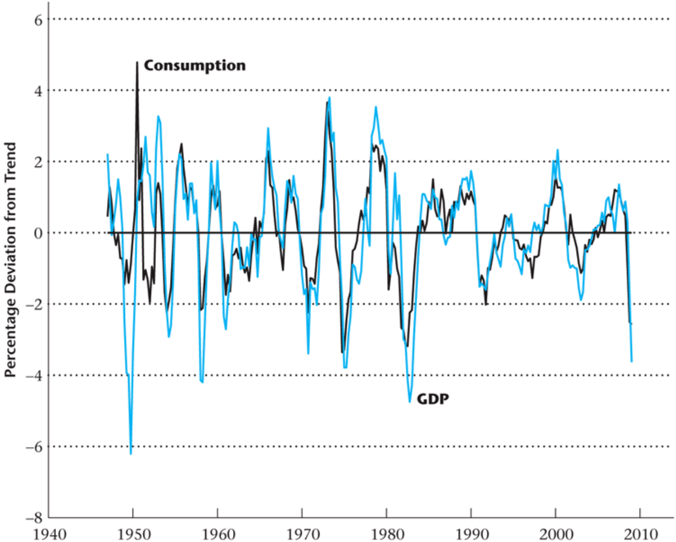


Percentage Deviations from Trend: GDP vs Leading Index

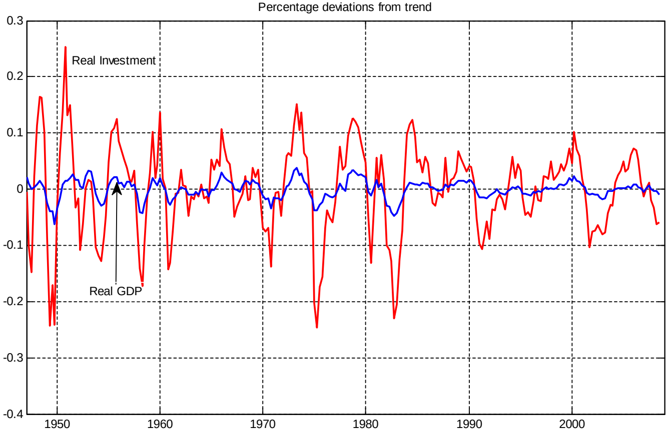


III - Behavior of key macroeconomic variables

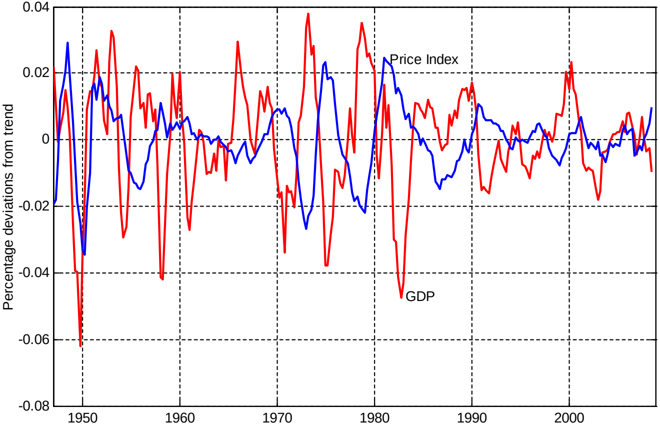
Percentage Deviations from Trend: GDP vs Consumption



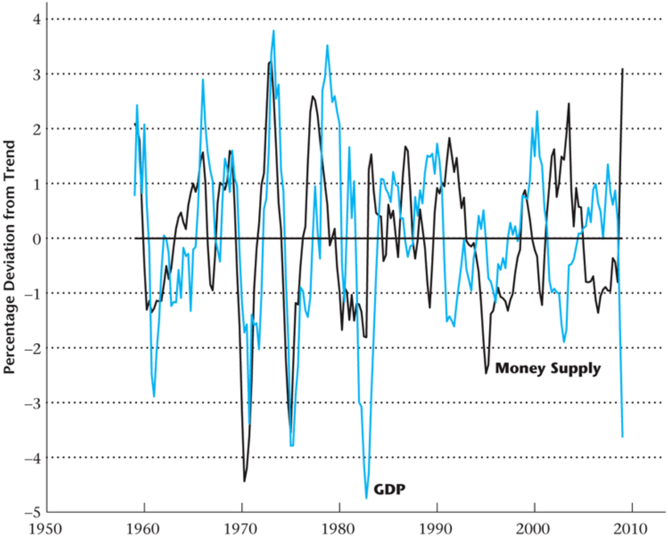
Percentage Deviations from Trend: GDP vs Investment



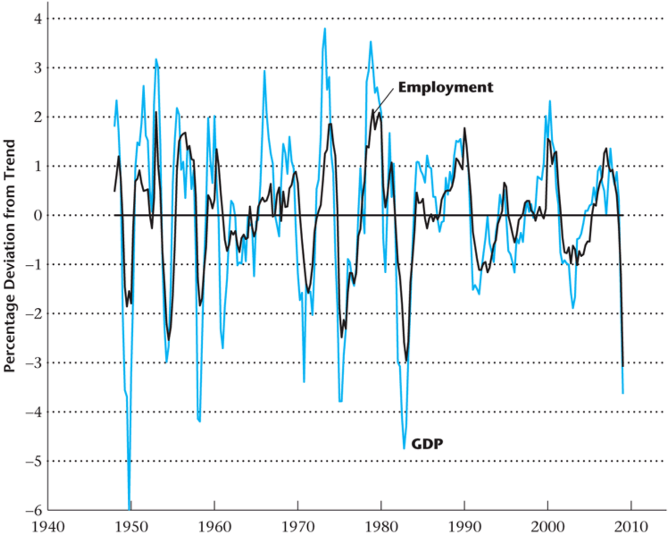
Percentage Deviations from Trend: GDP vs Price Index



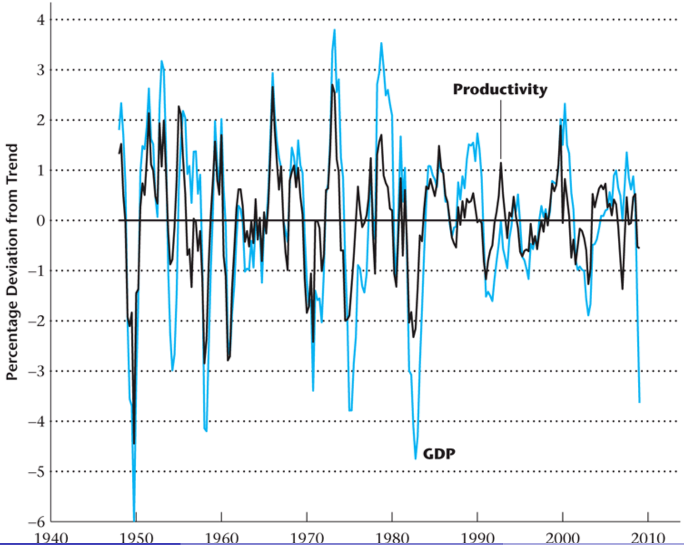
Percentage Deviations from Trend: GDP vs Money Supply



Percentage Deviations from Trend: GDP vs Employment



Percentage Deviations from Trend: GDP vs Productivity



Major stylized facts: summary

Major stylized facts of business cycles: Summary

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Table 3.1 Correlation Coefficients and Variability of Percentage Deviations from Trend

	Correlation Coefficient	Standard Deviation (% of S.D. of GDP)
Consumption	0.76	75.9
Investment	0.84	478.9
Price Level	−0.23	57.4
Money Supply	0.26	80.4
Employment	0.80	61.5
Average Labor Productivity	0.81	62.4

- **Attention: price level as countercyclical and coincident is controversial!**

Major stylized facts of business cycles: Summary

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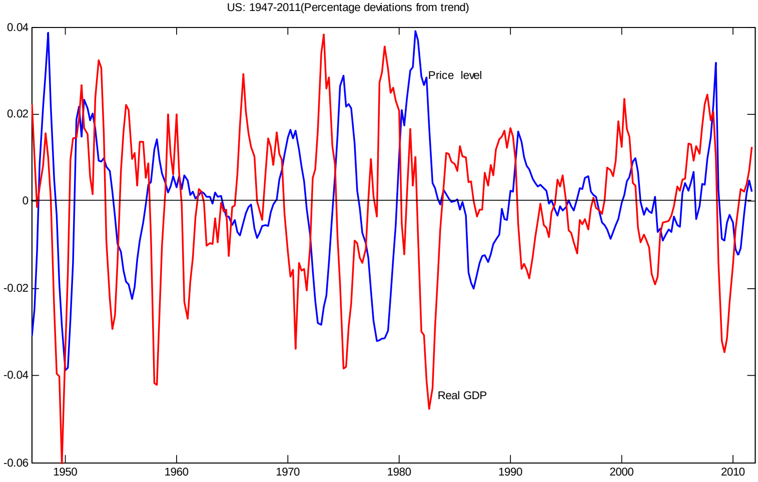
Table 3.2 Summary of Business Cycle Facts

	Cyclicality	Lead/Lag	Variation Relative to GDP
Consumption	Procyclical	Coincident	Smaller
Investment	Procyclical	Coincident	Larger
Price Level	Countercyclical	Coincident	Smaller
Money Supply	Procyclical	Leading	Smaller
Employment	Procyclical	Lagging	Smaller
Real Wage	Procyclical	?	?
Average Labor Productivity	Procyclical	Coincident	Smaller

- **Attention: price level as countercyclical and coincident is controversial!**
- See next slides

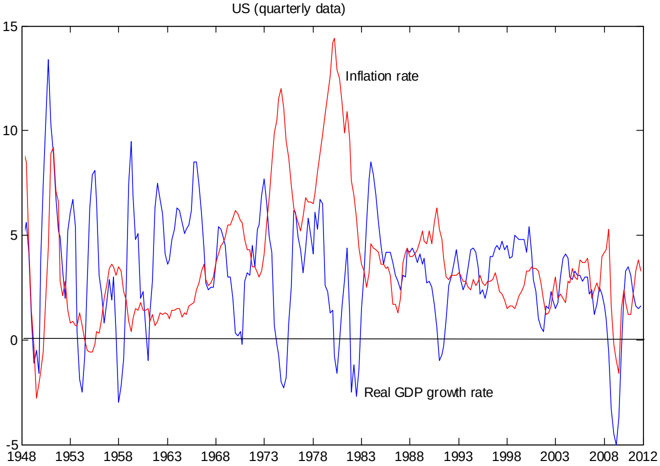
Is the price level really countercyclical? Time series

- % deviations from trend in Price level and real GDP (US: 1947-2011).



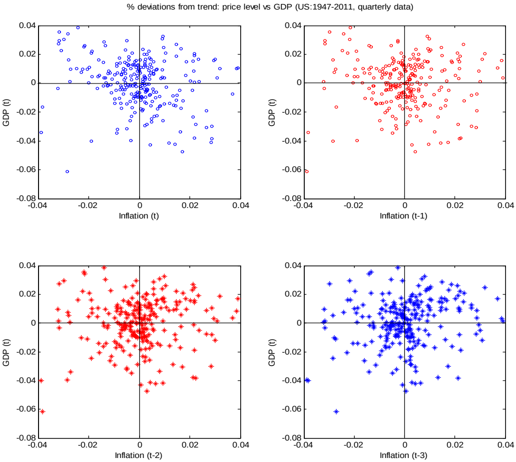
Is the price level really countercyclical? Time series

- Growth rates of price level (inflation rate) versus real GDP (US: 1948-2011).



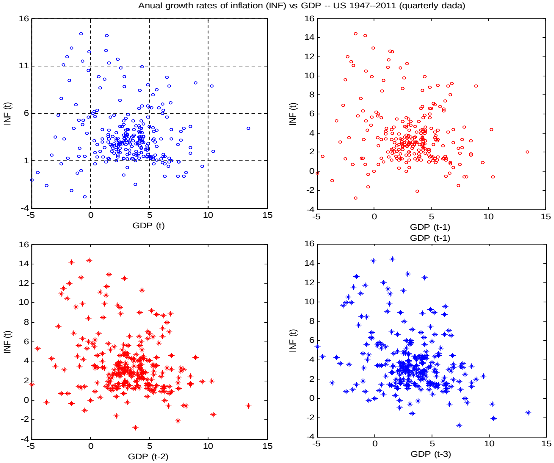
Is the price level countercyclical? Apparently not!

- **% deviations of GDP and Price level** hardly correlated (US: 1947-2011)



Is the price level countercyclical? Apparently not!

- **Growth rates:** prices (inflation rate) and real GDP hardly correlated (US: 1948-2011).



IV – Filters

Filters

1. Main objective: to separate the long-run trend from the short-run cyclical component of a time series $y(t)$.
2. There are various approaches to achieve this:
   1. Linear filter
   2. Linear filter with breaks
   3. Nonlinear filter
      1. Hodrick-Prescott filter
      2. Band Pass filter (Baxter and King, 1999)
      3. ...and some others

Log-linear trend filter

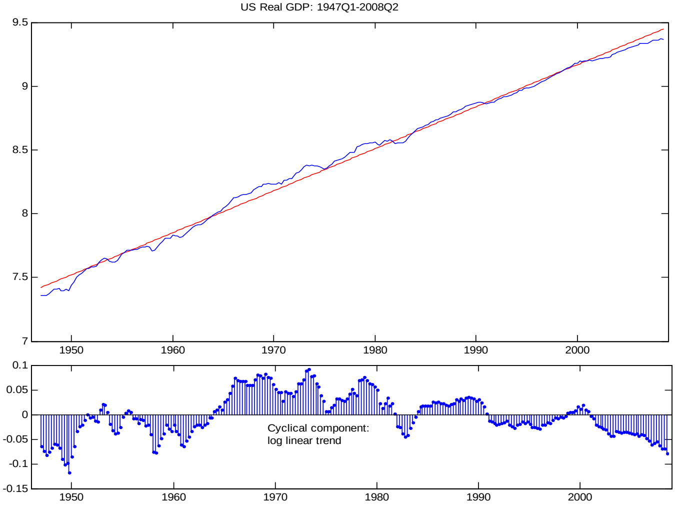
- Simplest method is to apply logs to some time series (Y_t) and detrend: log-linear trend

$$\ln(Y_t) = y_t = a + g \cdot t + \varepsilon_t$$

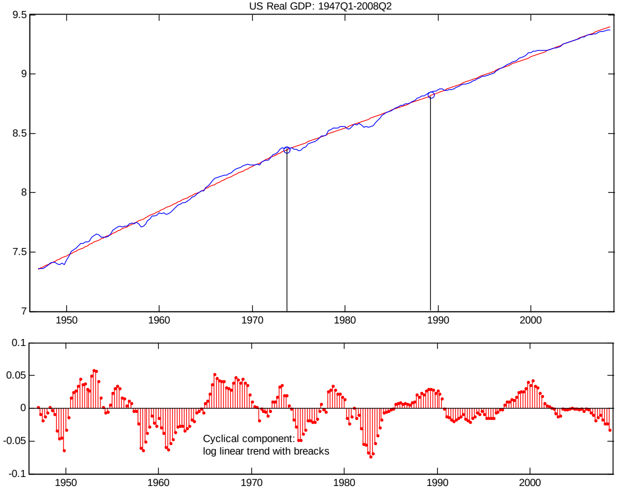
- Trend component: $a + gt$
- Zero-mean stationary cyclical component ε_t .
- Log-difference $\Delta y = y_{t+1} - y_t$ (equal to growth rate) has two components: constant trend growth g and the change in cyclical component ε_t.

$$\begin{aligned} \Delta y &= g(t+1-t) + (\varepsilon_{t+1} - \varepsilon_t) \\ &= g + \Delta\varepsilon \end{aligned}$$

Log-linear trend: US real GDP: 1947Q1-2008Q2



Log-linear trend with breaks: Real GDP (1947Q1-2008Q2)



The Hodrick-Prescott filter

- The two previous approaches show significant limitations:
  - produce too much volatility in the short-run cyclical component
  - produce too long recessions and expansions
- In the case "trend with breaks", imagine we pick up the wrong dates for the structural breaks: big problem
- In the case "trend without breaks", imagine that there are such breaks in the data. If these are ignored, big problem.
- So, let us assume that there may be structural breaks in the data, but it is not for us to decide arbitrarily when they occur, and how often they occur.
- Let us choose a technique that looks for those breaks inside the data.

The Hodrick-Prescott filter (cont.)

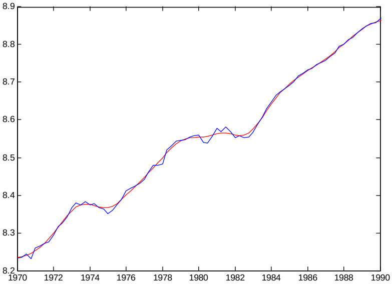
- Let's assume that the breaks in fact may occur almost permanently: **a smooth trend**
- Formula to do this: (booooo!)

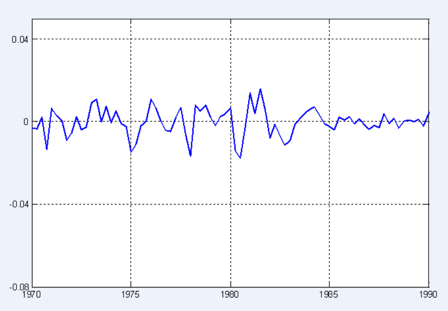
$$\min_{\tau_t} \sum_{t=1}^{T} \{(y_t - \tau_t)^2 + \lambda[(\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1})]^2\} \qquad (1)$$

- y_t is the original series
- τ_t is the smooth trend
- $(y_t - \tau_t)$ is the HP filtered series
- The choice of λ gives us how much curvature we accept in the filtered data
- $\lambda = 1600$, good for quarterly data; $\lambda \approx 7$, good for annual data
- $\lambda = 0$, trivial solution $(y_t = \tau_t)$; $\lambda \to \infty$, linear trend

The H-P filter: the importance of lambda

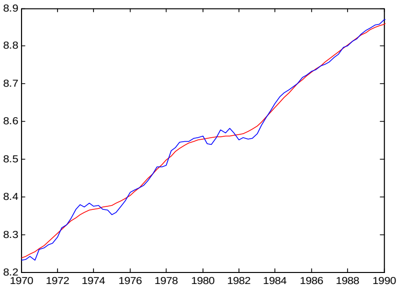
- Take the real GDP of US (1947–2011, quarterly data)
- $\lambda = 10$

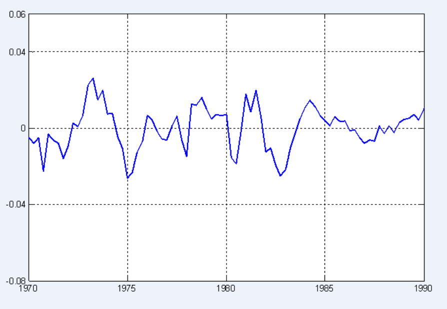




The H-P filter: the importance of lambda

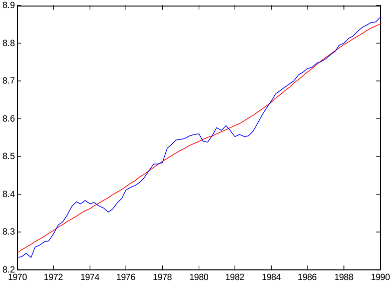
- Take the real GDP of US (1947–2011, quarterly data)
- $\lambda = 100$

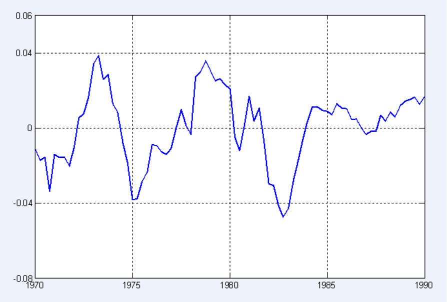




The H-P filter: the importance of lambda

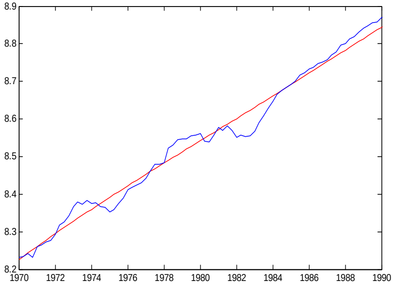
- Take the real GDP of US (1947–2011, quarterly data)
- $\lambda = 1600$

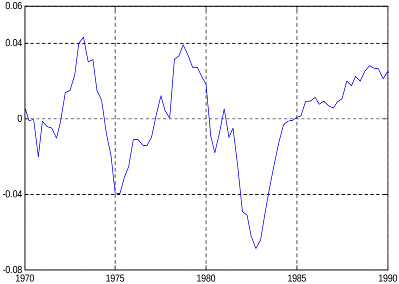




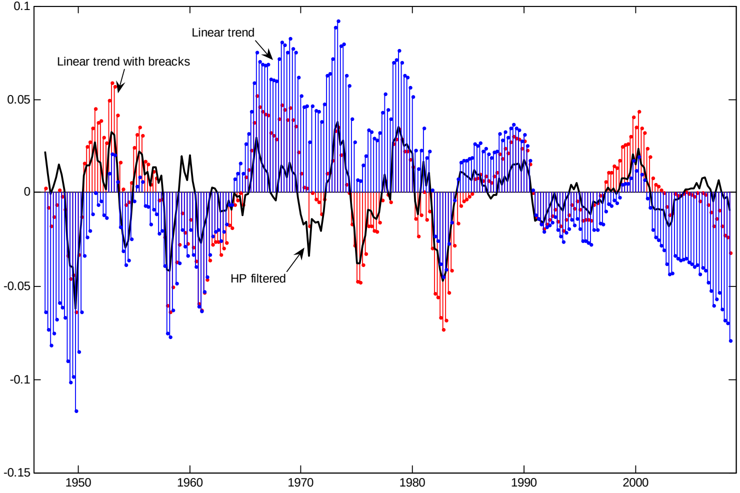
The H-P filter: the importance of lambda

- Take the real GDP of US (1947–2011, quarterly data)
- $\lambda = 100000$





Filters compared



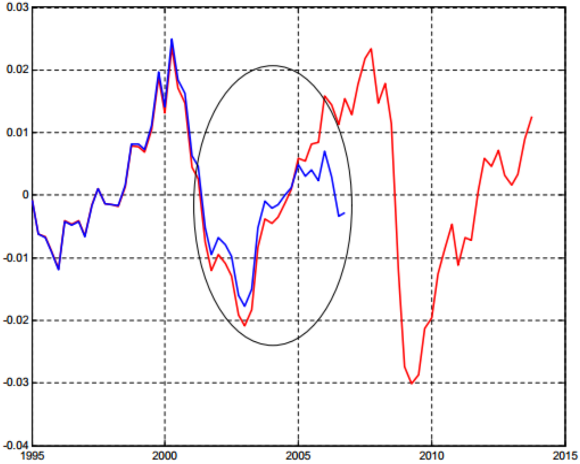
V – A more recent view of cycles

The fundamental problems with the HP filter

1. Rewriting history: when the future shows itself, the past has to be rewritten, which is awkward.
2. Expansions and contractions are symmetric in the HP: reality violates this
3. A recession caused by a big contraction in aggregate demand will lead to a reduction in productive capacity: it does not make sense
4. Supply shocks are supposed to entirely explain what happens to the trend: if so, what kind of negative shocks have regularly caused the destruction of productive capacity?
5. There have been no answers to these problems

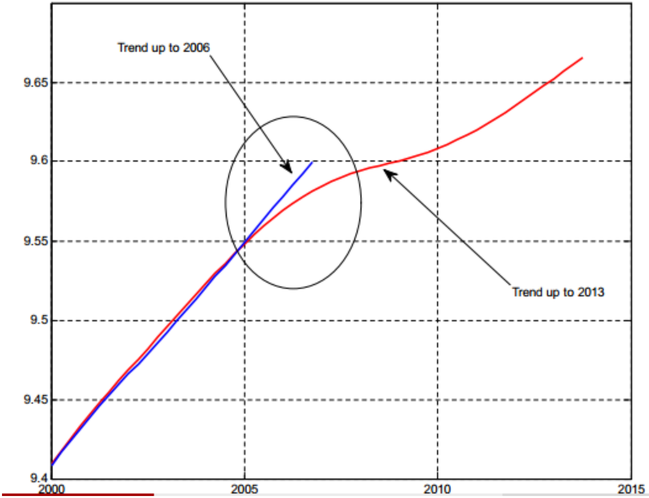
Rewriting history: cycles view

First, collect data up to 2007, then up to 2013

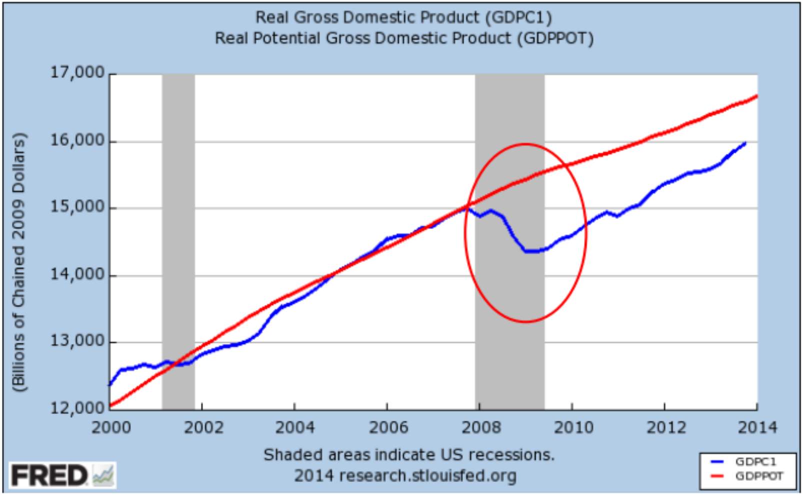


The mystery of the lost productive capacity

First, collect data up to 2007, then up to 2013



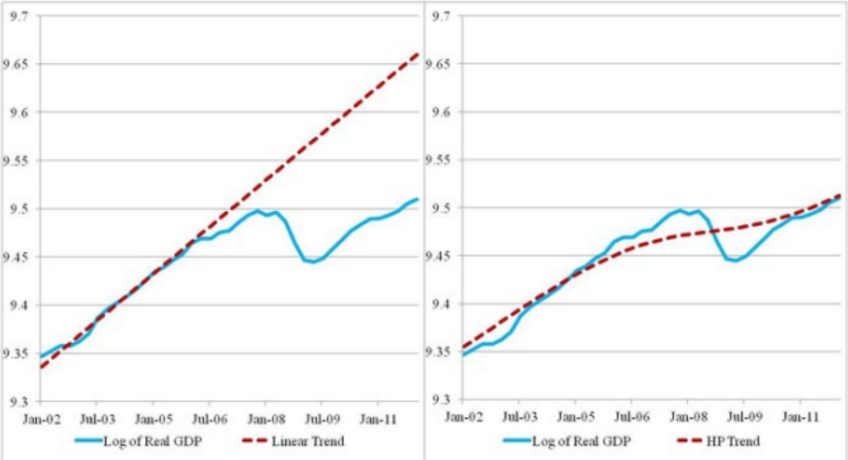
What negative supply shock can produce this?



An example of the problems we may have

1. In 2012, James Bullard (St. Louis FED President) made a speech calling for a stop to aggressive monetary policy of zero interest rates and Quantitative Easing
2. He argued that US economy was back on track (see next figure)
3. This statement launched a large controversy (see here: http://www.bruegel.org/nc/blog/detail/article/849-blogs-review-hp-filters-and-business-cycles/)
4. The argument by Bullard was wrong and he changed his views
5. Now he is one of the main supporters of even more aggressive monetary policy

Bullard's figure

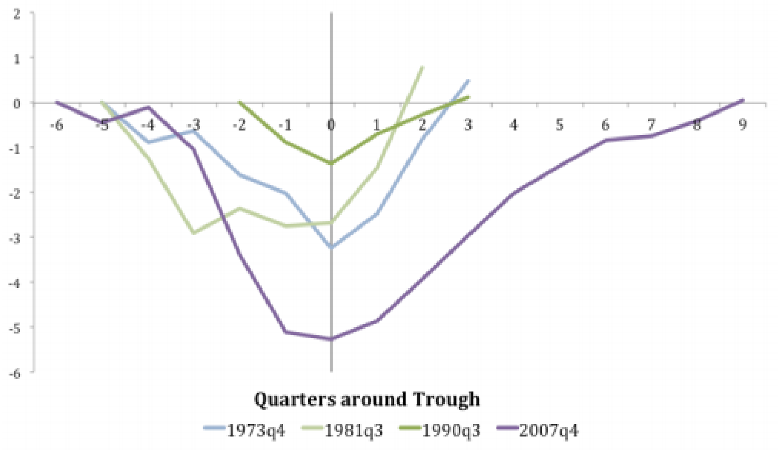


Cycles are asymmetric with respect to the "previous peak"

1. The problem lies with the HP filtter
2. The HP filter is built with this objective: the trend keeps changing all the time (that is, productive capacity changes all the time), in order to obtain symmetric cycles
3. The new view starts from the opposite objective: the trend should remain constant (productive capacity constant), so cycles come out asymmetric
4. The reference point: previous peak, and cycles are represented as the time the economy needs to come back to its previous peak
5. Used a lot in empirical work at the OECD, IMF, and others

Antonio Fatás and Ilian Mihov (2013) "Recoveries", CEPR, London

Fatas and Mihov: an example



VI – Readings

Readings

- For points (1) to (3) students **are advised** (but not obliged) to read chapter 3 of:

  Stephen Williamson (2011), *Macroeconomics*, 4th Edition, Prentice Hall .

  As some of this material has already been studied by you before, in some previous macroeconomics course, probably the study can be just confined to a light reading of this chapter.

- If you want to see how NBER dates the business cycles see the small paper **(not compulsory)**:

  NBER (December 2008). "Determination of the December 2007 Peak in Economic Activity", Cambridge, Mass.

Readings (cont.)

- For point (4), **no compulsory** reading. I hope the slides are self-suficient. But if you are very curious about filters, in particular about the Hodrick-Prescott filter, you can read:

  Dirk Krueger (2007). "Quantitative Macroeconomics: An Introduction" (Chapter 2), manuscript, Department of Economics University of Pennsylvania ".
  This is a small text (12 pages), easy to read and very useful for the study of the stylized facts of business cycles, in particular, to understand how the Hodrick-Prescott filter is calculated. But notice that, an mentioned, it is not of compulsory reading.

Readings (cont.)

- For point (5), **no compulsory** reading. Slides are supposed to be self-sufficient. However, you may have doubts about this stuff. If so, you can read just two sections of the paper below by

Antonio Fatás and Ilian Mihov (2013) "Recoveries", CEPR, London

- Section 1: "Introduction" (pages 1 and 2)
- Section 3: "Dating recoveries" (Pages 9–20)