Macro II

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Outline

- What are "Business Cycles"
  - definition - separating trend from cycle
  - some stylized "facts"
- Real business cycle theory
  - labor - leisure trade-off
  - shocks
  - how to solve – analytically and using linear approximations
- New Keynesian Theory
  - frictions
  - price setting
  - policy
- VAR-analysis

What are *Business Cycles*?

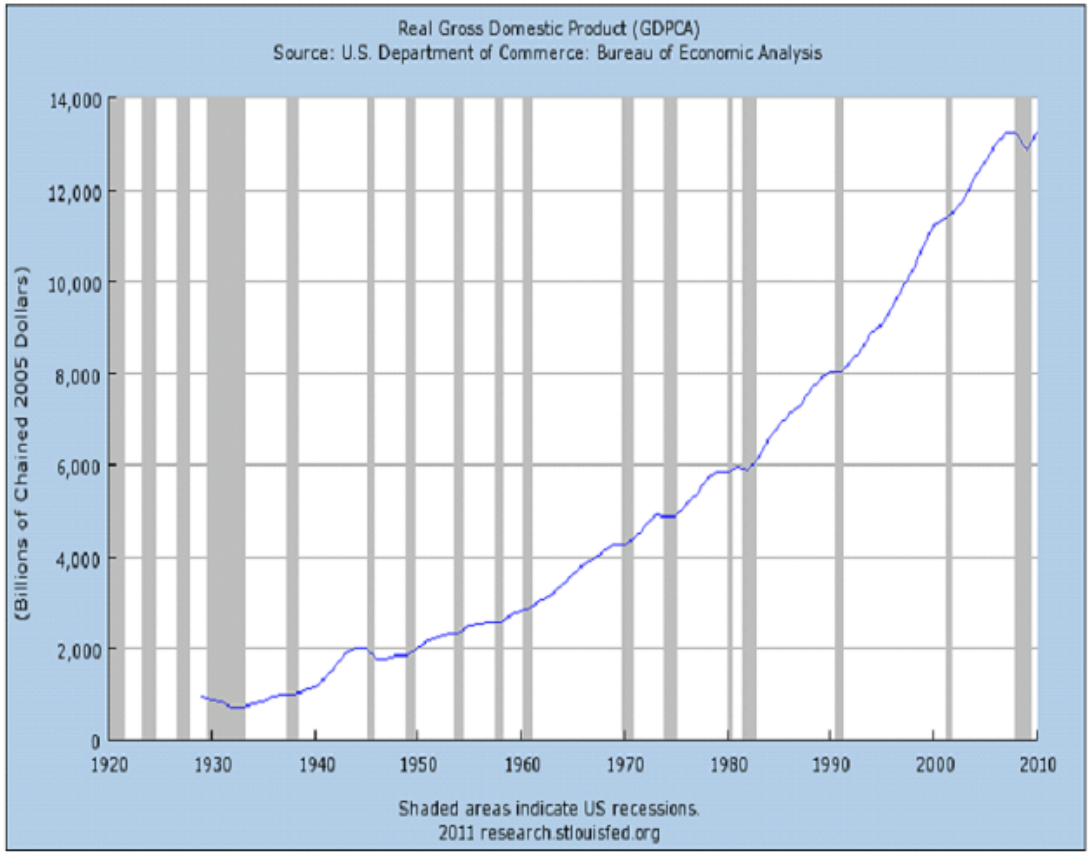
- Old idea that there is some cyclicality in the market economy.
- Rocking horse Wicksell (1907?) Frisch (1933).

What are *Business Cycles*?:2

- Schumpeter,1939, BUSINESS CYCLES - A Theoretical, Historical and Statistical Analysis of the Capitalist Process (Schumpeter, 1939). In his terminology, a 7-11 year cycle (of several) with four phases.
  1. expansion (increase in production and prices, low interest-rates)
  2. crisis (stock exchanges crash and multiple bankruptcies of firms occur)
  3. recession (drops in prices and in output, high interest-rates)
  4. recovery (stocks recover because of the fall in prices and incomes)
- Lucas "Though there is absolutely no theoretical reason to anticipate it, one is led by the facts to conclude that, with respect to the qualitative behavior of co-movements among series, business cycles are all alike." (Lucas 1977).

Decomposition

- Intuitive idea – some regular mean reverting deviations from a trend.



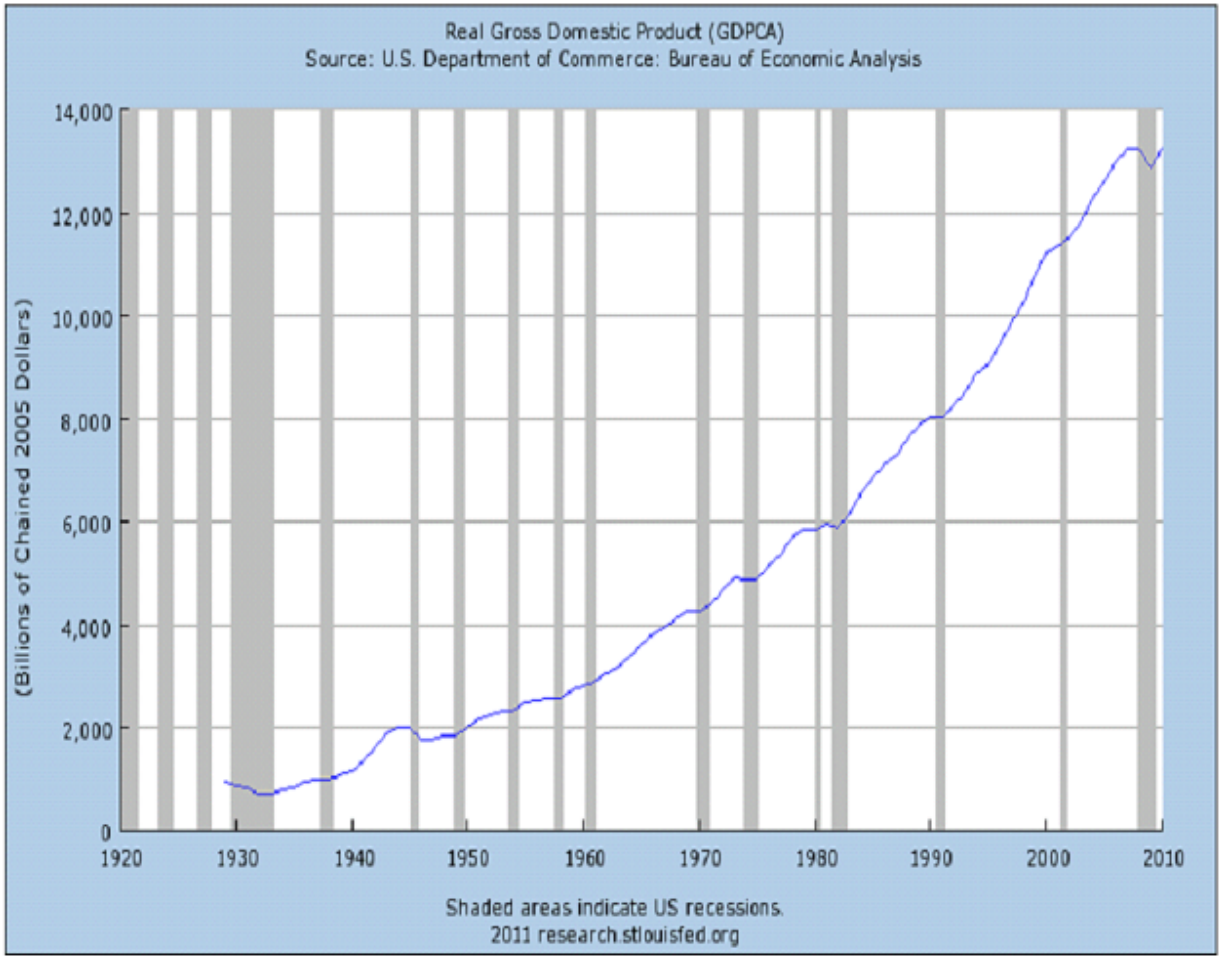
Two approaches

- NBER approach – judgemental.
- Statistical – using a particular standardized method.

NBER approach

- NBER Business Cycle Dating Committee
- Robert Hall, Martin Feldstein, Jeffrey Frankel, Robert Gordon, James Poterba, Valerie Ramey, Christina Romer, David Romer, James Stock, Mark Watson.
- " A recession is a significant decline in economic activity spread across the economy, lasting more than a few months, normally visible in real GDP, real income, employment, industrial production, and wholesale-retail sales. A recession begins just after the economy reaches a peak of activity and ends as the economy reaches its trough. Between trough and peak, the economy is in an expansion. Expansion is the normal state of the economy; most recessions are brief and they have been rare in recent decades".
- Peaks and troughs determined with a substantial lag (6-21 months). No changes so far.
- Note the difference compared to a definition based on the idea of positive or negative output gaps – deviations from trend. Where are Sweden and US today?

NBER recessions

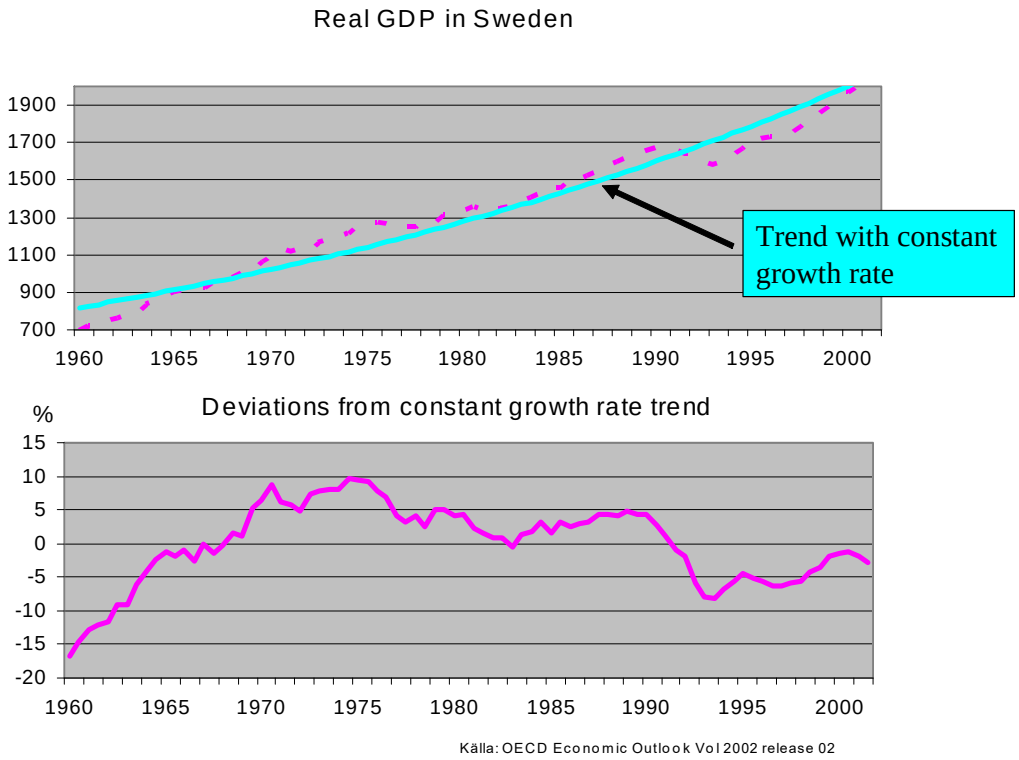


Statistical approach

- Idea: Non-stationary (trending) variables can be separated in a cyclical (stationary) part and a trending non-stationary.
- Stationary part should have well defined moments (mean, autocorrelation, standard deviation).
- Corresponds to standard treatment in undergraduate text books.
- Empirical problem – No unique way of separating cycle from trend.
- Economic time-series contain a lot of variation at fairly low frequencies. How much of this is "business cycle fluctuations"?

Example

- Estimate a trend with constant growth rate (log-linear). Define the deviation from this "Business cycle"



Hodrick-Prescott (Whittaker-Hendersson) filter

- Most common filter.
- Solution to

$$\min_{\{Y_{c,t},Y_{tr,t}\}_0^T} \sum_{t=0}^{T} \left(Y_{c,t}\right)^2$$

$$\text{s.t. } k \geq \sum_{t=2}^{T} \left(\left(Y_{tr,t} - Y_{tr,t-1}\right) - \left(Y_{tr,t-1} - Y_{tr,t-2}\right)\right)^2$$

$$Y_t = Y_{tr,t} + Y_{c,t}$$

- Trading of tracking Y_t (giving small $Y_{c,t}$) against a changing the slope of the trend $Y_{tr,t}$.
- Lagrange multiplier on first constraint determines split. Can be *correct* given a special structure of the data generating process, e.g.,

$$\left(1-L\right)^2 Y_{tr,t} \equiv \left(Y_{tr,t} - Y_{tr,t-1}\right) - \left(Y_{tr,t-1} - Y_{tr,t-2}\right) = \varepsilon_t$$

$$Y_{c,t} = \nu_t$$

with ε_t and ν_t i.i.d.

Implementation

- A linear filter – easy to implement
- Decide λ first, then multiply series by the matrix

$$\mathbf{Y}_c = \left[I - \left(I + \lambda \kappa' \kappa \right)^{-1} \right] \mathbf{Y}.$$

where κ is a matrix with dimension $n-2, n$ if the sample size is n, given by

$$\kappa = \begin{bmatrix} 1 & -2 & 1 & 0 & ... & 0 \\ 0 & 1 & -2 & 1 & ... & 0 \\ 0 & 0 & 1 & -2 & ... & 0 \\ . & . & . & . & ... & . \\ . & . & . & . & ... & . \\ 0 & 0 & 0 & 1 & -2 & 1 \end{bmatrix}$$

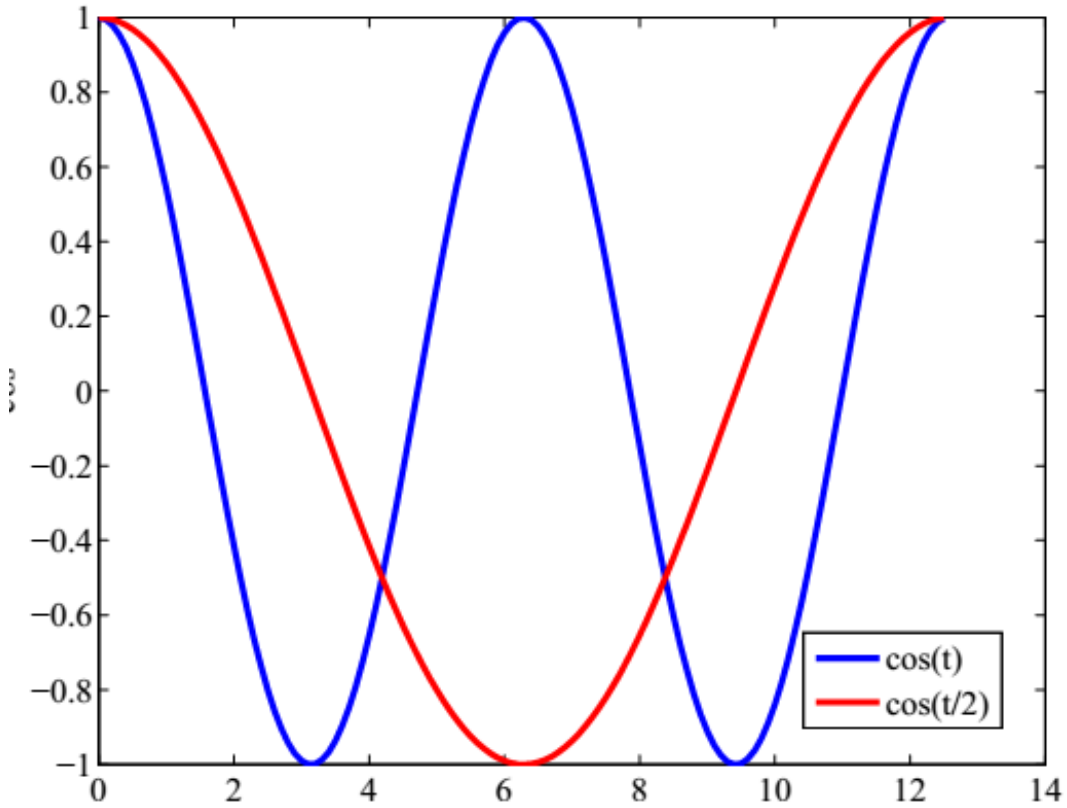
- The matrix $\left[I - \left(I + \lambda \kappa' \kappa \right)^{-1} \right]$ doesn't contain many (any) zeros. This means that $Y_{c,t}$ is a linear combination of all previous *and future* values of Y_t.

Implementation:2

- It has become a standard to use $\lambda = 1600$ for quarterly data.
- λ should be adjusted down with lower frequency. Unclear how much, some use linear, implying ($\lambda = 1600/4 = 400$) for yearly, some quadratic (1600/16=100) some even forth power adjustment ($1600/4^4 = 6.25$).
- For a discussion see e.g., Ravn and Uhlig 2002.
- Some potential problems, but still used a lot. Can keep too much low frequencies and too much high.
- Can be important if low frequency variation is important and behaves differently than other frequencies, e.g., with respect to correlation with other series.

Spectral decomposition

- Idea: A stationary time-series can be represented as a sum of sine and (cosine) waves with different frequency and amplitude.
- Implementation: regress time series on sine and cosine waves with different frequency (wave length).



Implementation

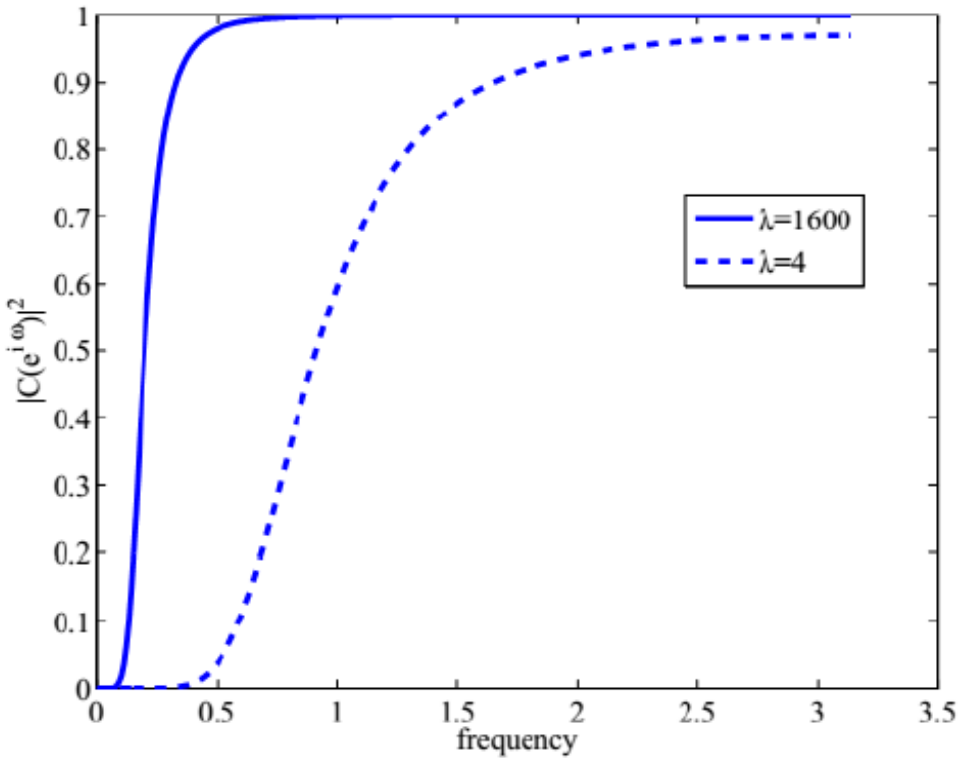
- Regress T observations of (stationary) y_t on different sine and cosine waves

$$\begin{aligned} y_t &= a_1 \sin(\omega_1 t) + b_1 \cos(\omega_1 t) \\ &\quad + a_2 \sin(\omega_2 t) + b_2 \cos(\omega_2 t) \\ &\quad + ... \\ &\quad + a_{T/2} \sin(\omega_{T/2} t) + b_{T/2} \cos(\omega_{T/2} t) \end{aligned}$$

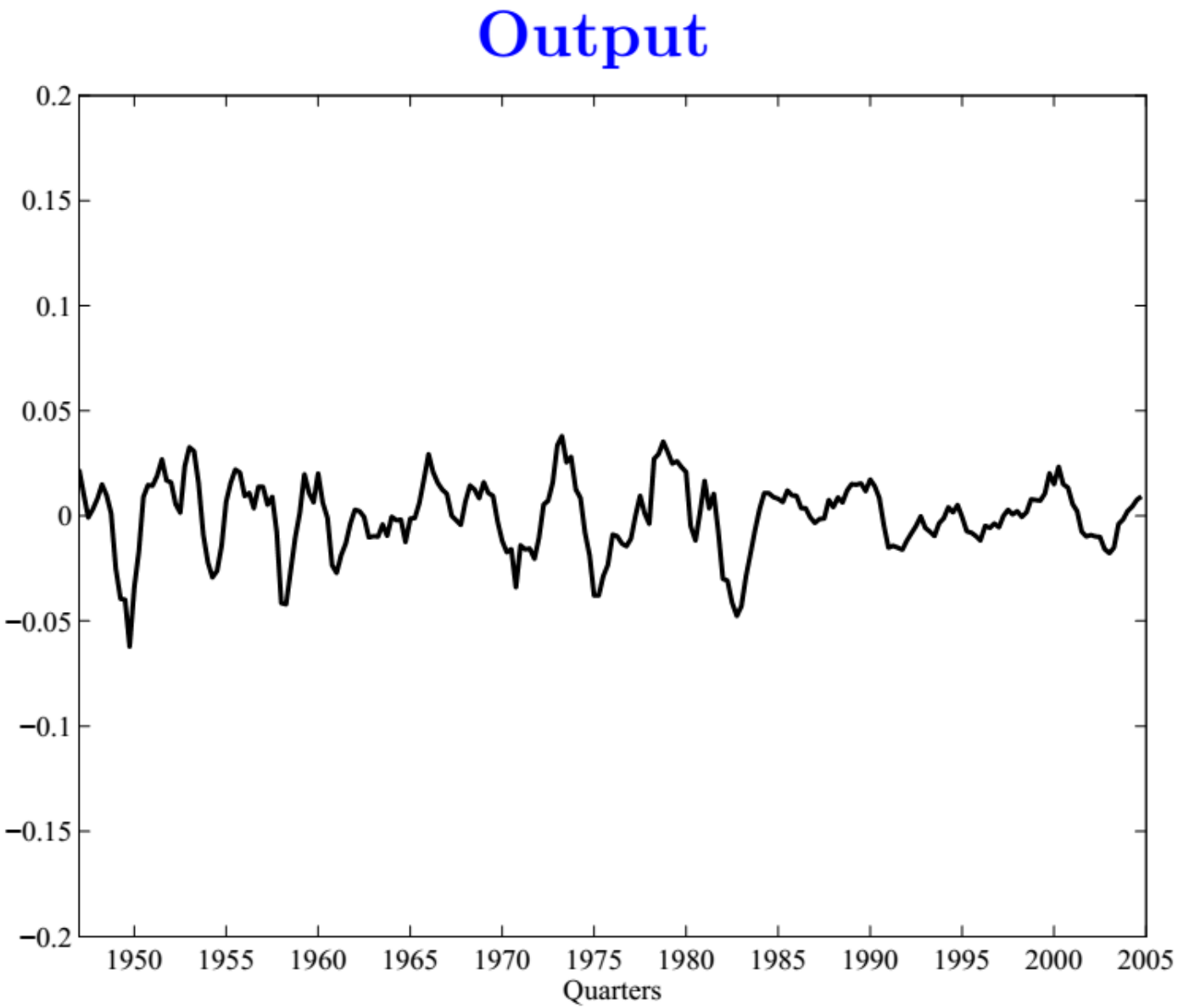
- the a_s and b_s determine contribution to variance and phase of the different contributions.
- Note that we have T linearly independent regressors. What is the regression R^2?
- In the *frequency domain*, it is easy to:
  - determine the contribution to the variance, the *spectral density*, at different frequencies, and
  - cancel particular unwanted frequencies by setting relevant $a's$ and $b's$ and use model to "predict" y_t. This is a *band-pass filter*.

Filter gain

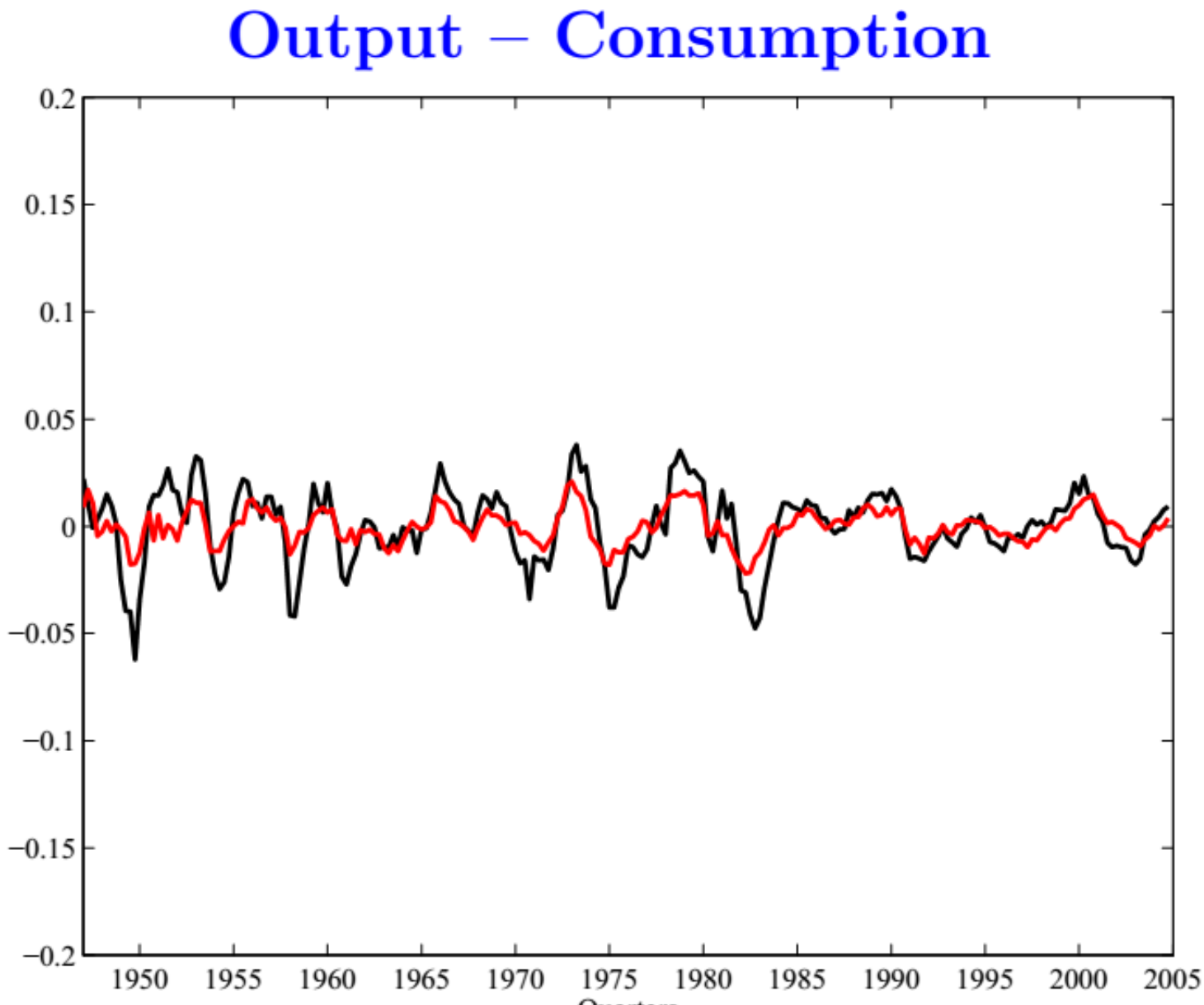
Figure 18: HODDRICK-PRESCOTT Filter



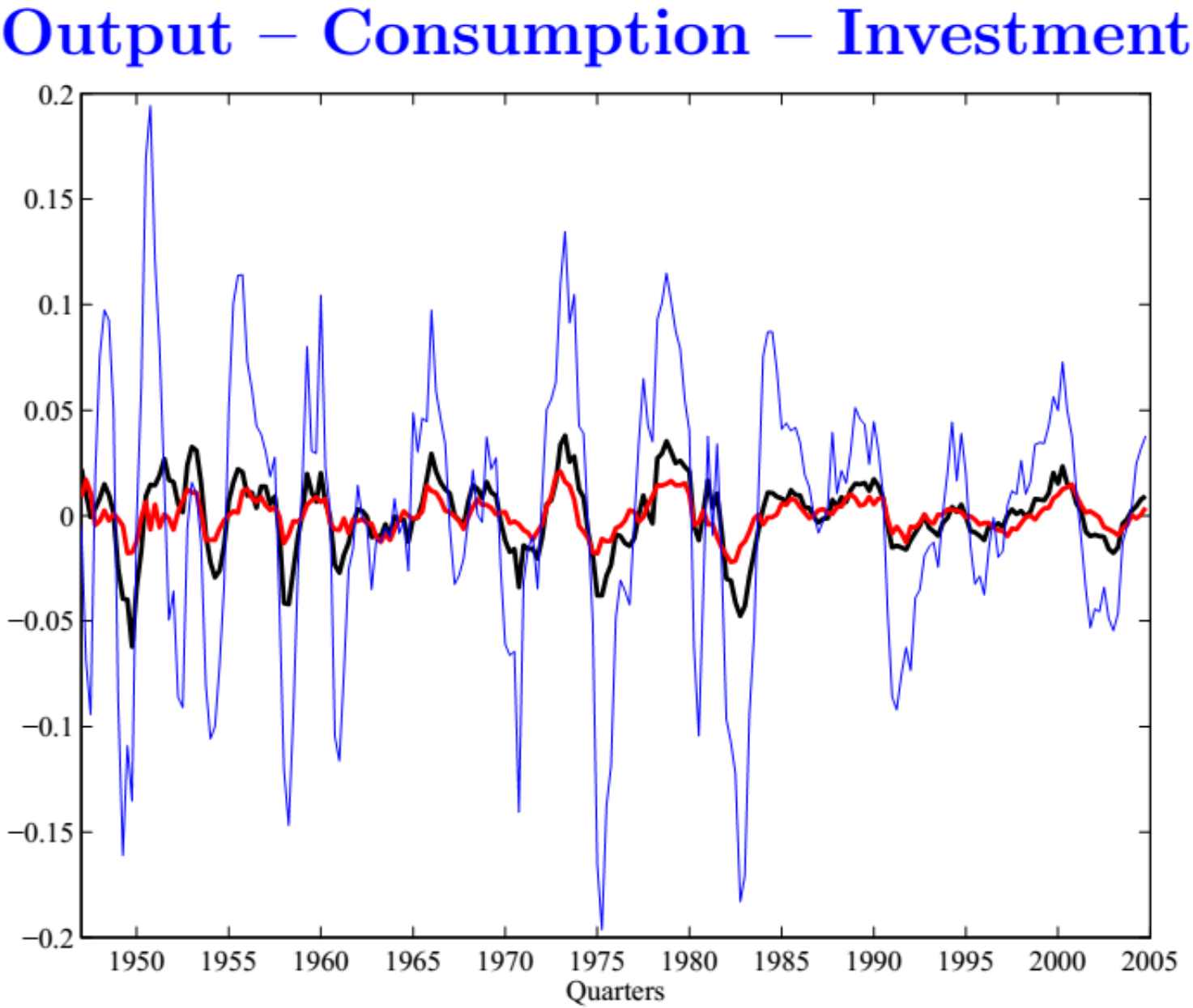
Comovements



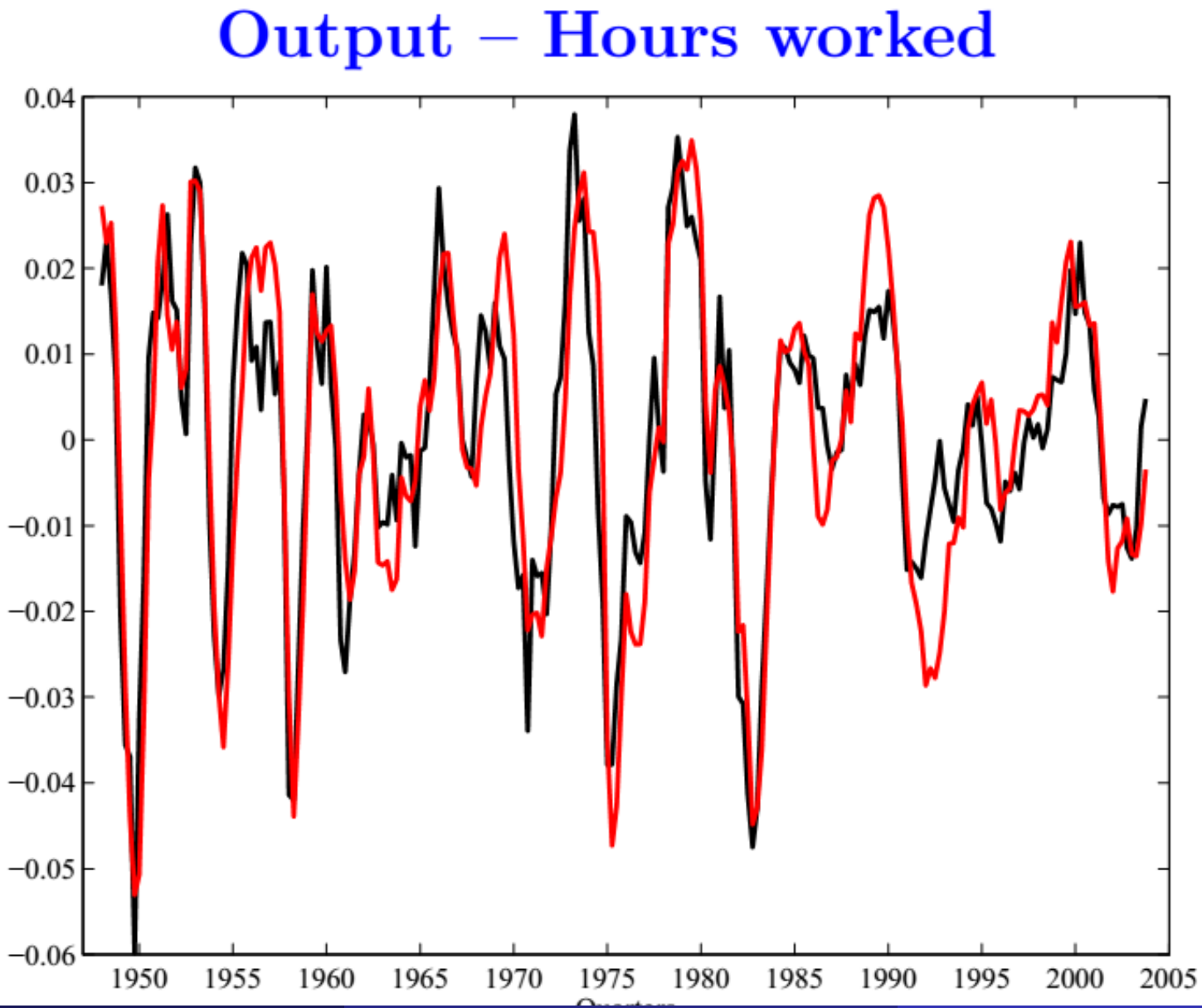
Comovements:2



Comovements:3



Comovements:4



Regularities: definitions

- Typically look at correlation (possibly covariance) with output, $Y_{c,t}$.
- X is **Procyclical** if $corr(Y_{c,t}, X_{c,t}) > 0$.
- X is **Countercyclical** if $corr(Y_{c,t}, X_{c,t}) < 0$.
- X is **Leading** if $corr(Y_{c,t+s}, X_{c,t})$ is highest and positive for $s > 0$.
- X is **Lagging** if $corr(Y_{c,t+s}, X_{c,t})$ is highest and positive for $s < 0$.

Regularities: some typical findings

- Consumption smoothing – $\sigma_C < \sigma_Y$
- Investment volatile – $\sigma_I > \sigma_Y$
- Consumption and investments strongly procyclical.
- Durables purchases very volatile and procyclical.
- Most sectors correlated (except mining).
- Employment and hours strongly procyclical, employment with a slight lag.
- Employment more volatile than hours/employee.
- Real wages only weakly procyclical
- Raw inflation not cyclical while detrended is or when separating sub-periods.
- Monetary policy seems to affect output, prices much later.