Seminar to Advanced Macroeconomics

A Cookbook Introduction to the Analysis of Macroeconomic Time Series

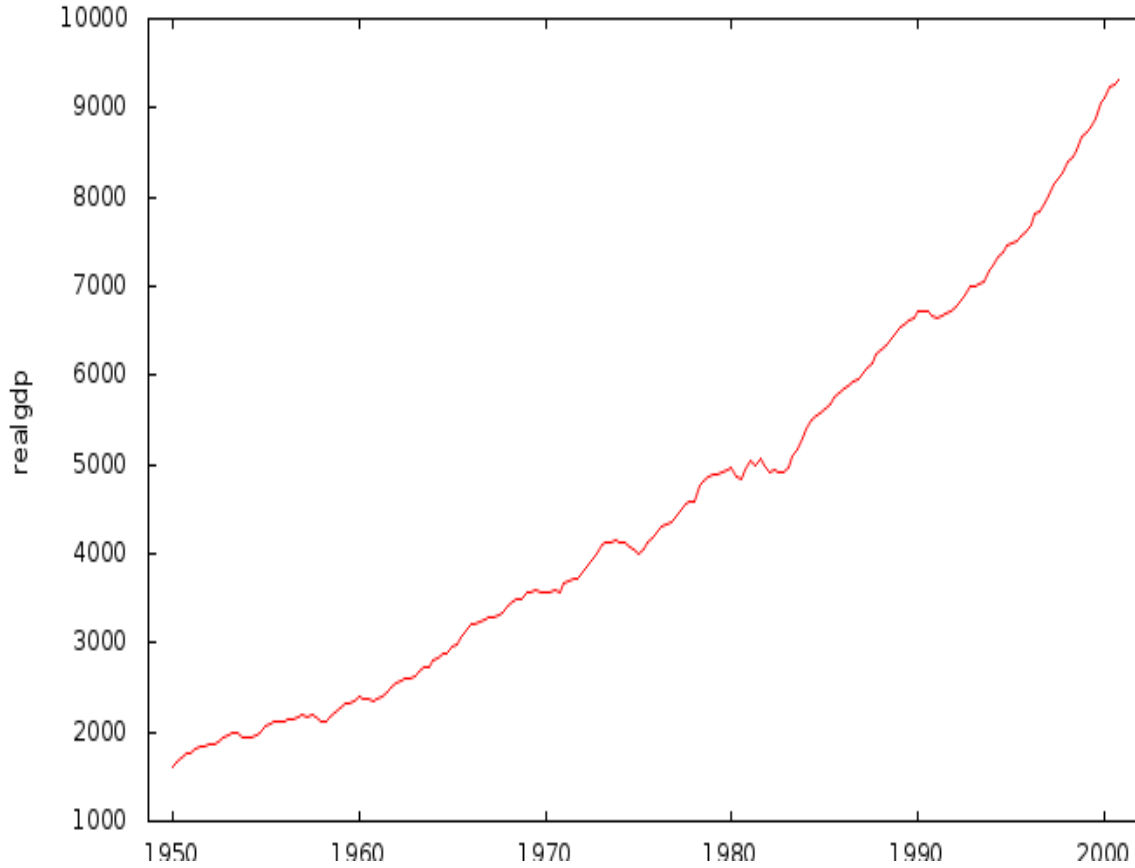
Outline

- Motivation: Identification of trend and cycles
- A quick look at GDP time series
- Trends and their extraction
- Seasonal Adjustment Methods

Motivation

- GDP in the U.S.
  - Clear trend
  - Business cycles?
  - Periods of faster and slower growth
- Extracting the cycles
  - Trend → Growth
  - Cycle → monetary and fiscal policy (Taylor rule, golden rules for budget balances)

GDP of the U.S. economy, 1950-2000



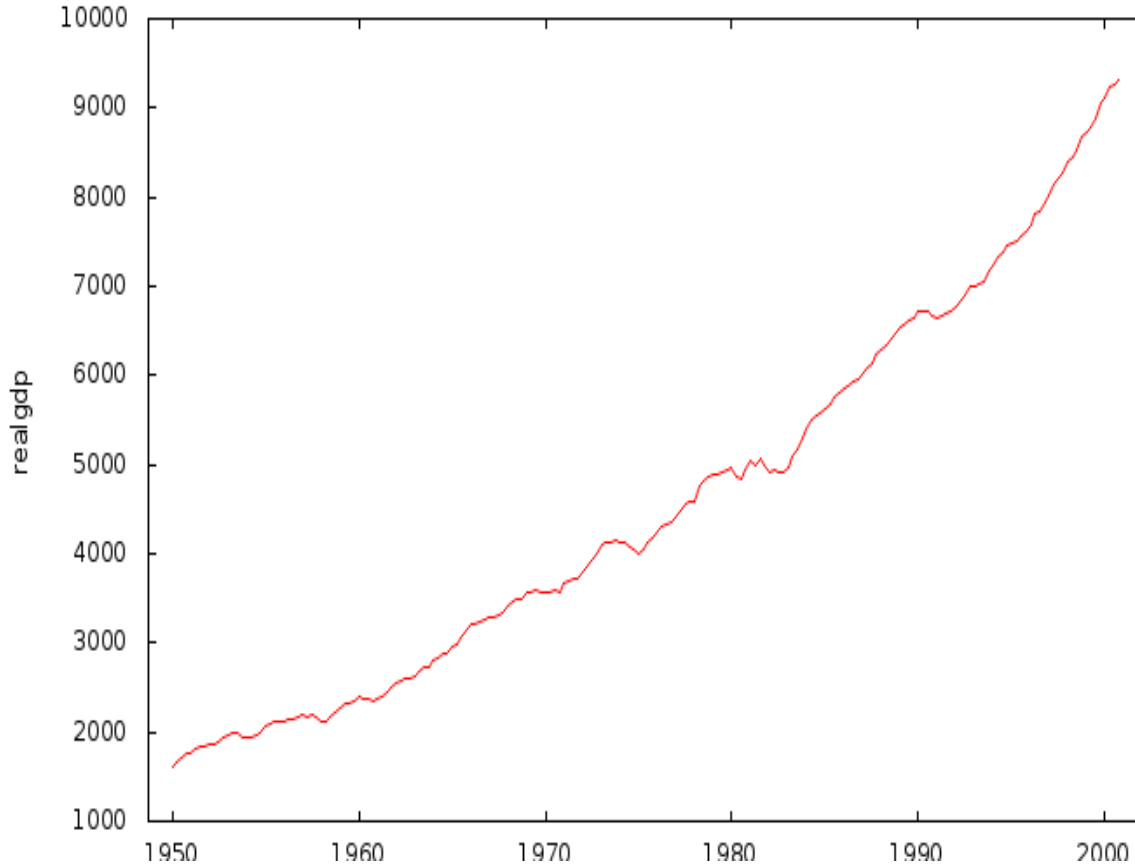
A Quick Look at GDP Time Series

- Data file:

Gretl sample files → Greene → U.S. Macro

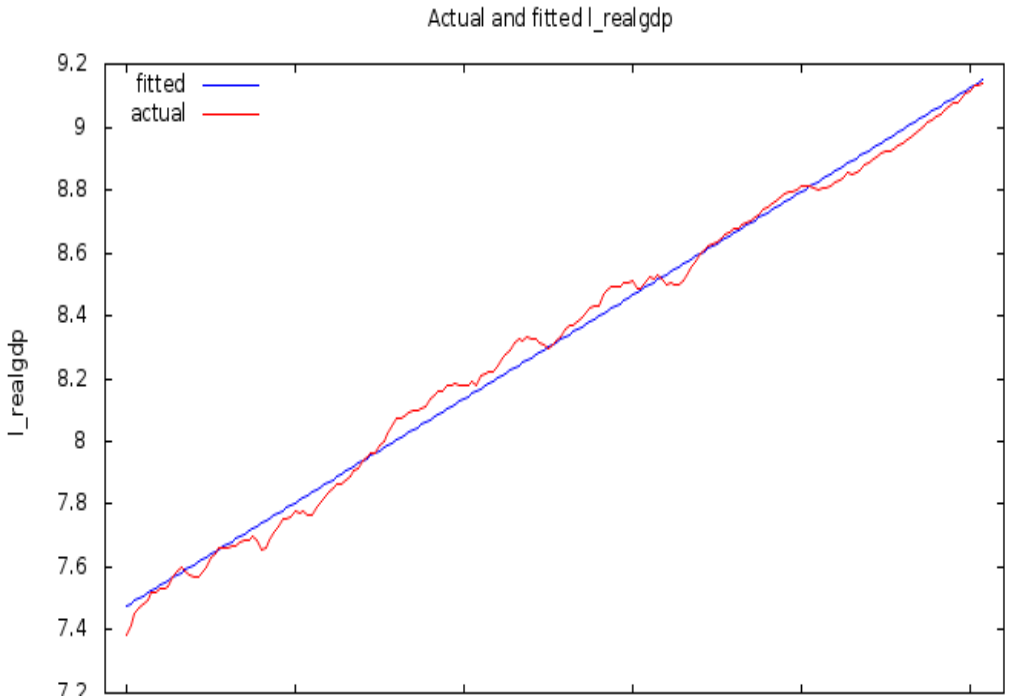
- Exponential growth
  - $gdp_{t+k}=gdp_{t0}(1+\beta)^k$
- Natural approach: Deterministic trend with OLS on logs
  - $\log(gdp_{t+k}) = \alpha + \beta*k + u_t$

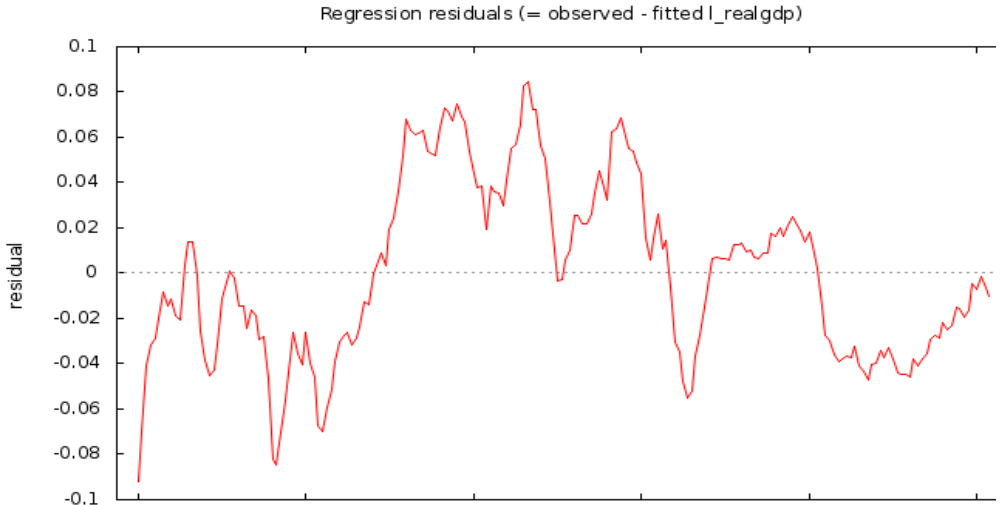
GDP of the U.S. economy, 1950-2000



A Quick Look at GDP Time Series

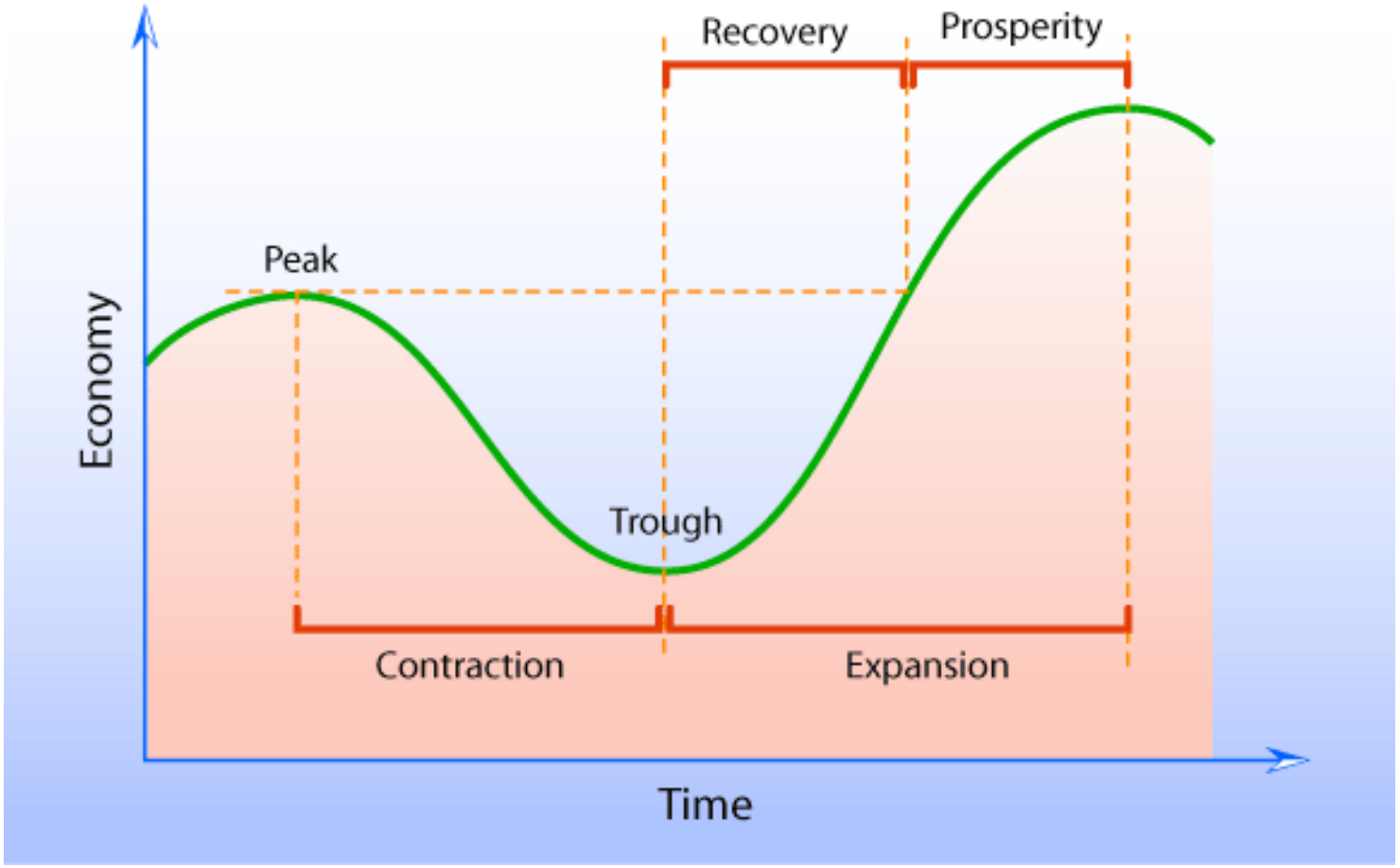
- Linear trend
- Residuals = cycle.
- Some tests necessary:
- Is the trend adequate?
- Do the cycle correspond to our intuition about cycles?





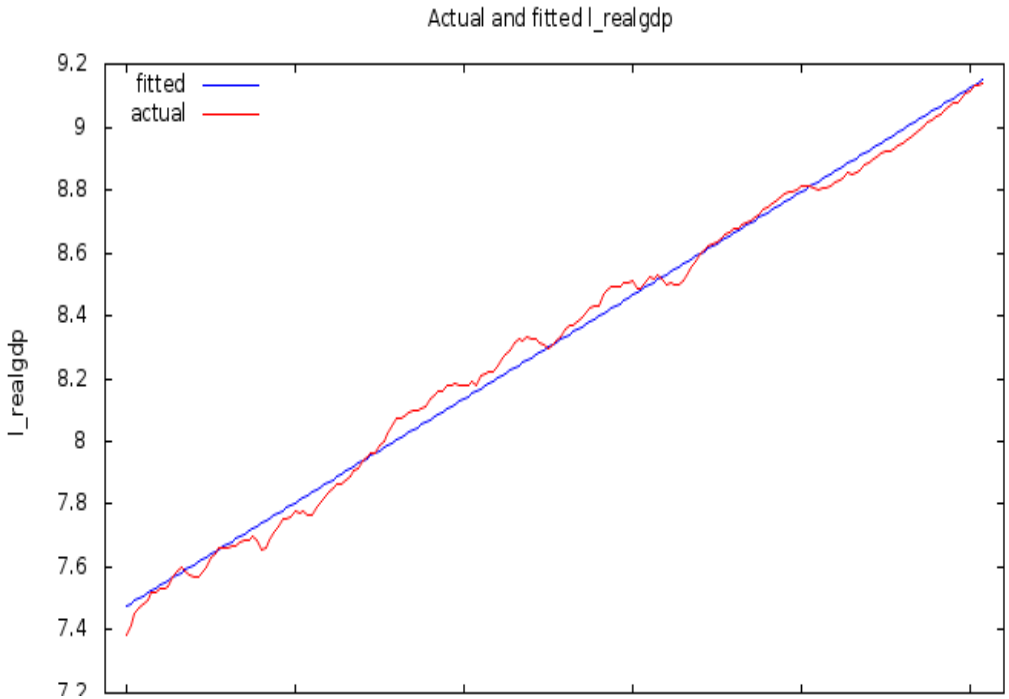
Ideal Business Cycle

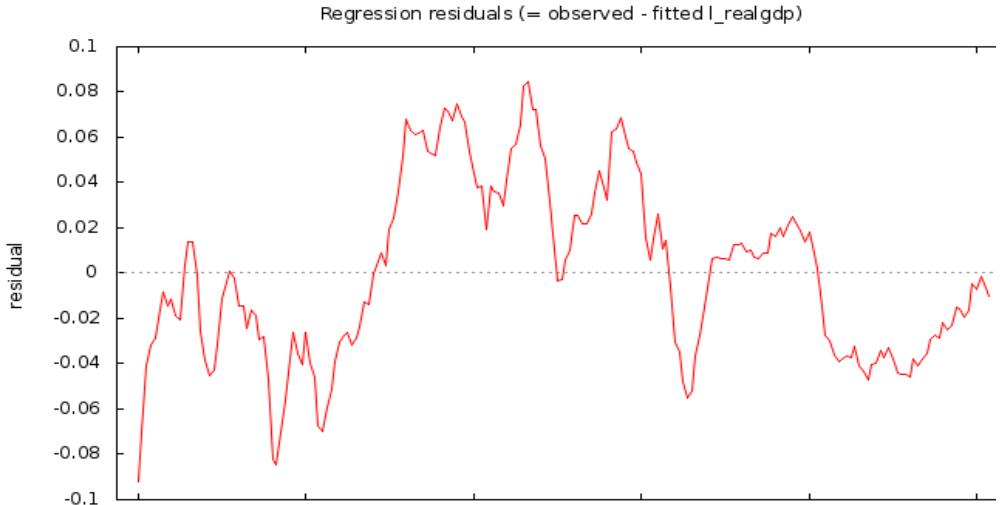
(Picture from Wikipedia)



Nature of the Trend

- Intuition about cycles:
- Oscilating... → cycles are temporary.
- It has to be mean reverting, zero mean, no heteroscedasticity
- So called **stationarity**



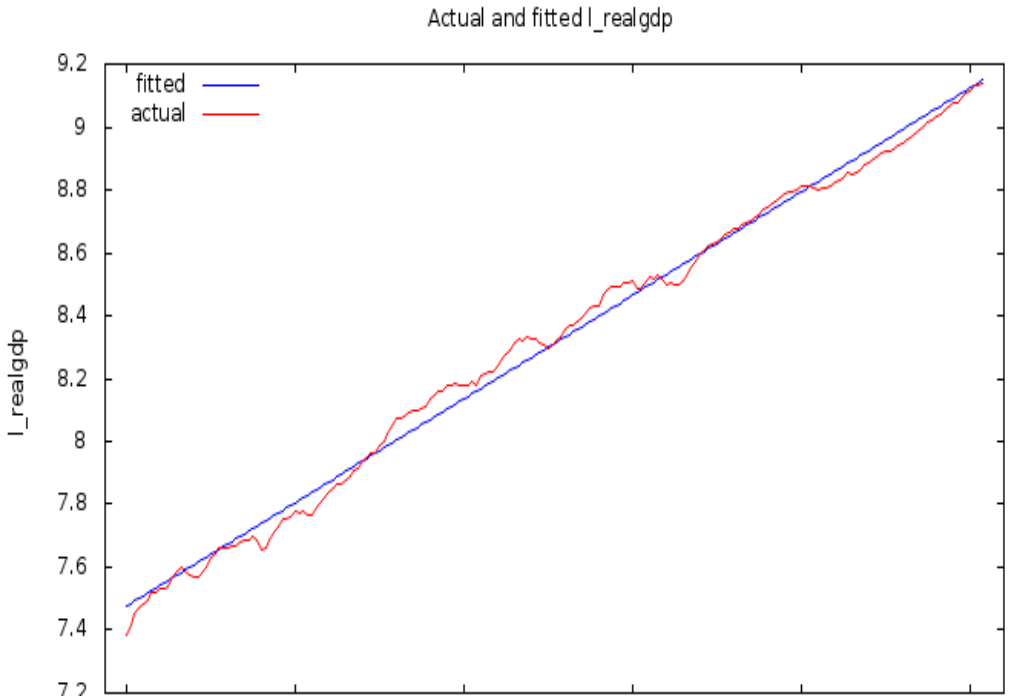


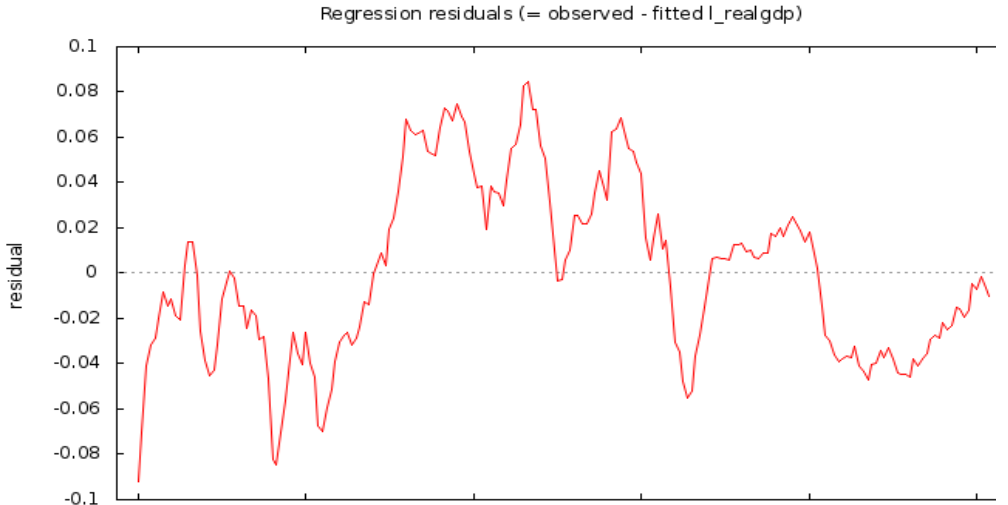
Intermezzo: Stationarity I

- A *stationary* time series = one whose statistical properties such as mean, variance, autocorrelation, etc. are all constant over time.
- Most statistical forecasting methods assume that the time series can be made approximately stationary through the use of mathematical transformations.
- A stationarized series is relatively easy to predict: you simply predict that its statistical properties will be the same in the future as they have been in the past!
- The predictions for the stationarized series can then be "untransformed," by reversing whatever mathematical transformations were previously used, to obtain predictions for the original series.

Nature of the Trend

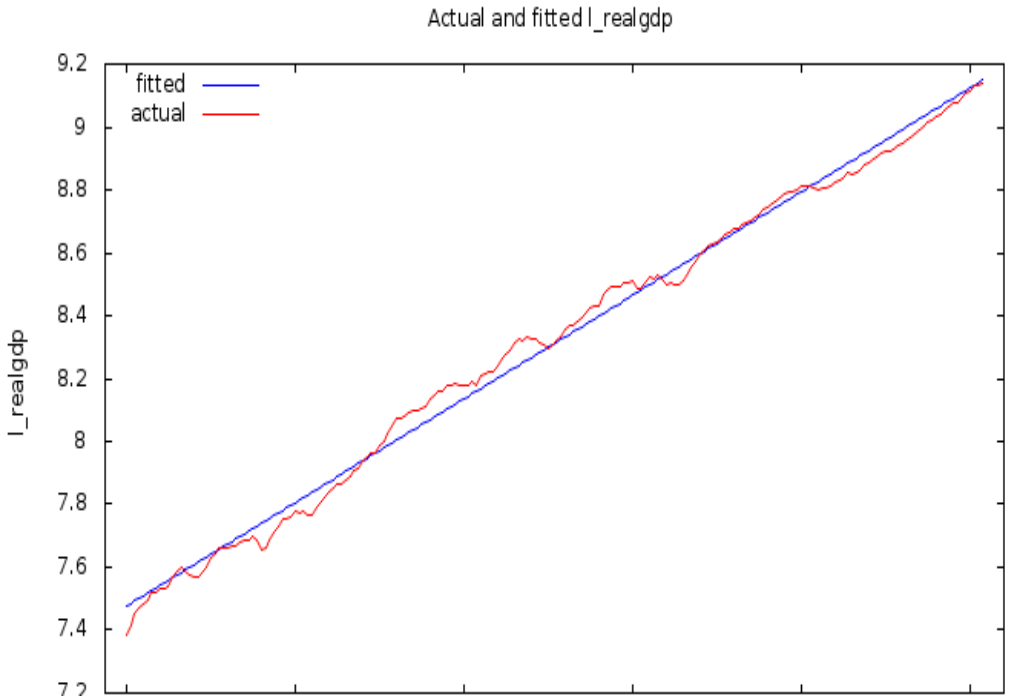
- If stationarity of residuals rejected => trend stationarity does not correspond fully to the true model of the time series
- The trend is somehow stochastic

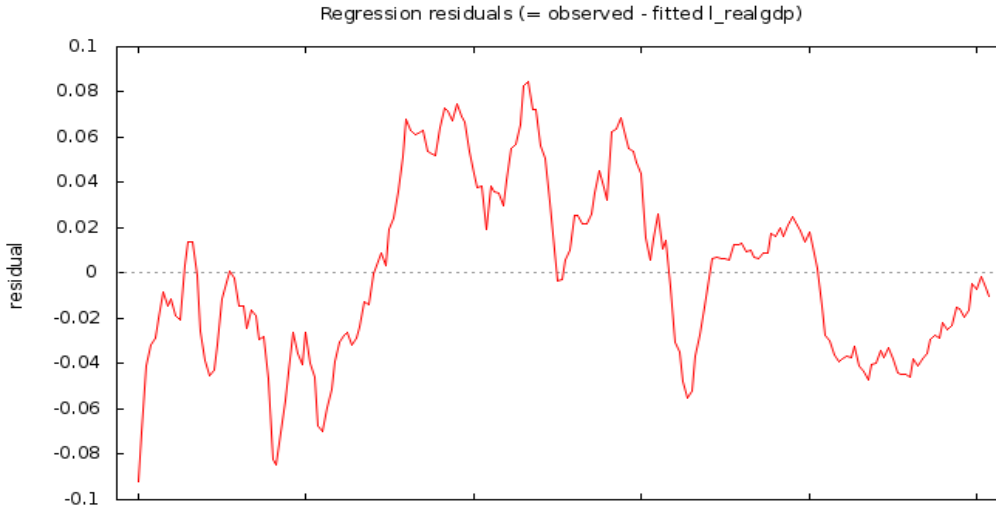




Nature of the Trend: Structural Breaks

- Sometimes stationarity of cycles rejected because of structural breaks.
- How to detect them?
- And how to deal with them?





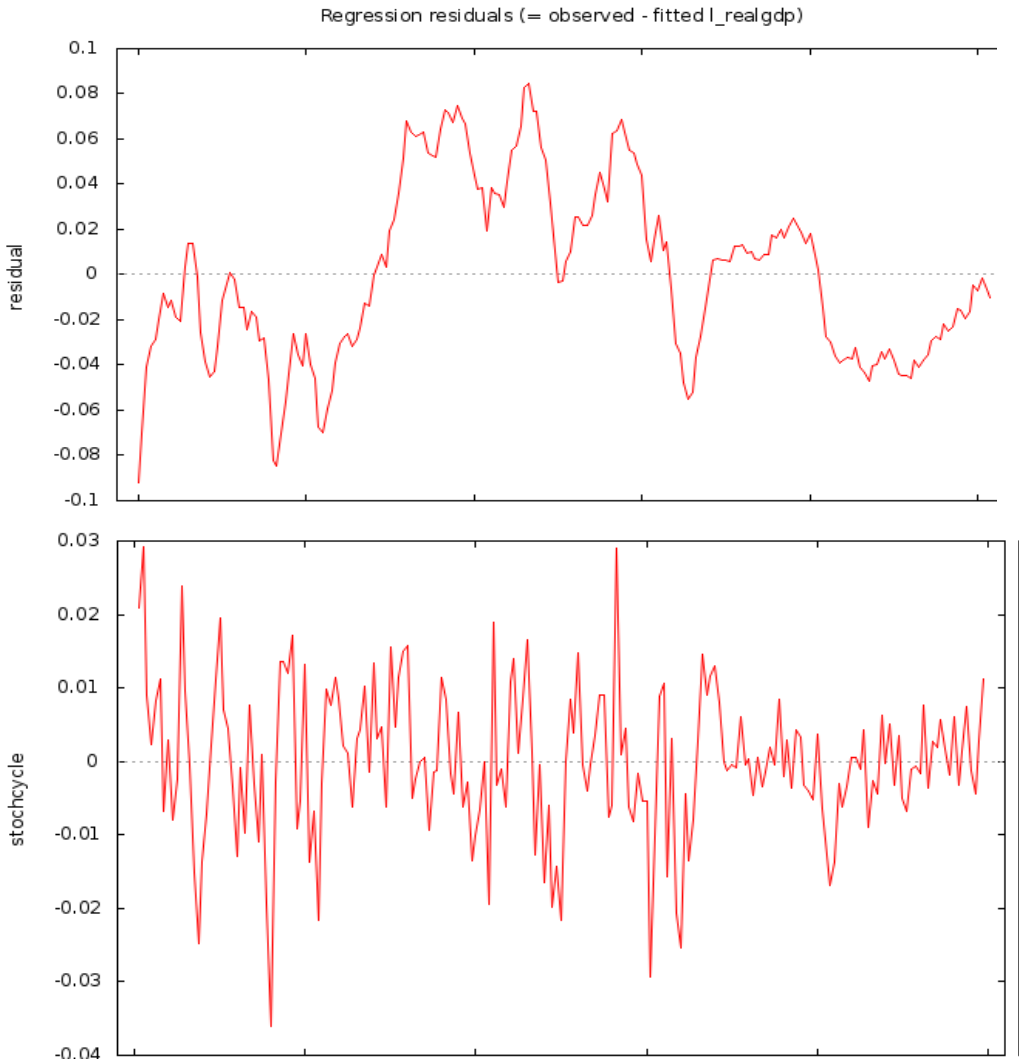
Nature of the Trend

- Stochastic trend

Difference-stationarity

- First differences to detect periods with growth below mean
- Or seasonal differences: $(y_t - y_{t-4})$.

Cycle of the U.S. economy, 1950-2000



Filtering methods

- Currently most popular approach to separate trend and cycle from original time series.
- Based on frequency domain → it simply extracts frequencies corresponding to the frequencies of business cycles (from 6 to 32 quarters)
- Transformation of spectrum

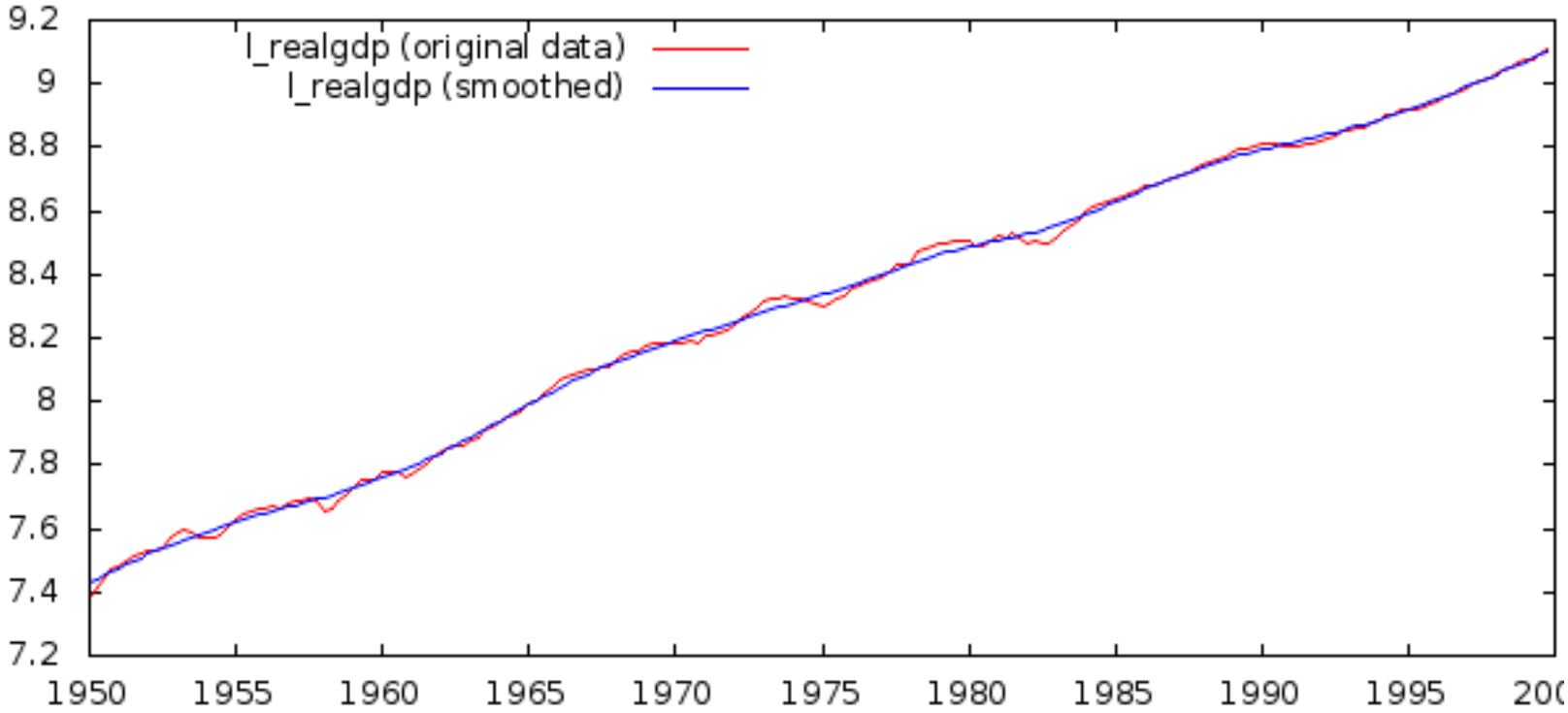
Hodrick-Prescott Filter

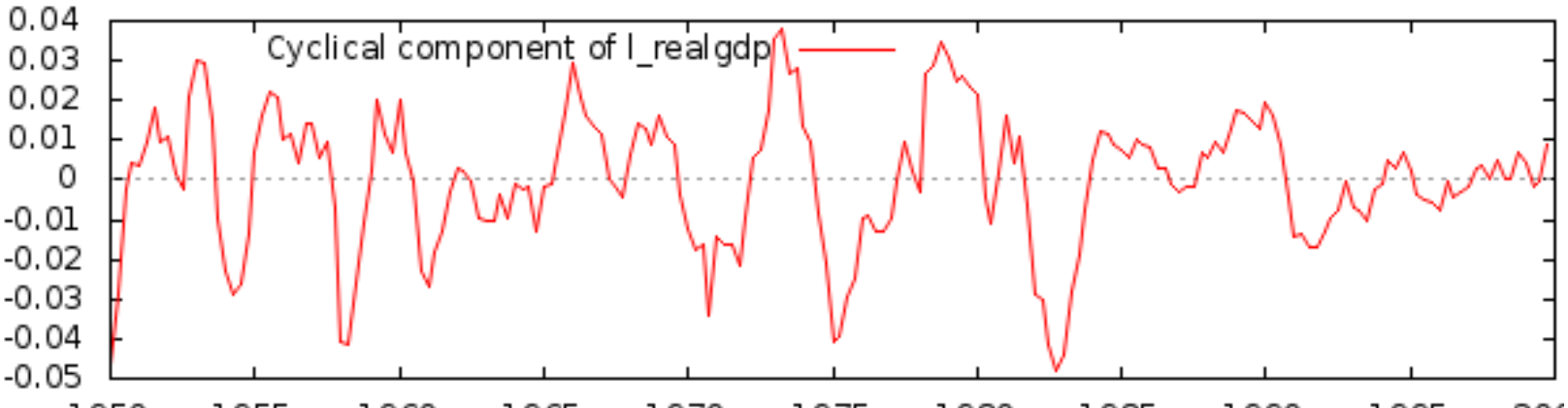
- Formula:

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

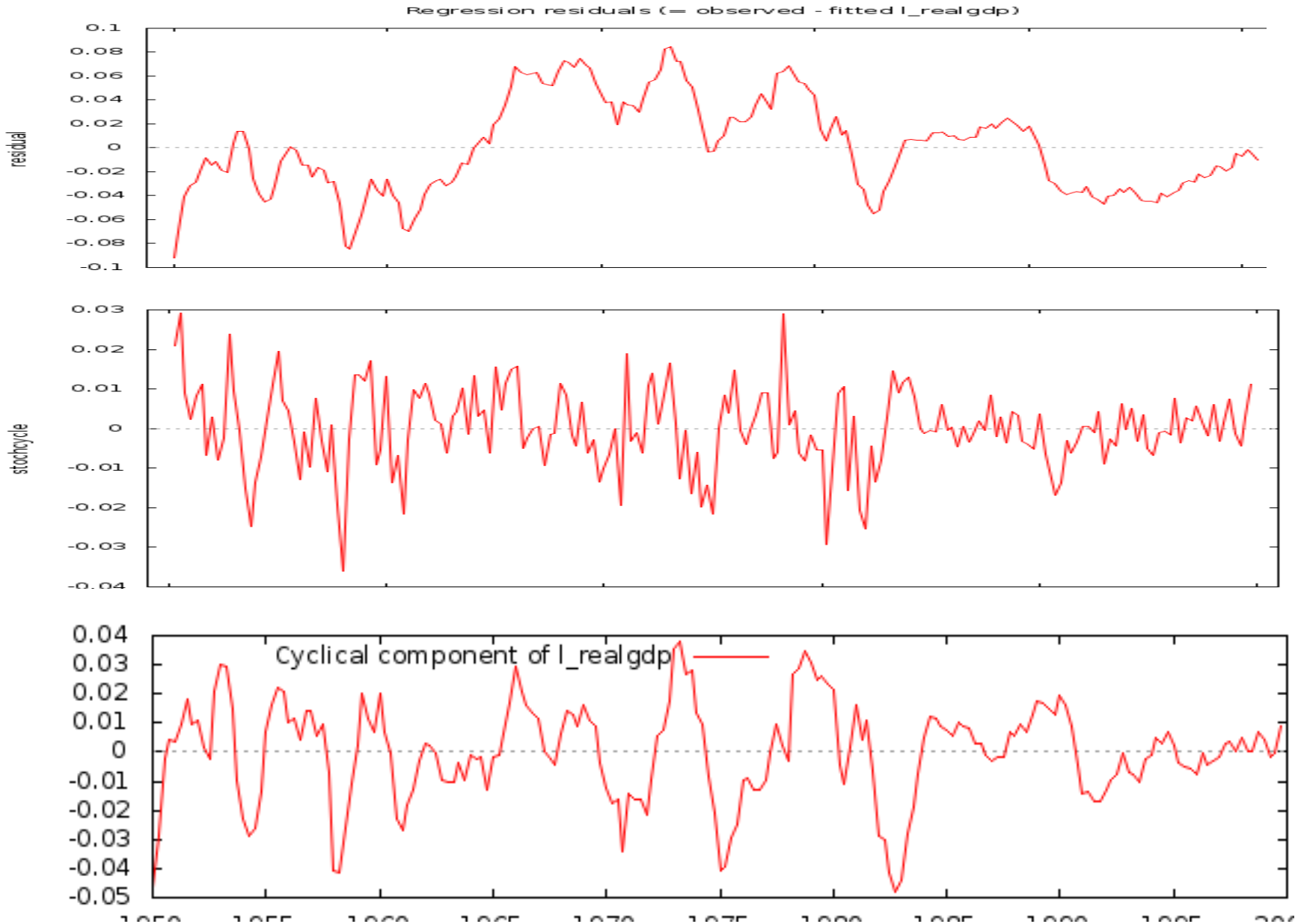
- y_t … actual value of gdp, τ_t … trend in time t
- λ … smoothing parameter, for quarterly data set usually to 1600, for annual data 10.
- The value has been set more less arbitrarily: authors commented it that the value to derive "*trend, which students of business cycles would draw into the plot of GDP.*"

Hodrick-Prescott Filter - Results





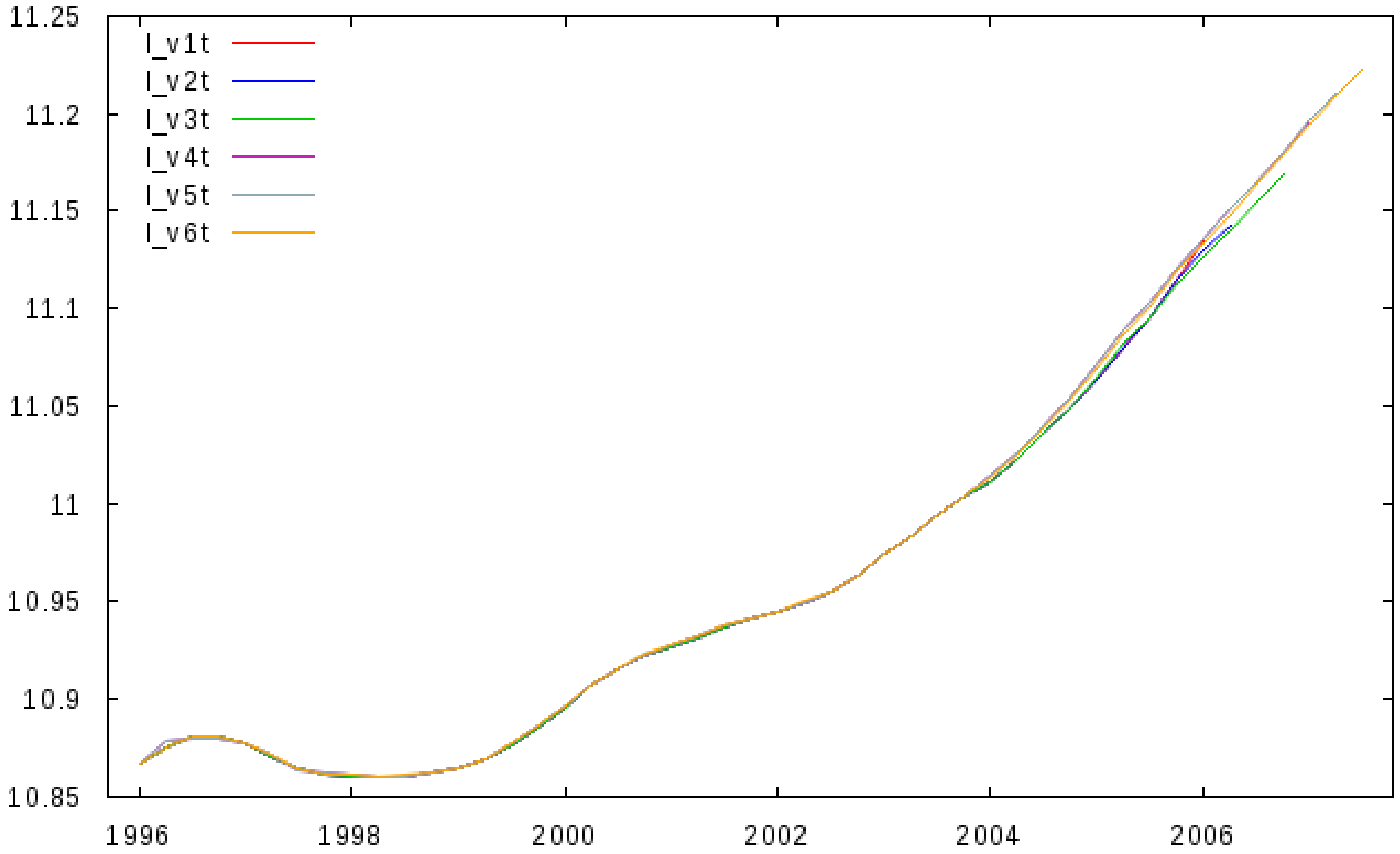
Comparing All the Cycles: The Great Moderation



Final Note: Economic Data and Revisions

- Macro data are often revised.
- Example: GDP
- Estimate – First calculation – Revision – Final number 2 years after.
- Causes: all information have to be gathered; minor changes in seasonal adjustment...
- Real-time vs. Ex-post data

Final Note: Economic Data and Revisions



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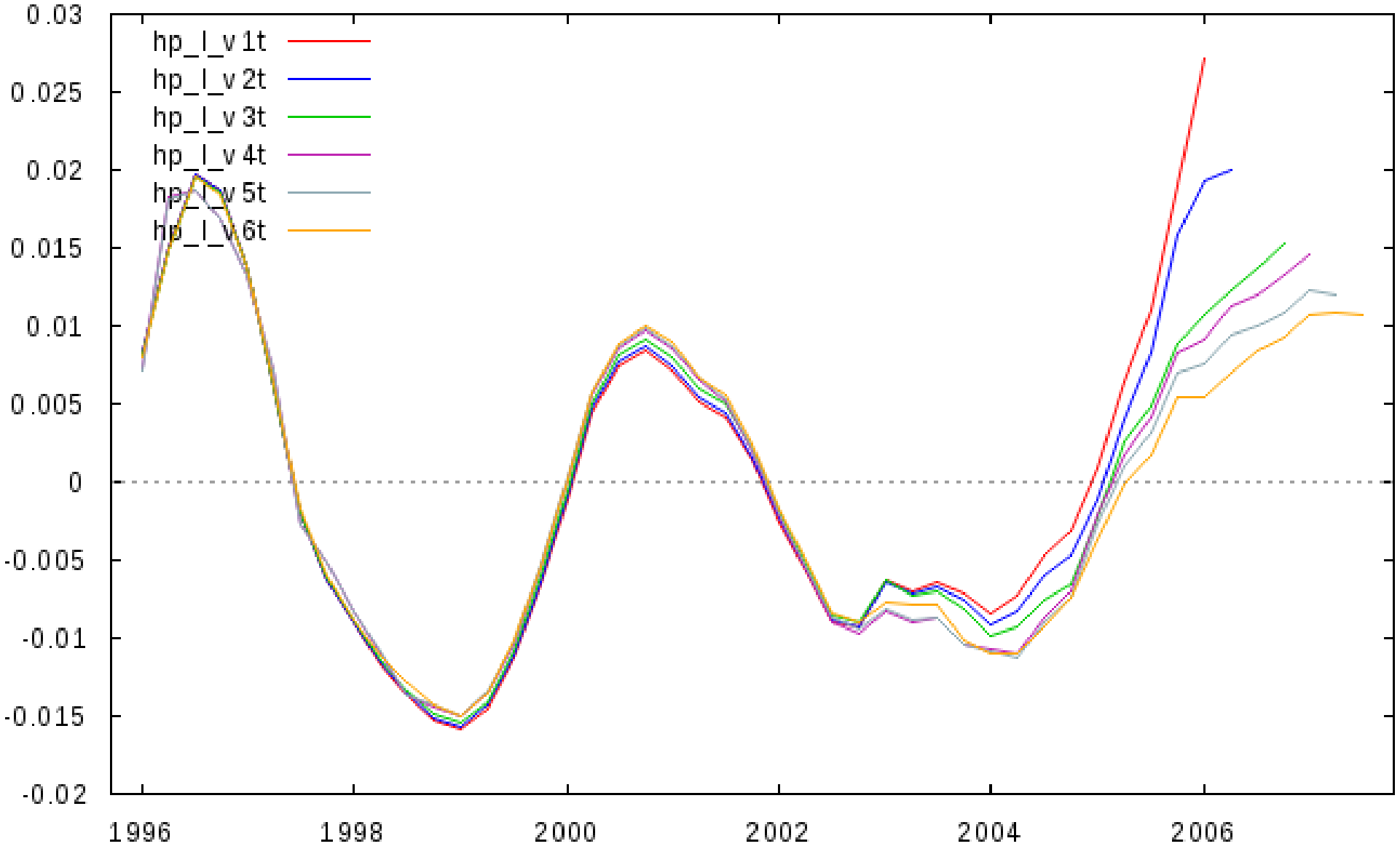
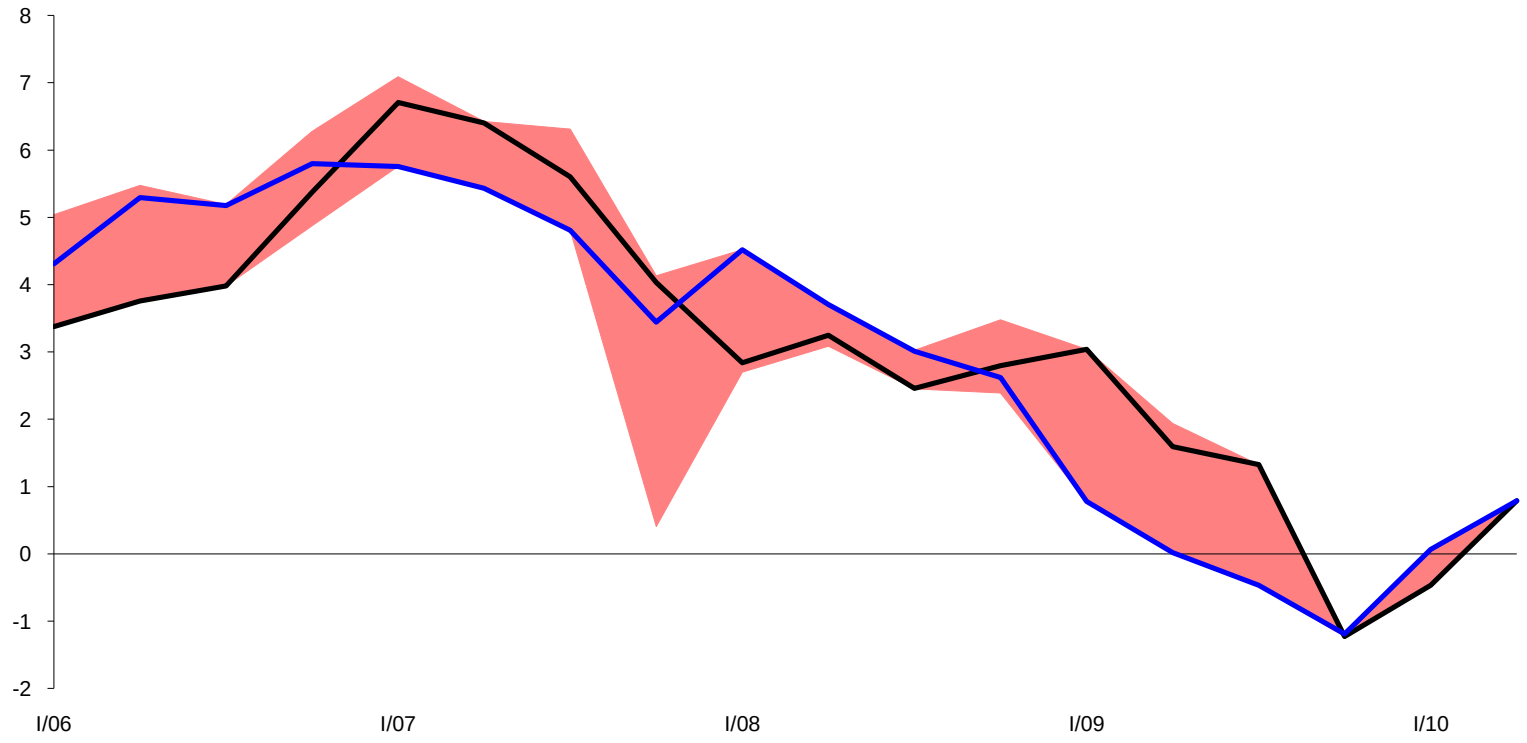


Final Note: Economic Data and Revisions
Magnitude of revisions of household consumption

Constant prices; seasonaly adjusted, annual % change



Key Points

- Linear trend on logs of data (Log-linear model)
- Cycles – stationarity, economic intuition
- Differencing, filtering.
- Hodrick-Prescott filter, smoothing parameter
- Ex-post vs. real-time data, revisions