HP Filter in R

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Overview

Introduction

- Hodrick and Prescott (1997): Postwar U.S. Business Cycles: An Empirical Investigation

HP Filter

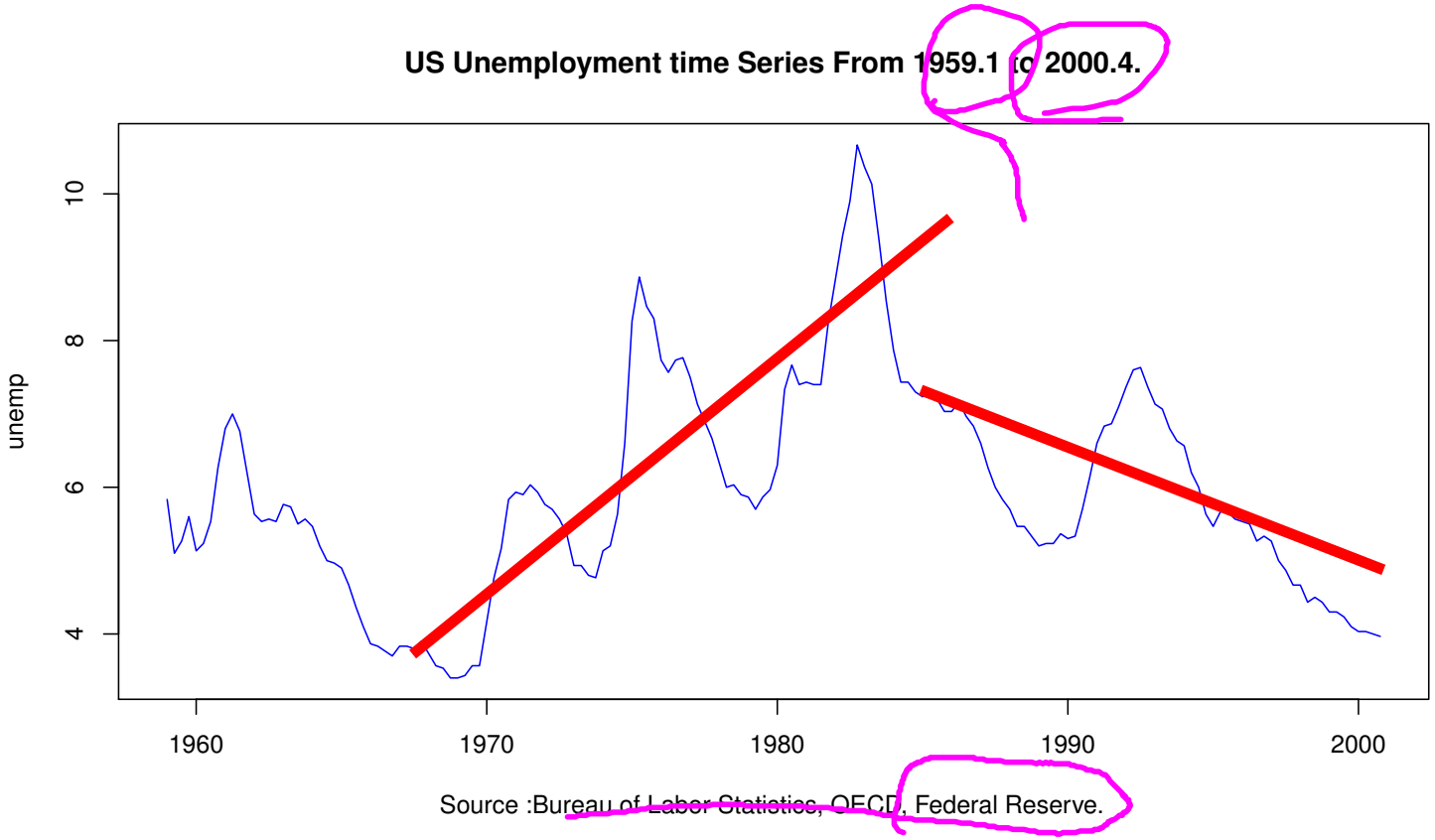
We propose a procedure for representing a time series as the sum of a smoothly varying trend component and a cyclical component

What is HP filter?

- HP filter is based on Kalman filter!
- time series is decomposition of trend component and a cyclical component.
- we can apply this to macroeconomic time series data- GNP, inflation, unemployment rate.

US Quarterly Unemployment time Series

Number of observations : 168



Idea and the Model:

Data have two components: trends τ_t and cycles $g_t = y_t - \tau_t$.
The trend, should be a smooth time series but should also follow the observed data, y_t, closely.

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

Take the FOC's and Verify that

$$\sum_{t=1}^{T} (g_t) = 0$$

Dumb rule about λ

Setting λ rule. (!?)

- $\lambda = 100$ for annual data
- $\lambda = 1600$ for quarterly data
- $\lambda = 14400$ for monthly data

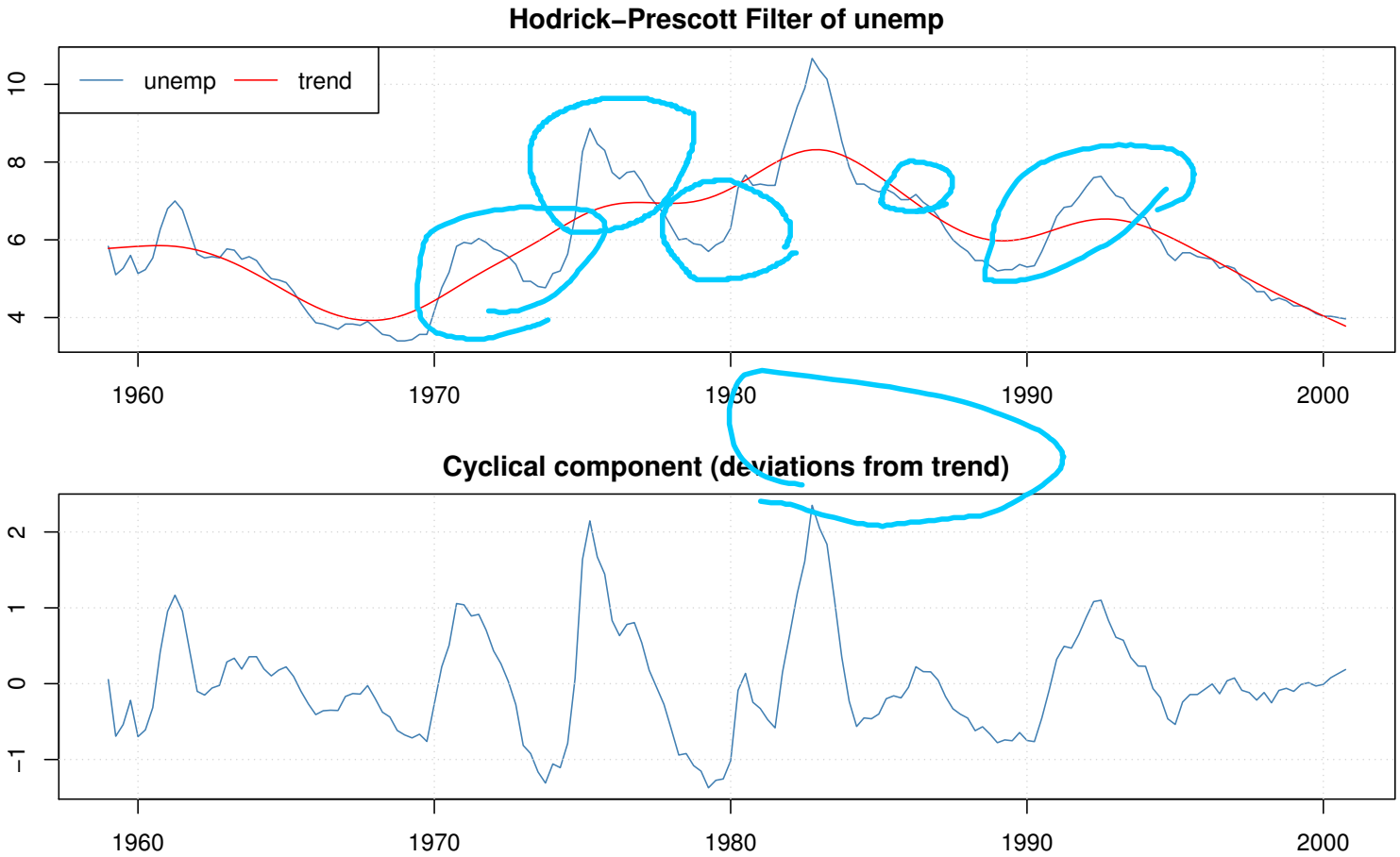
Observe that : (you can practice this via R codes as well)

- if $\lambda = 0$, then the solution is for $\tau_t = y_t \quad \forall t$. In other words, the trend and the actual series would be identical.
- if $\lambda \to \infty$, then the solution is for for the trend to be a linear time trend; i.e. for $\tau_t = \alpha t$ for some α

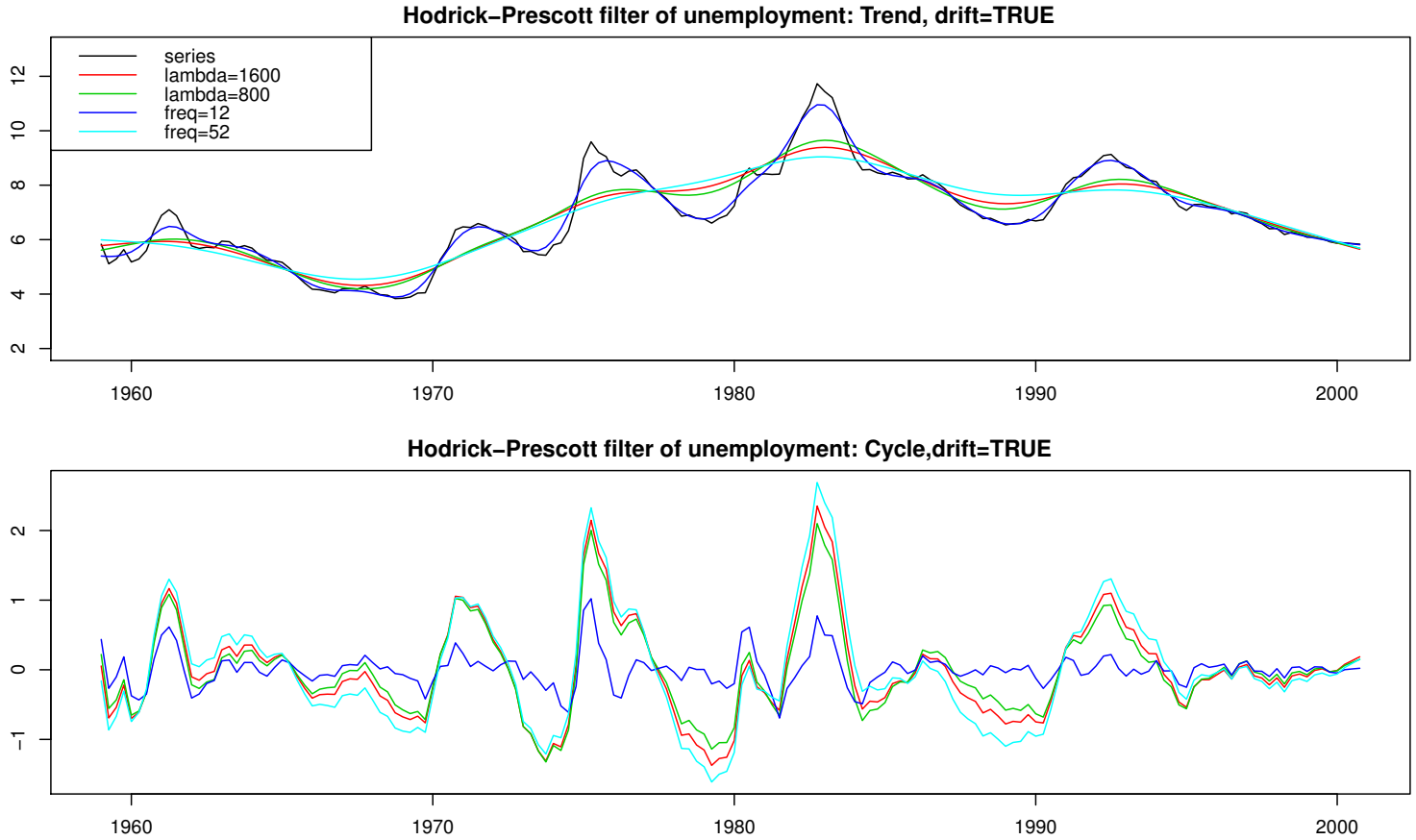
Looking for Research idea?

1. So far, we should know what type of data we have first before applying HP filter! $\rightarrow$ weakness of this filter!
2. Yet another problem is the determination of λ is based on experience. You are welcome to verify or reject it by your math knowledge!
3. HP can produce cycles even when there is no cycle in data

hpfilter function in R



Compare


Hodrick–Prescott filter of unemployment: Trend, drift=TRUE
series
lambda=1600
lambda=800
freq=12
freq=52
2
4
6
8
10
12
1960
1970
1980
1990
2000
Hodrick–Prescott filter of unemployment: Cycle,drift=TRUE
−1
0
1
2
1960
1970
1980
1990
2000

References:

Emina Cardamone, From Kalman to HP filter Theory and Application

Sang Seok Lee, Macroeconomic Theory 2: Theory and Methods of Modern Macroeconomics

Mehmet Balcilar, HP Filter of a time series

mFilter v0.1-3 library . R Package

The End