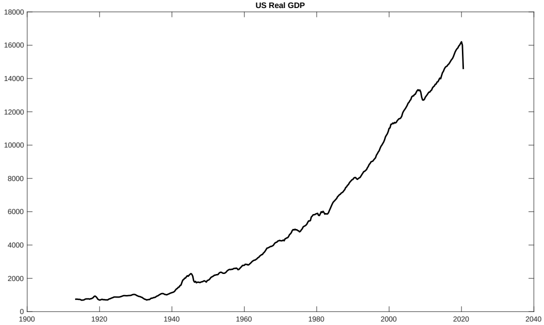
Business Cycle Analysis

Giovanni Ricco

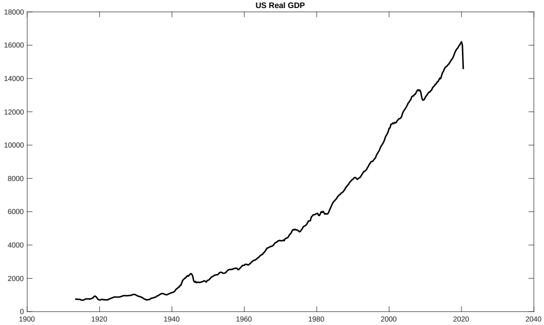
17th October 2023

Business Cycle Analysis

US Real GDP in Levels



US Real GDP in Levels



- What are the determinants of LR growth?
- What are recessions and expansions?
  - How to describe business cycle fluctuations?
  - What are the drivers of business cycles?

Macroeconomics

Usually, we study long-run and medium-run phenomena as separated:

- Trend and low frequency components (**Growth Models**)
- Business cycle fluctuations (**BC Models**)
- Seasonal variations...

Business Cycle

Burns, Mitchell (1946)

> *A cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals which merge into the expansion phase of the next cycle; this sequence of changes is recurrent but not periodic; in duration business cycles vary from more than one year to ten or twelve years; they are not divisible into shorter cycles of similar character with amplitudes approximating their own.*

Business Cycle

The National Bureau of Economic Research (**NBER**) **Business Cycle Dating Committee** and the Center for Economic and Policy Research (**CEPR**) **Business Cycle Dating Committee** date business cycle turning points using a small number of aggregate measures of real economic activity.

The NBER committee mentioned that it considers five series (NBER Business Cycle Dating Committee 2008):

- quarterly real GDP

and the ‘big four’ monthly series

- real personal income less transfers
- wholesale retail trade sales
- industrial production
- nonfarm employment.

Business Cycle Dating

Harding, Pagan (2002) – Dissecting the cycle, a methodological investigation

Dating cycles:

- Isolating ‘turning points’ in the relevant series
- dates are used to mark off periods of expansions and contractions

The best known algorithm is Bry and Boschan (1971)

- definition of a local peak (trough) as occurring at time t whenever $y_t > y_{t\pm k}$ ($y_t < y_{t\pm k}$) for $k = 1, \ldots, K$
- for monthly series K is generally set to 5
- for quarterly series K is generally set to 2
- a phase must last at least 6 months and a complete cycle should have a minimum duration of 15 months (censoring criterium)

US Real GDP in Levels

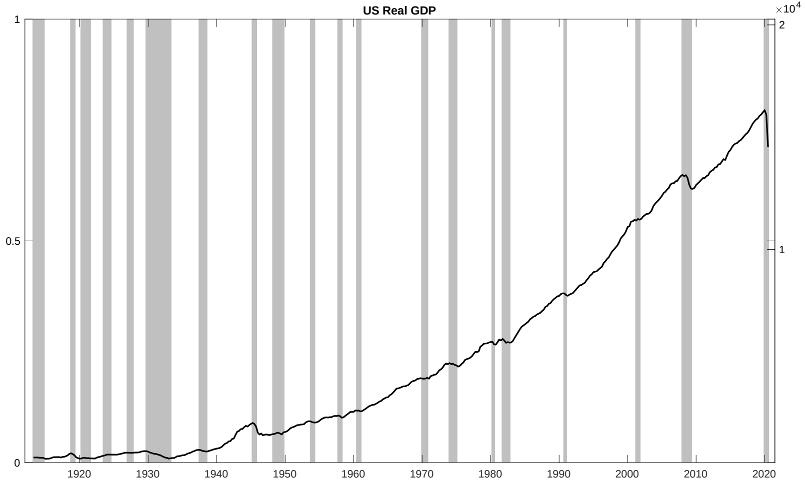
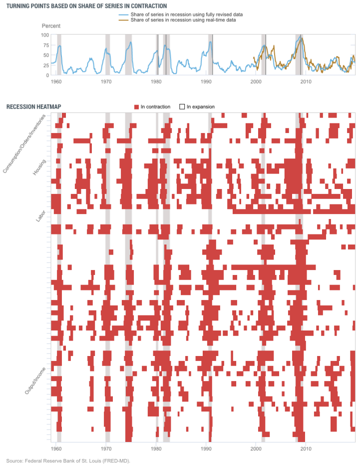


Figure: US GDP and NBER Recession Dates

Business Cycle Dating

Crump, Giannone, and Lucca (2019)



US GDP and NBER Recession Dates – Top: percentage of series in contraction by the Bry-Boschan (BB) algorithm (revised data - blue, real - time gold). Bottom heatmap: periods for which each series is judged to be in expansion (white) or contraction (red) based on the BB algorithm.

How to separate trends and cycles in the time-series?

Given a time-series often we need:

- Filter out seasonal variations
- Business cycle fluctuations
- Trend and low frequency components

How can we formally decompose a time series x_t into a trend τ_t and a cycle c_t?

$$x_t = \tau_t + c_t$$

Trend-Cycle Decomposition

The 'traditional' approach it to define c_t as the residual of x_t on polynomials in time

$$\tau_t = a_0 + \sum_{j=1}^{J} a_j t^j$$

τ_t is a deterministic trend

The modern approach is to use 'filters', e.g.

- High-pass/Band-pass filter (e.g., **HP filter**, **BK filter**, etc.)
- **Kalman filter**: define τ_t and c_t and stochastic process and then apply signal extraction methods.

HP Filter

The Hodrick, Prescott (1997) filter separates trend τ_t and cycle c_t components

$$x_t = \tau_t + c_t$$

solving the problem:

$$\min_{\tau_t} \left\{ \sum_t (\tau_t - x_t)^2 + \lambda(\tau_{t+1} - 2\tau_t + \tau_{t-1})^2 \right\}$$

that can be re-written as

$$\min_{\tau_t} \left\{ \sum_t (\underbrace{\tau_t - x_t}_{c_t})^2 + \lambda \left(\underbrace{(\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1})}_{\Delta^2 \tau_t} \right)^2 \right\}$$

the parameter λ penalises the growth acceleration of the trend component

HP Filter

Solving the FOC:

$$F(L)\tau_t = x_t$$

where

$$F(L) = 1 + \lambda(1-L)^2(1-L^{-1})^2$$

Hence:

$$\begin{aligned} \tau_t &= F(L)^{-1}x_t = T(L)x_t \\ c_t &= (1-T(L))x_t = F(L)^{-1}(F(L)-1)x_t = C(L)x_t \end{aligned}$$

The filter for the cyclical component is

$$C(L) = \frac{\lambda(1-L)^2(1-L^{-1})^2}{1+\lambda(1-L)^2(1-L^{-1})^2}$$

HP Filter

Observations:

- The filter is capable of render stationary any integrated process up to order four, since there are 4 differences in C(L).
- λ is a parameter to be fixed to select the appropriate ‘range’ of fluctuations

Business Cycle Components

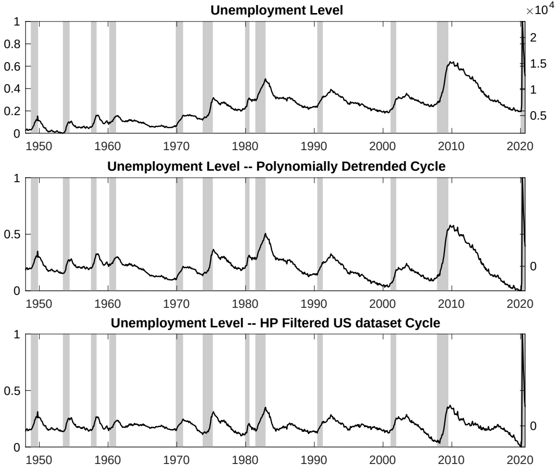


Figure: US Unemployment and NBER Recession Dates

Business Cycle Components

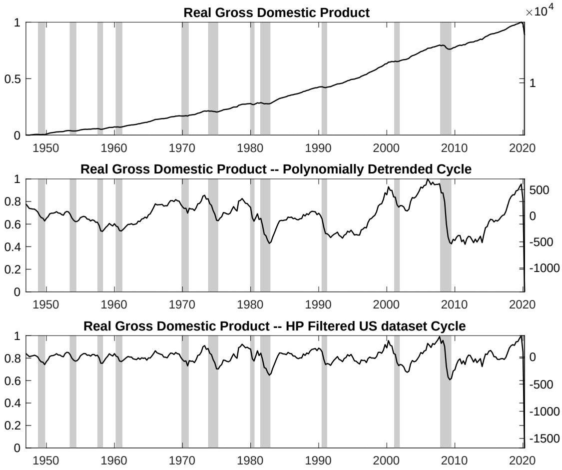


Figure: US GDP and NBER Recession Dates