Advanced Macroeconomics II

Economic Fluctuations: Concepts and Evidence

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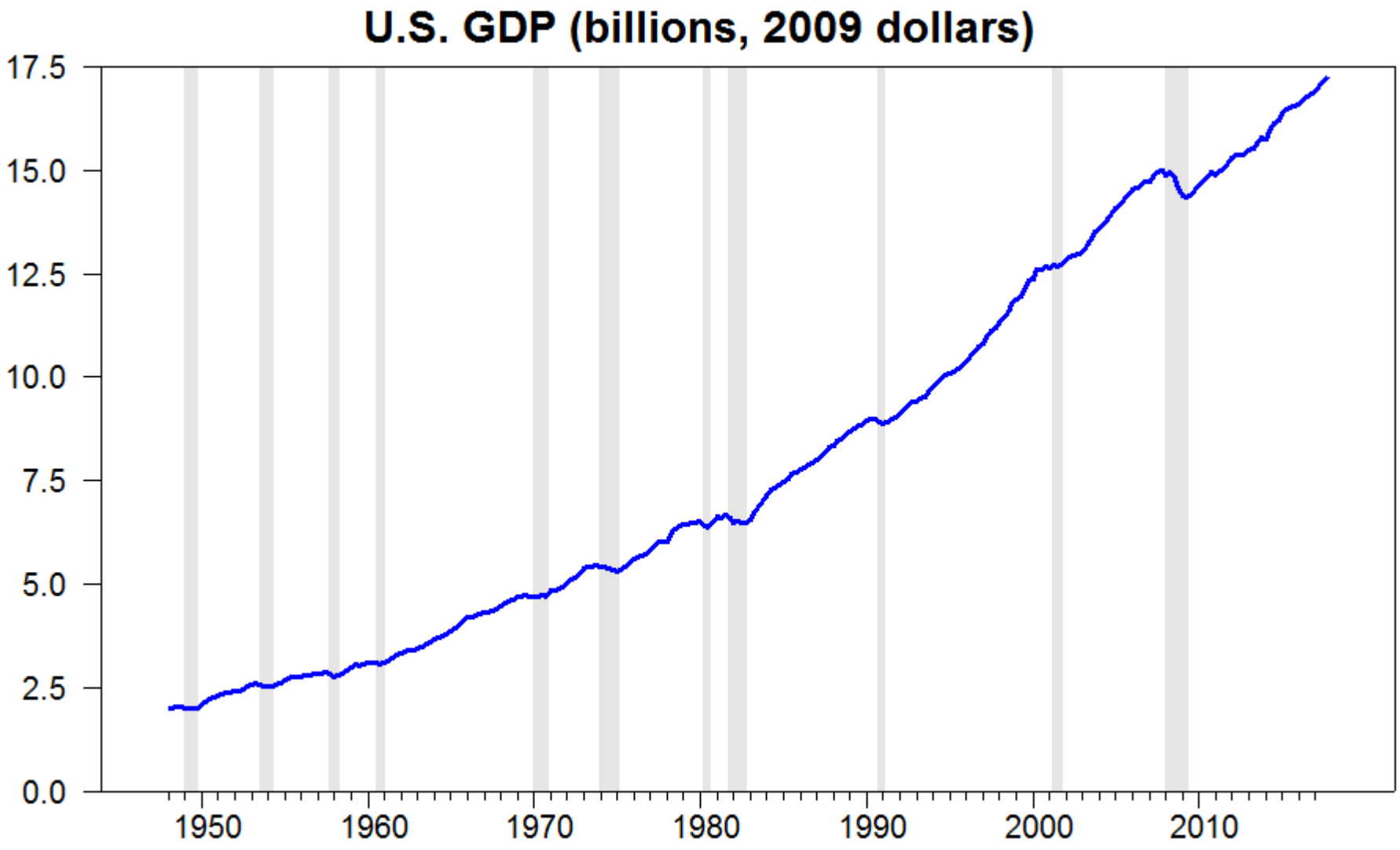
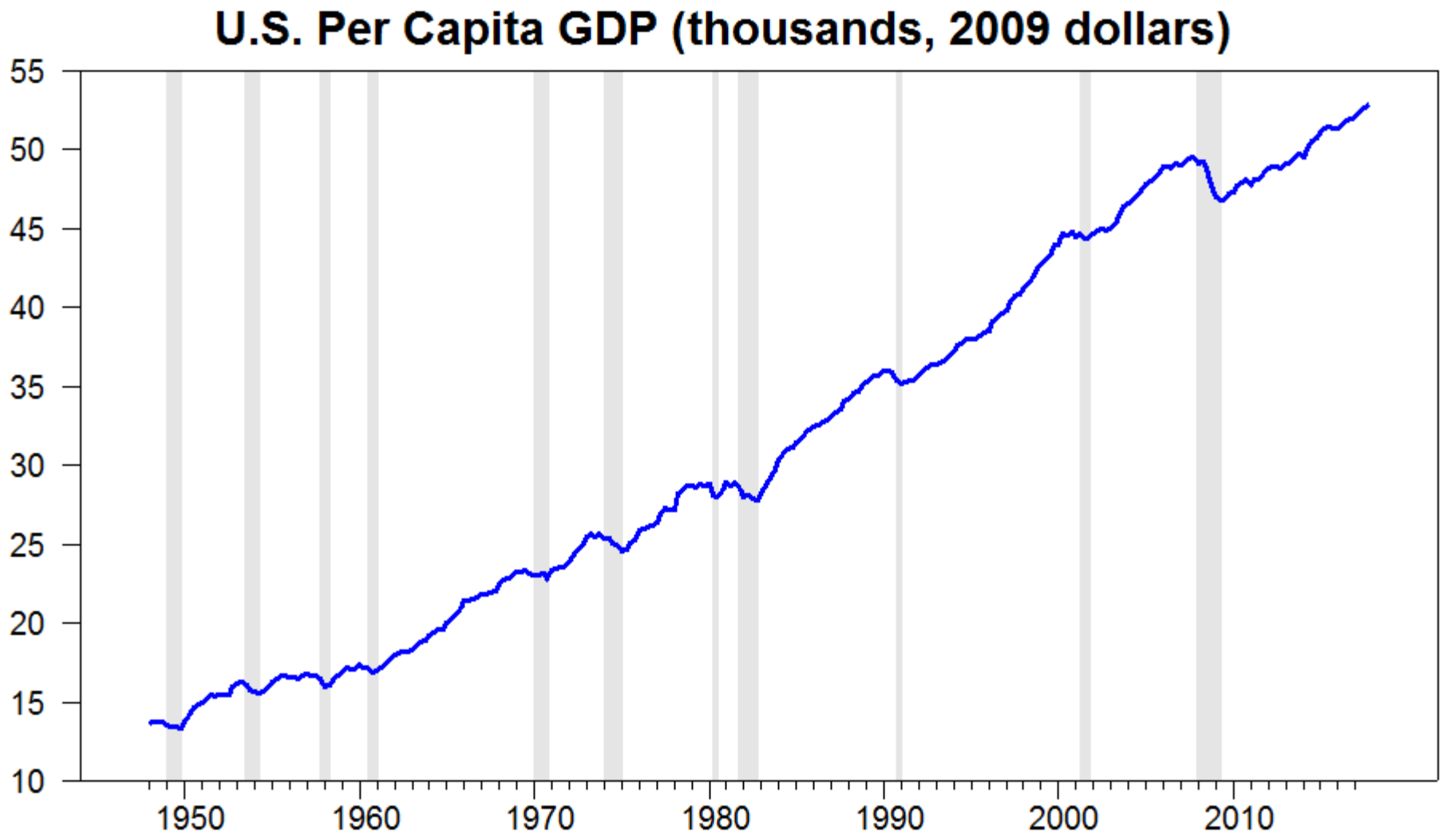
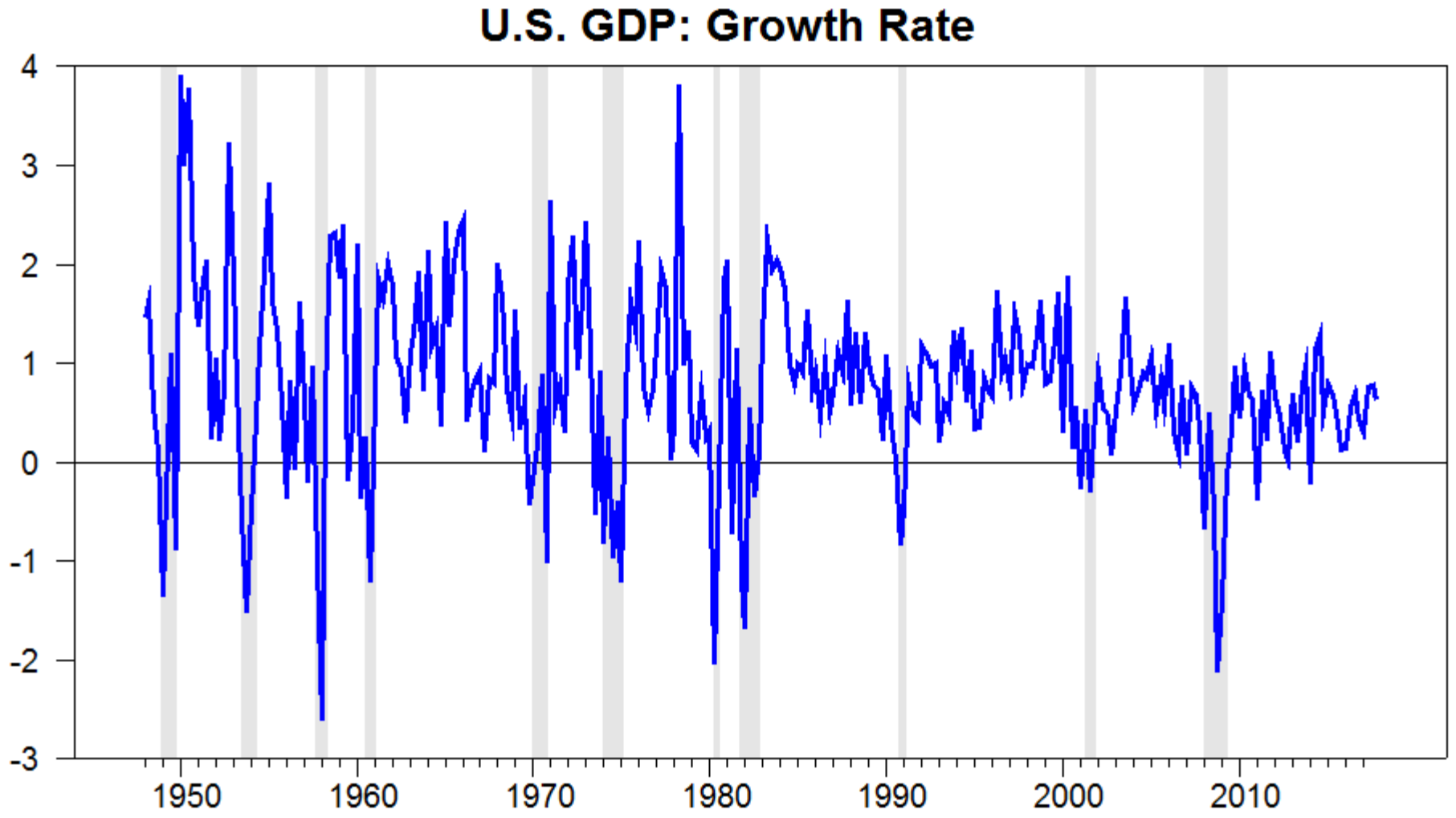
April 2018

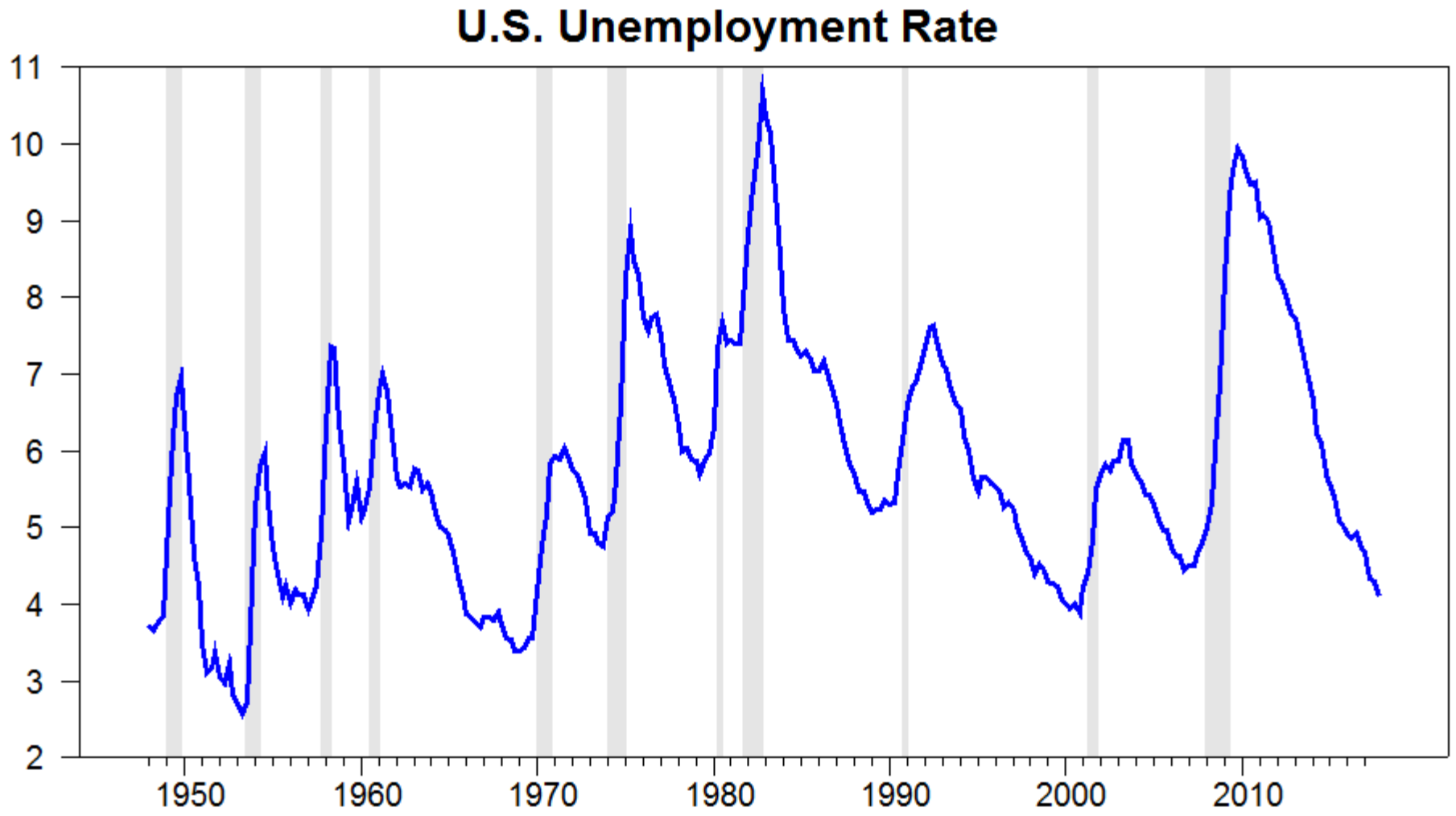

U.S. GDP (billions, 2009 dollars)
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
1950
1960
1970
1980
1990
2000
2010

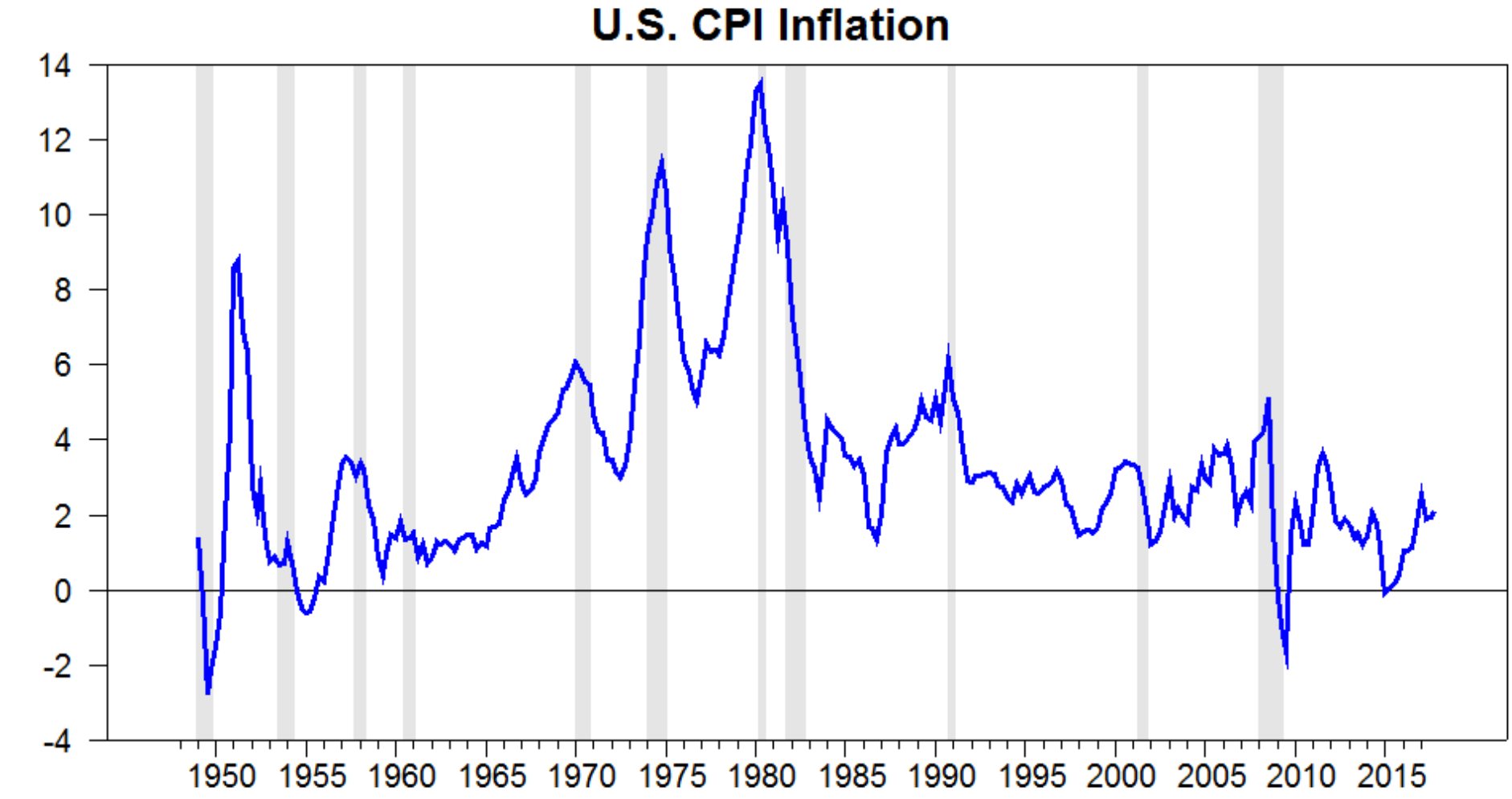

U.S. Per Capita GDP (thousands, 2009 dollars)
55
50
45
40
35
30
25
20
15
10
1950
1960
1970
1980
1990
2000
2010

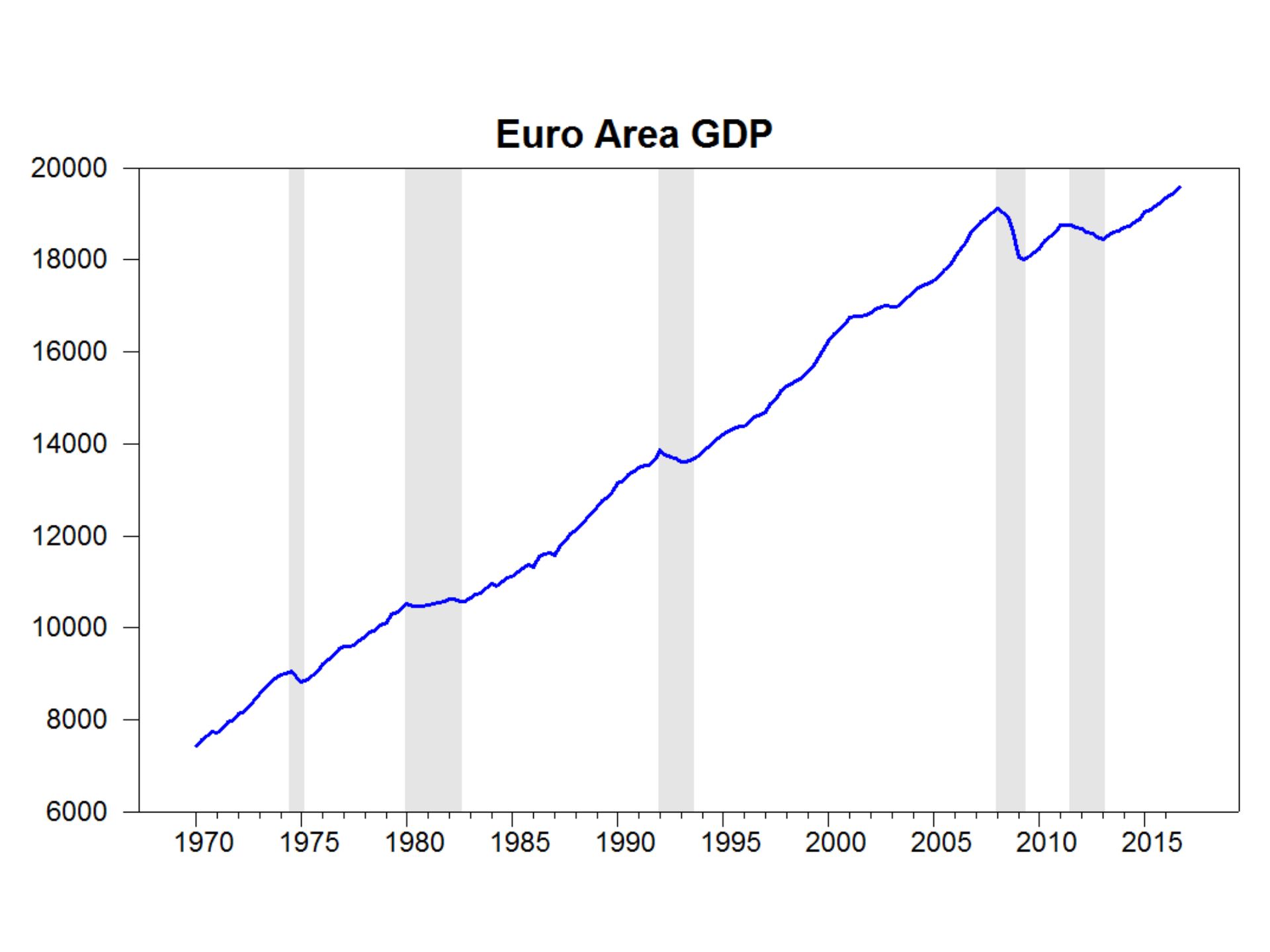
Business cycles: recurrent fluctuations in the level of economic activity

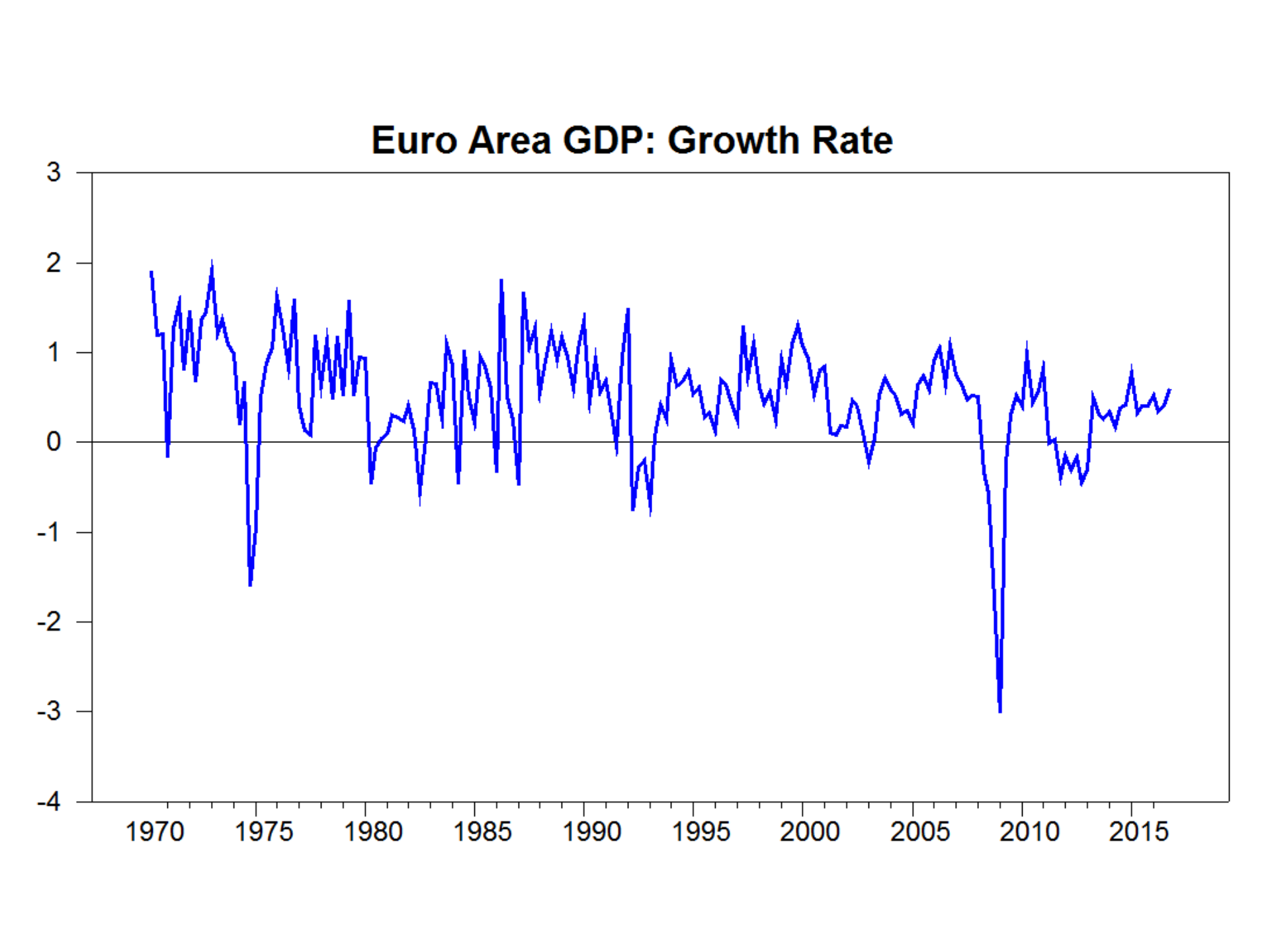
- economy-wide
- reflected in variations in growth rates of output, employment, etc.
- not periodic $\longrightarrow$ *economic fluctuations*

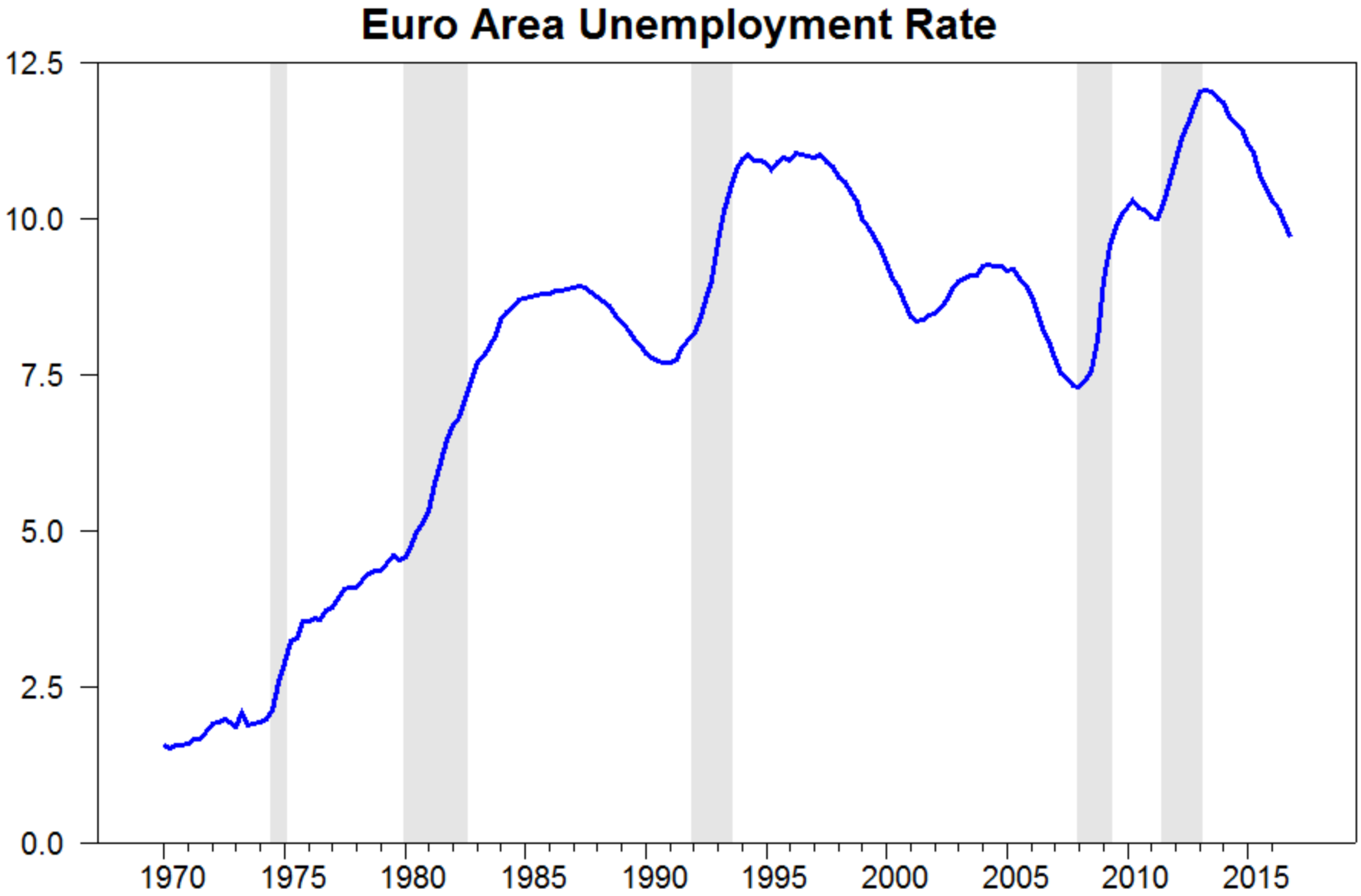

U.S. GDP: Growth Rate
4
3
2
1
0
-1
-2
-3
1950
1960
1970
1980
1990
2000
2010

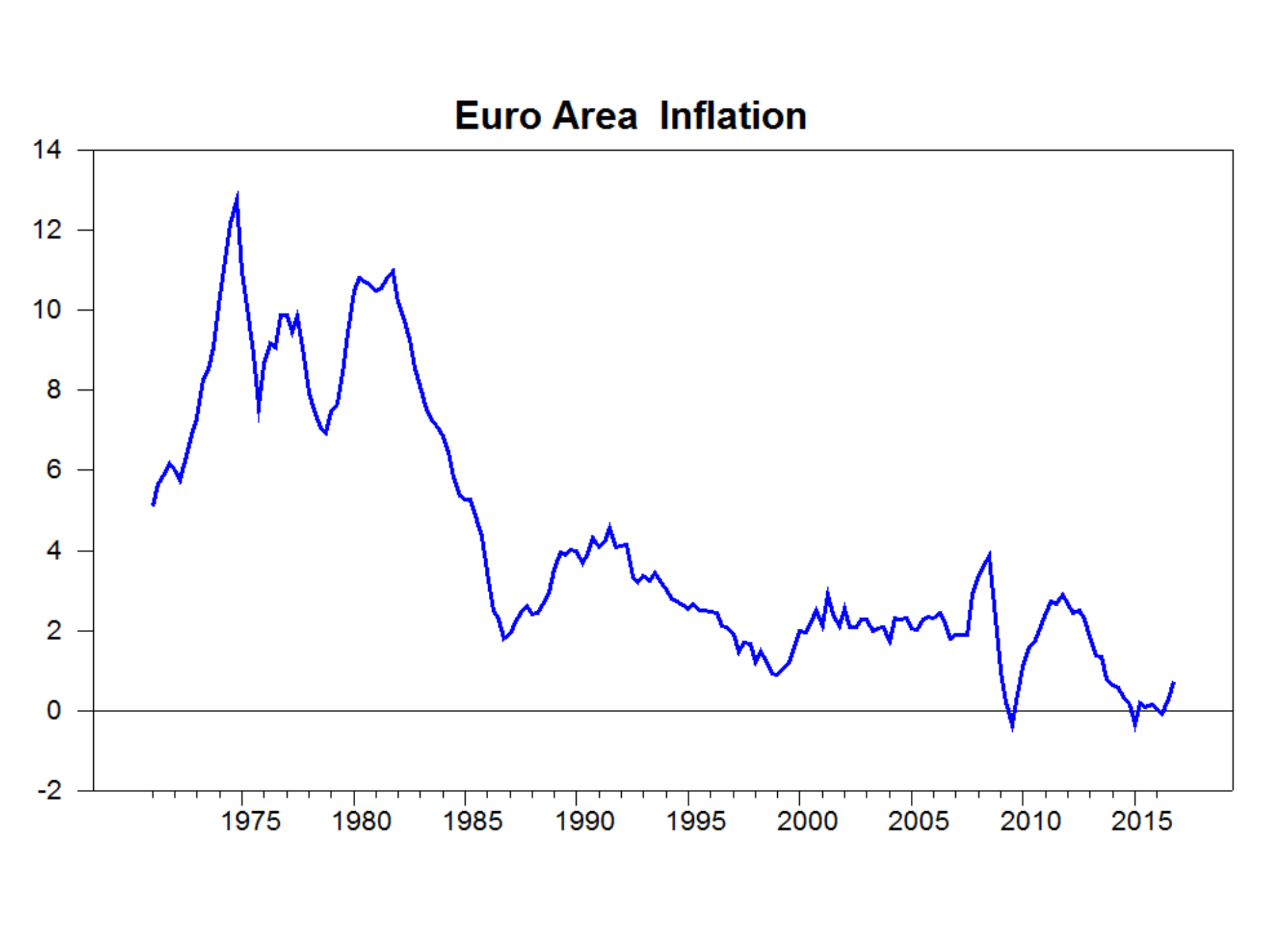

U.S. Unemployment Rate
11
10
9
8
7
6
5
4
3
2
1950
1960
1970
1980
1990
2000
2010


U.S. CPI Inflation
14
12
10
8
6
4
2
0
-2
-4
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015


Euro Area GDP
20000
18000
16000
14000
12000
10000
8000
6000
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015


Euro Area GDP: Growth Rate
3
2
1
0
-1
-2
-3
-4
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015


Euro Area Unemployment Rate
12.5
10.0
7.5
5.0
2.5
0.0
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015


Euro Area Inflation
14
12
10
8
6
4
2
0
-2
1975
1980
1985
1990
1995
2000
2005
2010
2015

Business cycles: recurrent fluctuations in the level of economic activity

- economy-wide
- reflected in variations in growth rates of output, employment, etc.
- not periodic $\longrightarrow$ *economic fluctuations*

Key questions:

- What are the main features of observed fluctuations? Have they changed over time? Do they differ across countries?
- What are their ultimate causes? How are they propagated?
- What is the role of policy? Is stabilization possible? Is it desirable?

Math Preliminaries

- Natural logarithm:

$$y \equiv \log Y$$

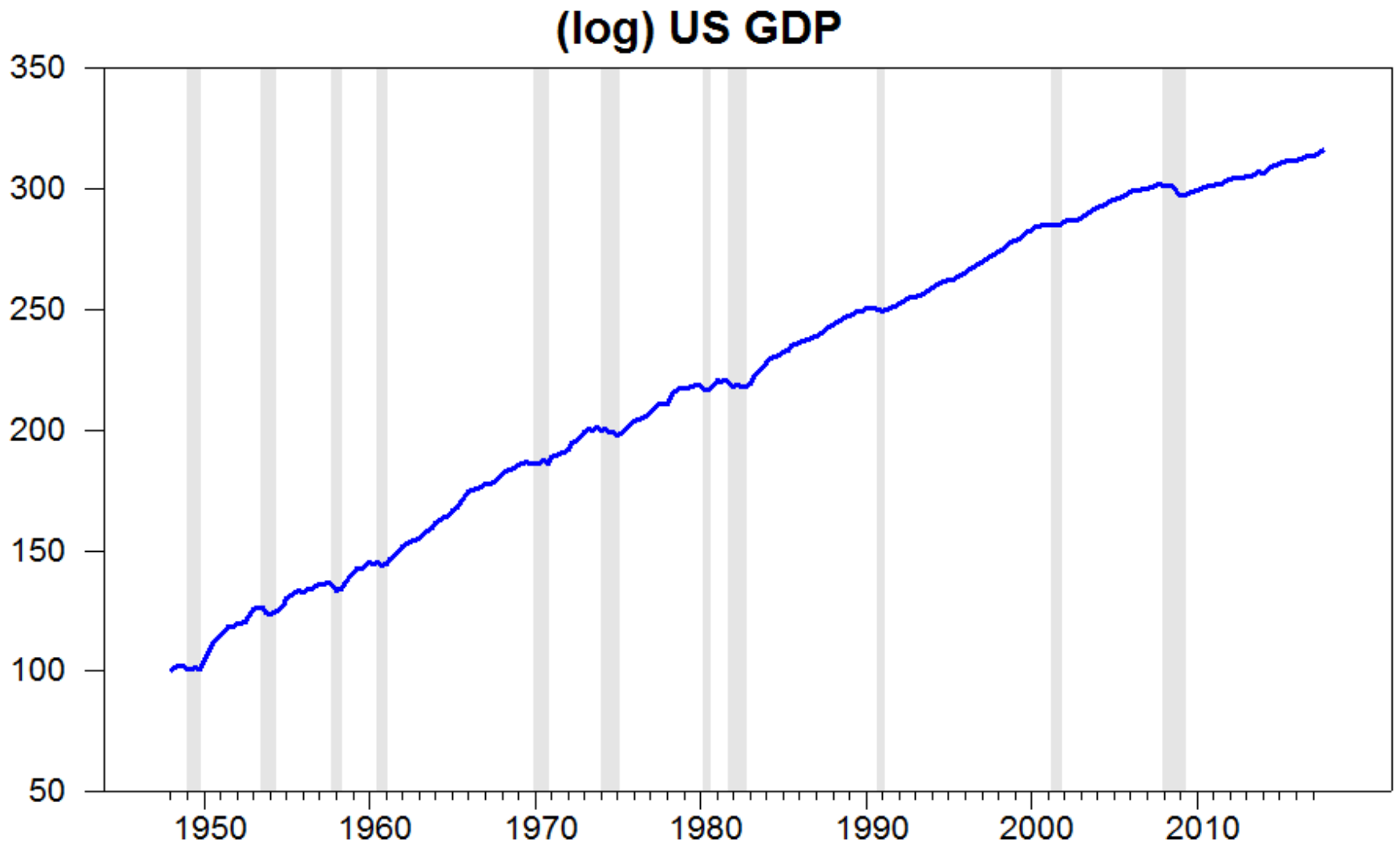
- Approximation:

$$\frac{Y - Y^*}{Y^*} \simeq y - y^*$$

- Application:

$$\begin{aligned} \frac{Y_t - Y_{t-1}}{Y_{t-1}} &= y_t - y_{t-1} \\ &\equiv \Delta y_t \end{aligned}$$

$$\text{Constant growth rate} \Leftrightarrow \; y_t = \alpha_0 + \alpha_1 t$$


(log) US GDP
350
300
250
200
150
100
50
1950
1960
1970
1980
1990
2000
2010

Trends and Cycles

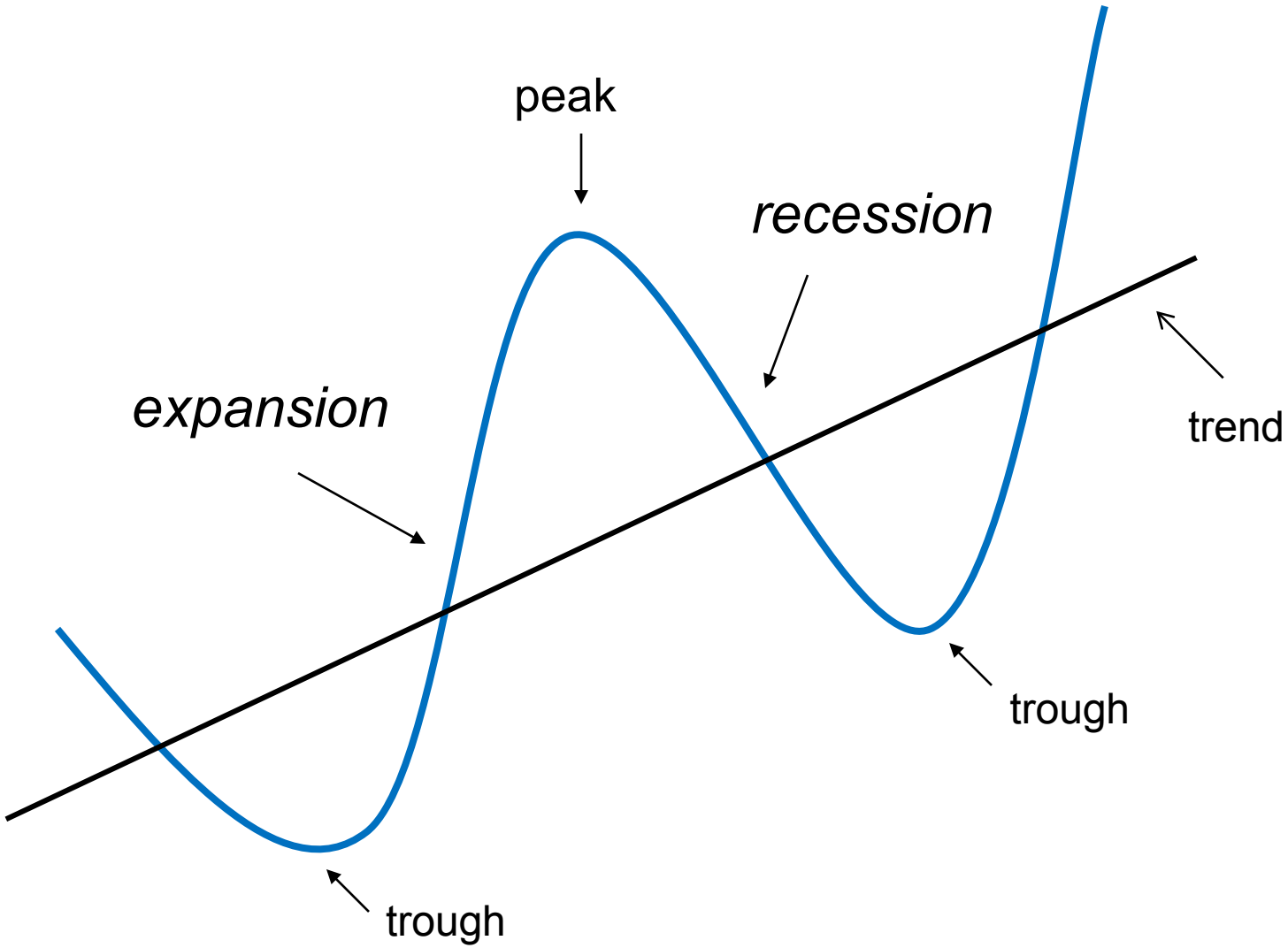
- Time series: $y_1, y_2, y_3, ..., y_T \Longleftrightarrow \{y_t\}$
- Decomposition:

$$y_t = z_t + x_t$$

z_t : trend
x_t : cycle

- Different "detrending" methods

The Business Cycle



Example (I): Differences

First-difference:

$$x_t = y_t - y_{t-1}$$

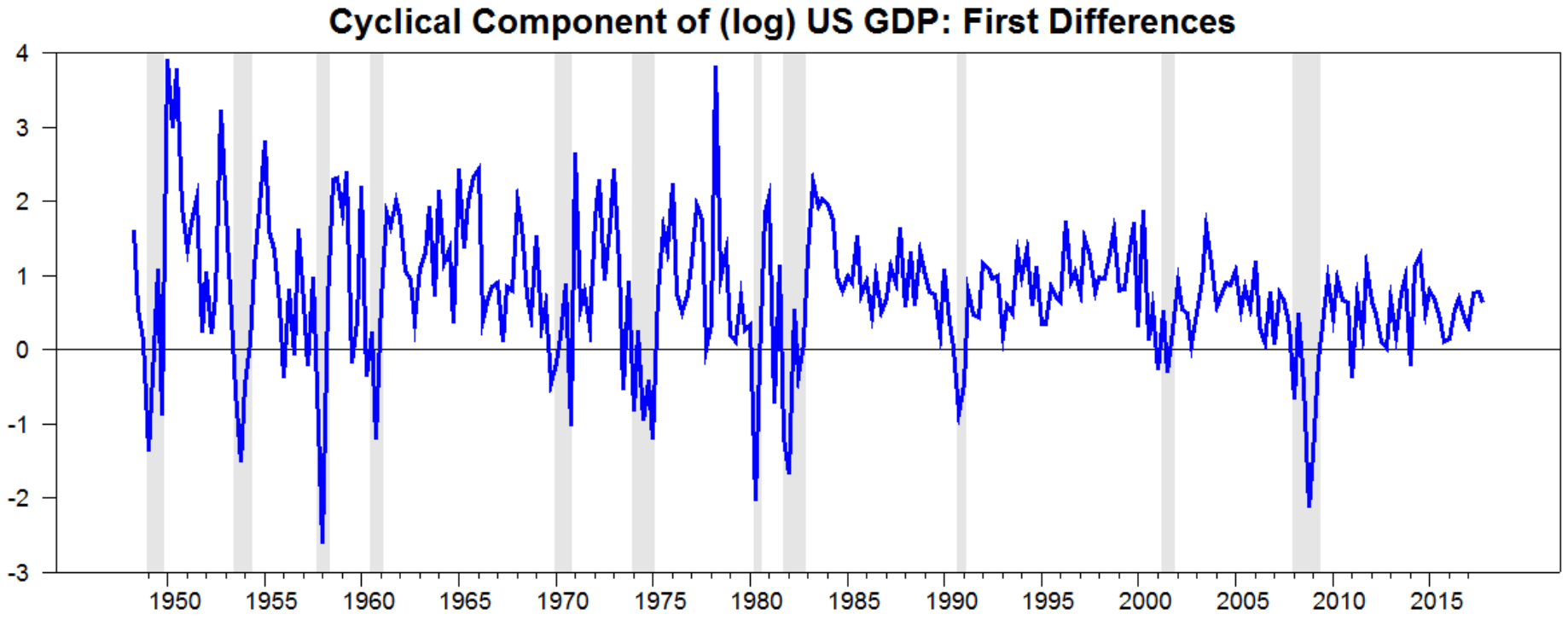
Interpretation as a growth rate

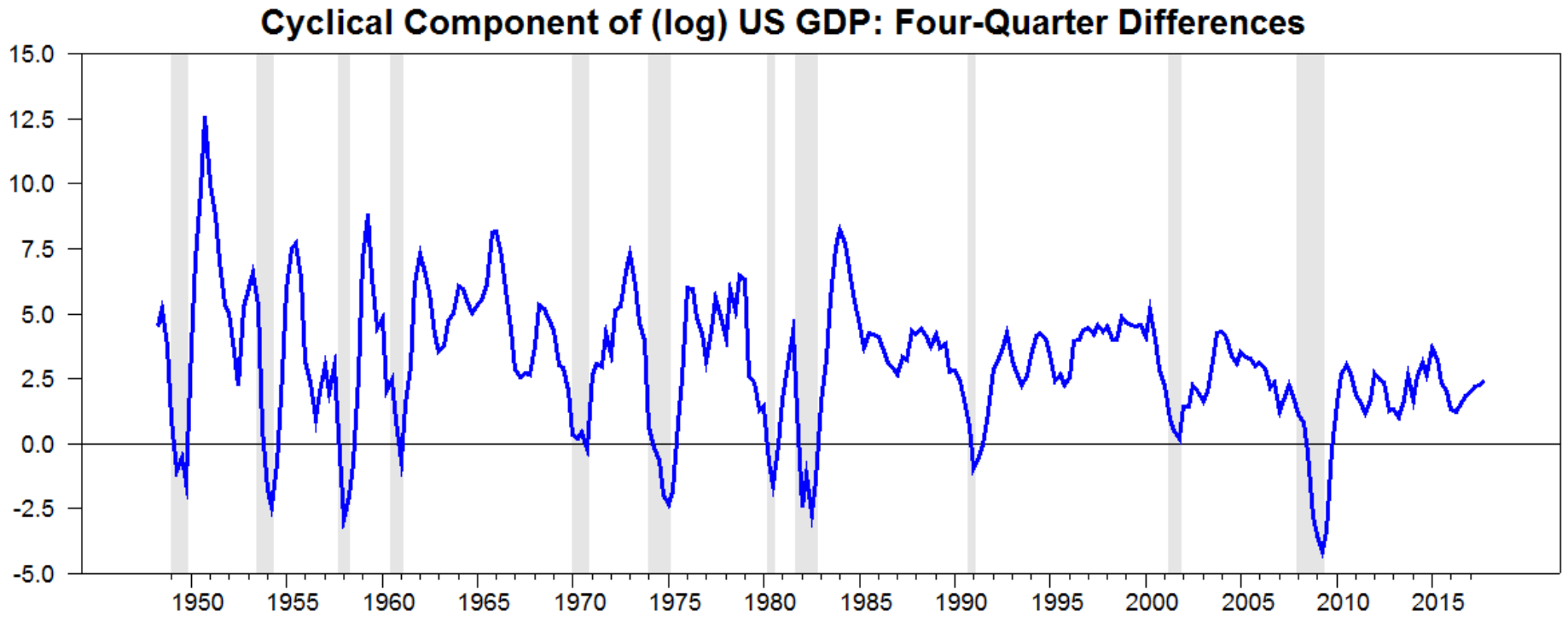
Limitation: too much weight given to high-frequency variations unrelated to business cycles.

k-period differences:

$$x_t = y_t - y_{t-k}$$

Example: with quarterly data, $k = 4$: year-on-year growth rate


Cyclical Component of (log) US GDP: First Differences
4
3
2
1
0
-1
-2
-3
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015


Cyclical Component of (log) US GDP: Four-Quarter Differences
15.0
12.5
10.0
7.5
5.0
2.5
0.0
-2.5
-5.0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015

Example (II): Deterministic Trend

Linear:

$$z_t = \alpha_0 + \alpha_1 t$$

OLS estimation:

$$\min_{\alpha_0,\alpha_1} \sum_{t=1}^{T} [y_t - (\alpha_0 + \alpha_1 t)]^2$$

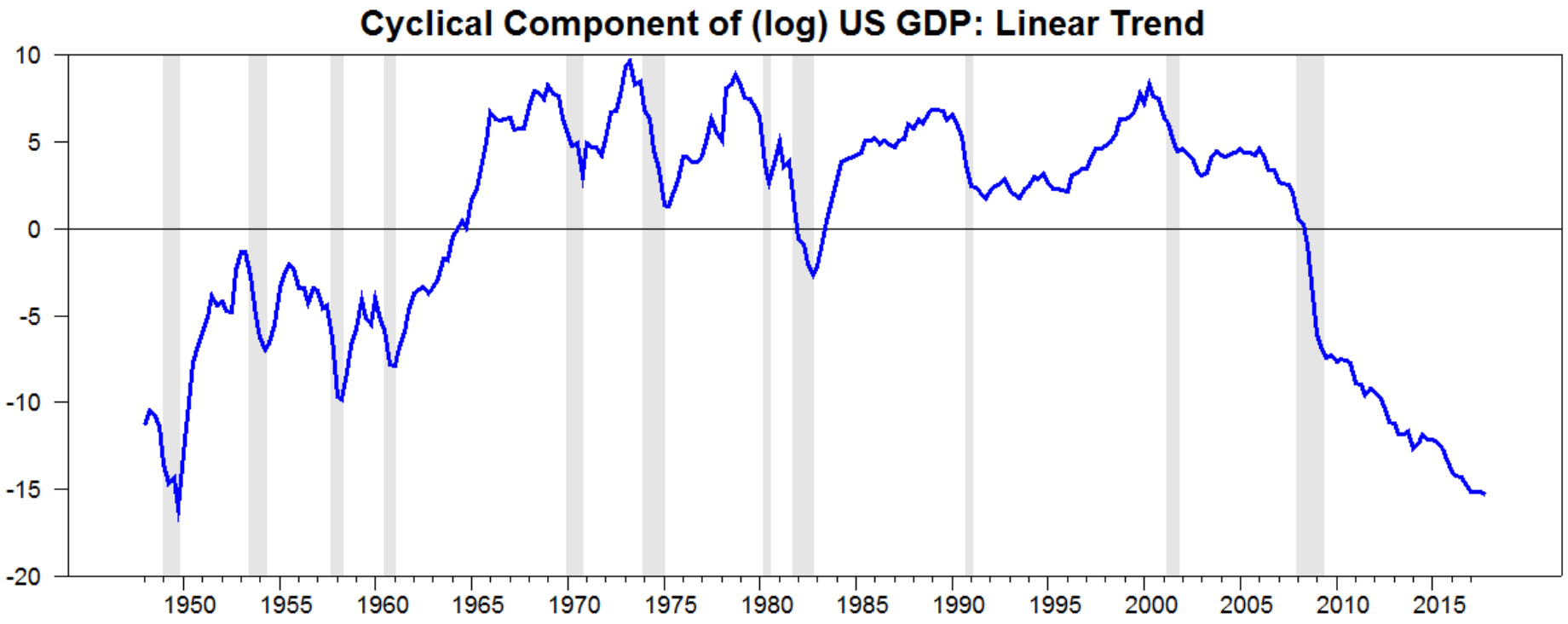
Cyclical component:

$$x_t = y_t - (\widehat{\alpha}_0 + \widehat{\alpha}_1 t)$$

Generalization:

$$z_t = \alpha_0 + \alpha_1 t + \alpha_2 t^2 + ... + \alpha_q t^q$$

Limitation: many macroeconomic variables have a "stochastic trend" (Nelson and Plosser (JME 1982))


Cyclical Component of (log) US GDP: Linear Trend
10
5
0
-5
-10
-15
-20
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015

Example (III): Moving Average

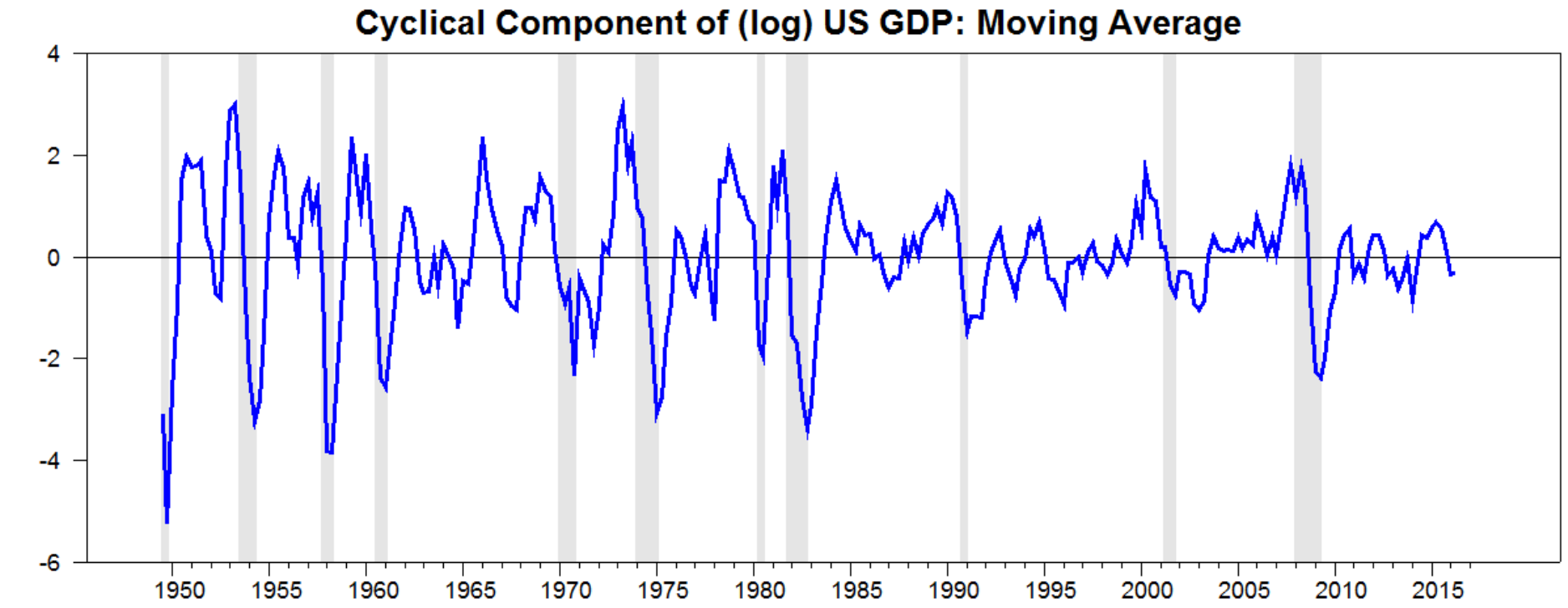
Centered:

$$z_t = \frac{y_{t+q} + ... + y_{t+1} + y_t + y_{t-1} + ... + y_{t-q}}{2q+1}$$

One-sided:

$$z_t = \frac{y_t + y_{t-1} + ... + y_{t-q}}{q+1}$$

Limitation: ignores observations far in time


Cyclical Component of (log) US GDP: Moving Average
4
2
0
-2
-4
-6
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015

Other Examples (IV):

General filter:

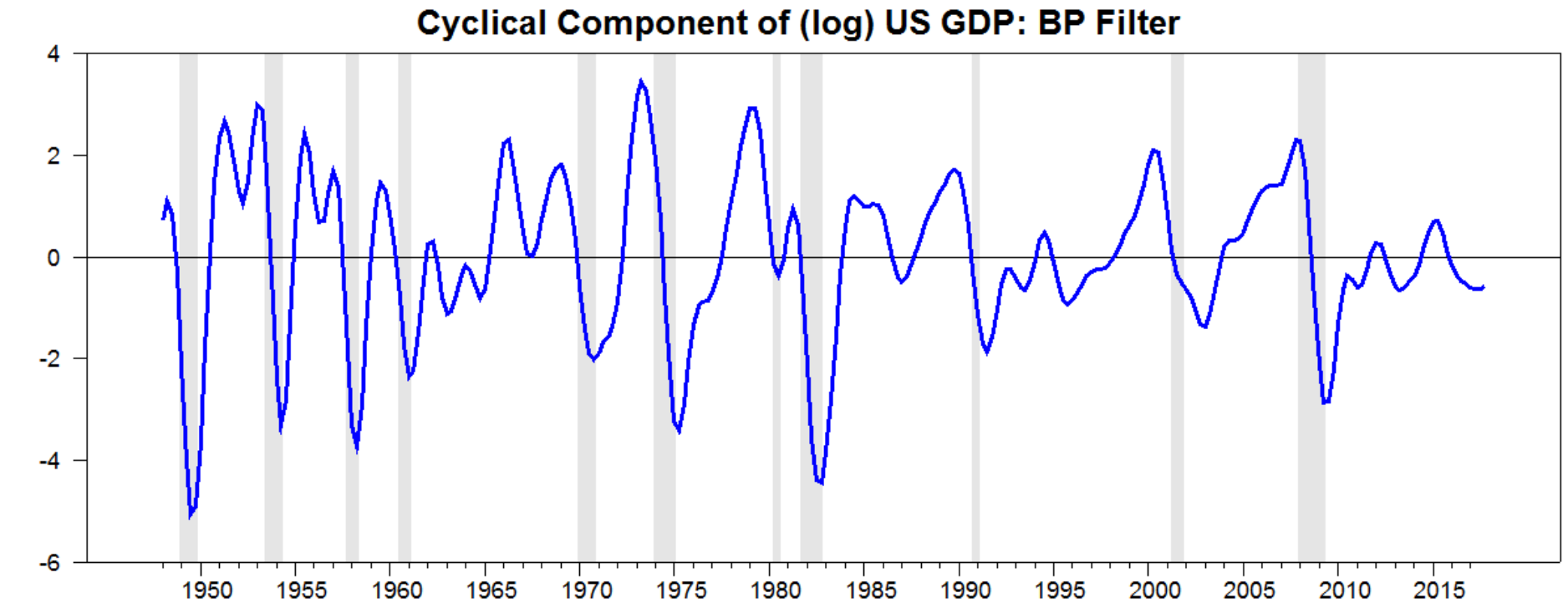
$$z_t = \sum_{k=-K}^{K} \gamma_k y_{t+k}$$

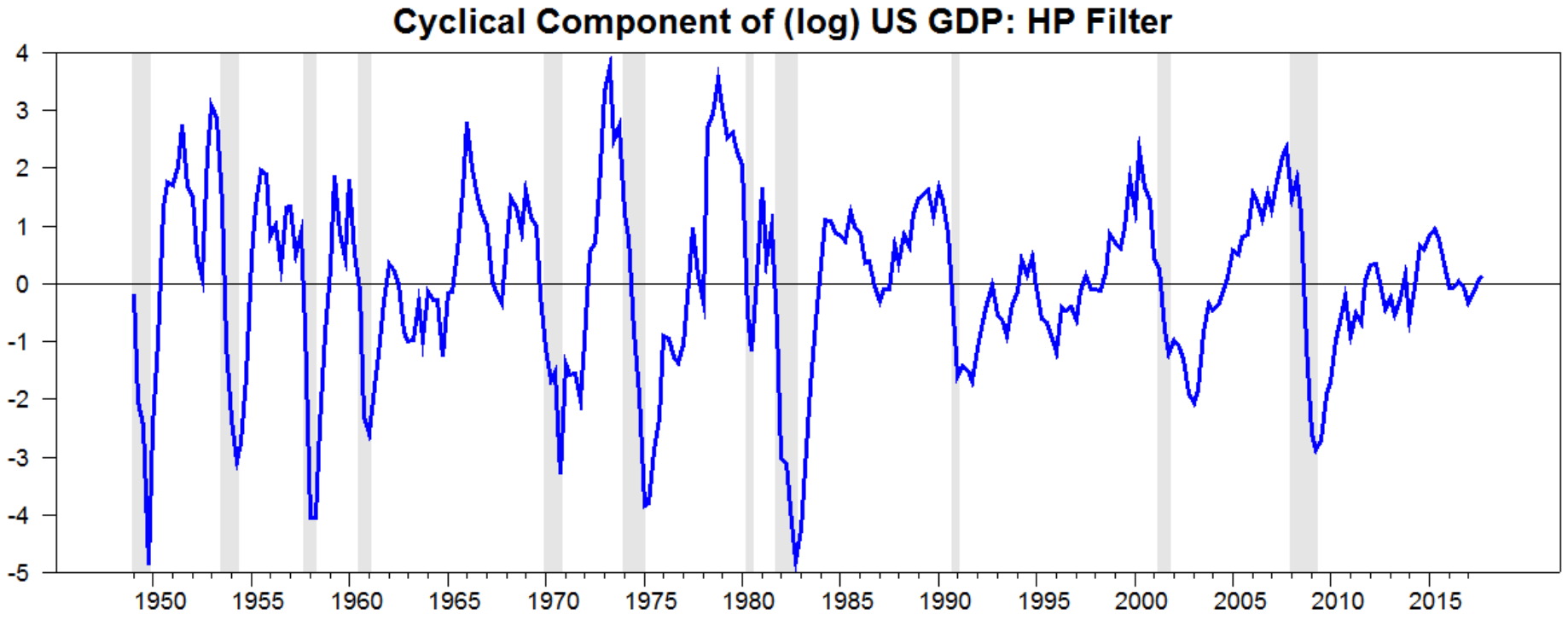
- Hodrick-Prescott filter (Hodrick and Prescott (JMCB 1997))

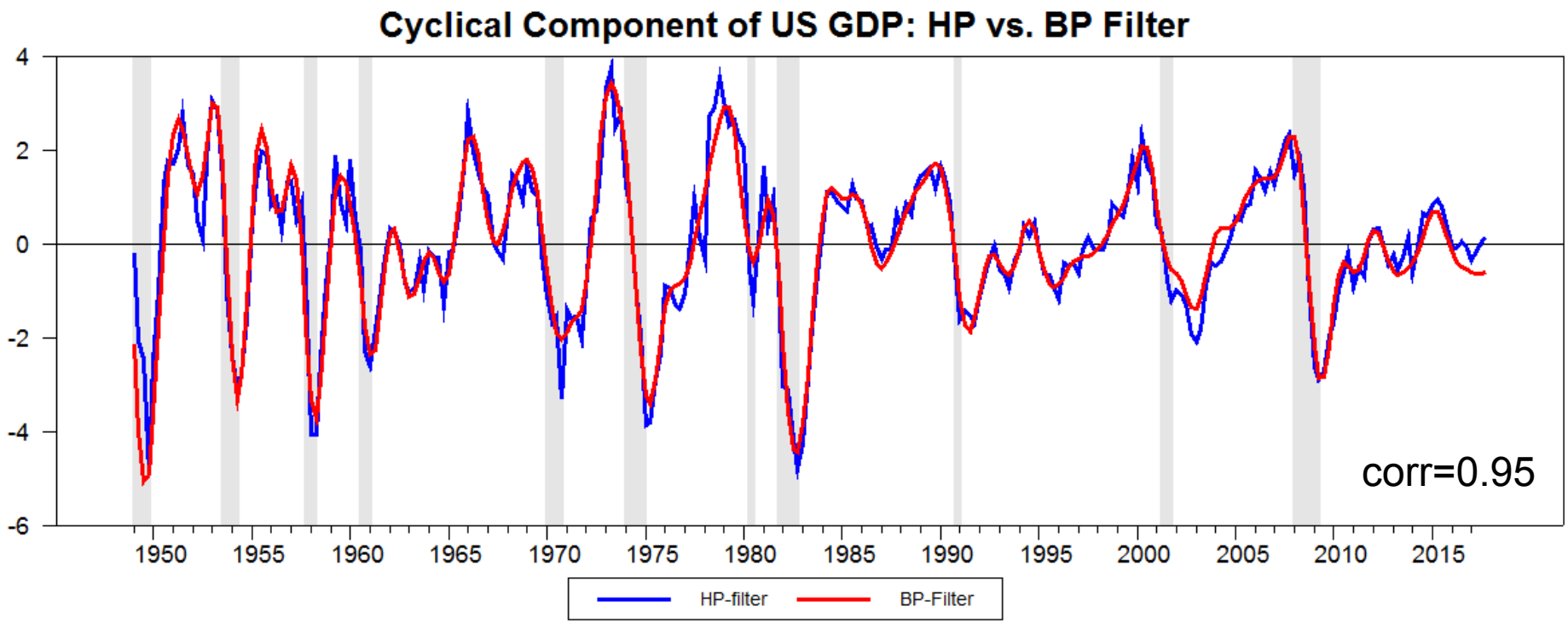
  - Parameter λ determines the smoothness of the trend component
  - Limitation: does not eliminate high-frequenct variations

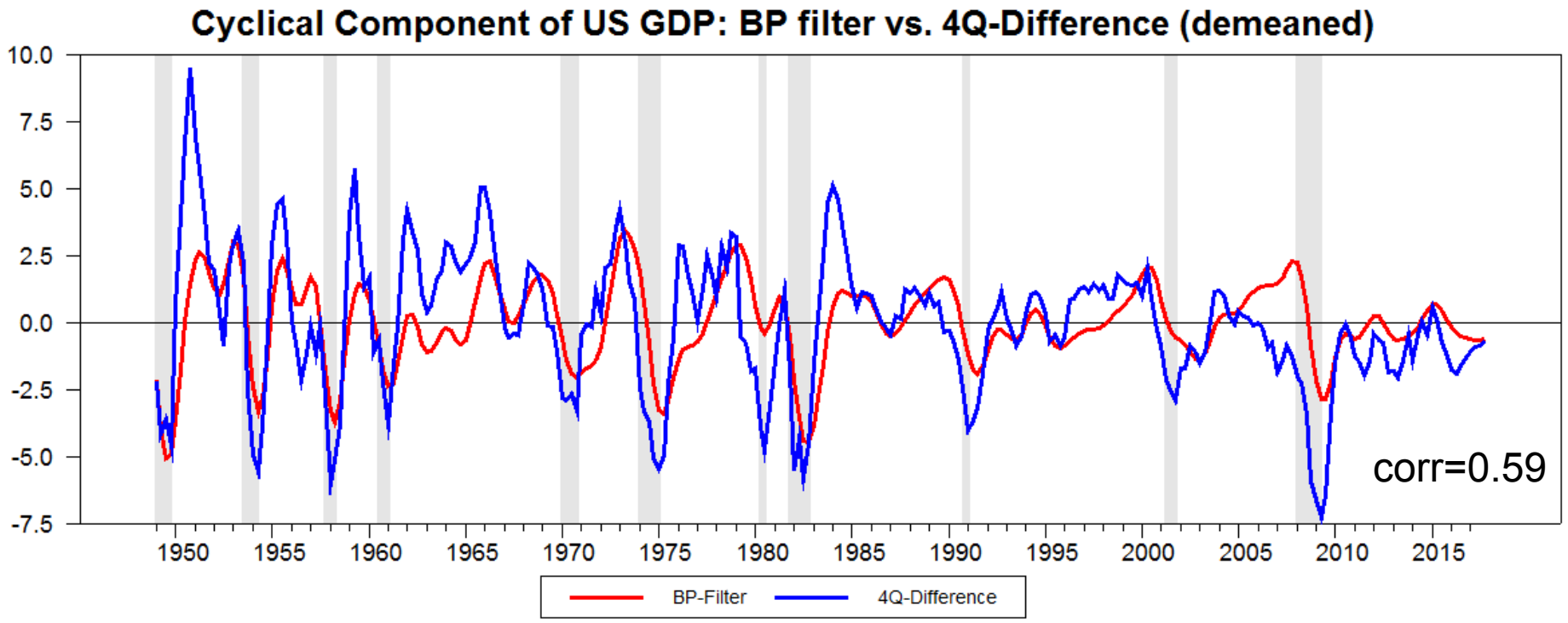
- "Band-Pass" filter (Baxter and King (Restat 1999))

  - Choice of frequency band for cyclical component (e.g. 6-32 quarters)


Cyclical Component of (log) US GDP: BP Filter
4
2
0
-2
-4
-6
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015


Cyclical Component of (log) US GDP: HP Filter
4
3
2
1
0
-1
-2
-3
-4
-5
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015


Cyclical Component of US GDP: HP vs. BP Filter
4
2
0
-2
-4
-6
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
HP-filter
BP-Filter
corr=0.95


Cyclical Component of US GDP: BP filter vs. 4Q-Difference (demeaned)
10.0
7.5
5.0
2.5
0.0
-2.5
-5.0
-7.5
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
corr=0.59
BP-Filter
4Q-Difference

Characterizing Economic Fluctuations

$\{x_t\}$: cyclical component of a variable of interest (with zero mean).

- Amplitude

$\rightarrow$ standard deviation: $\sigma(x_t) \equiv \sqrt{(1/T)\sum x_t^2}$

- Persistence

$\rightarrow$ autocorrelation: $corr(x_t, x_{t-1}) \equiv \frac{cov(x_t, x_{t-1})}{\sigma^2(x_t)}$ where $cov(x_t, x_{t-1}) \equiv (1/T)\sum x_t x_{t-1}$

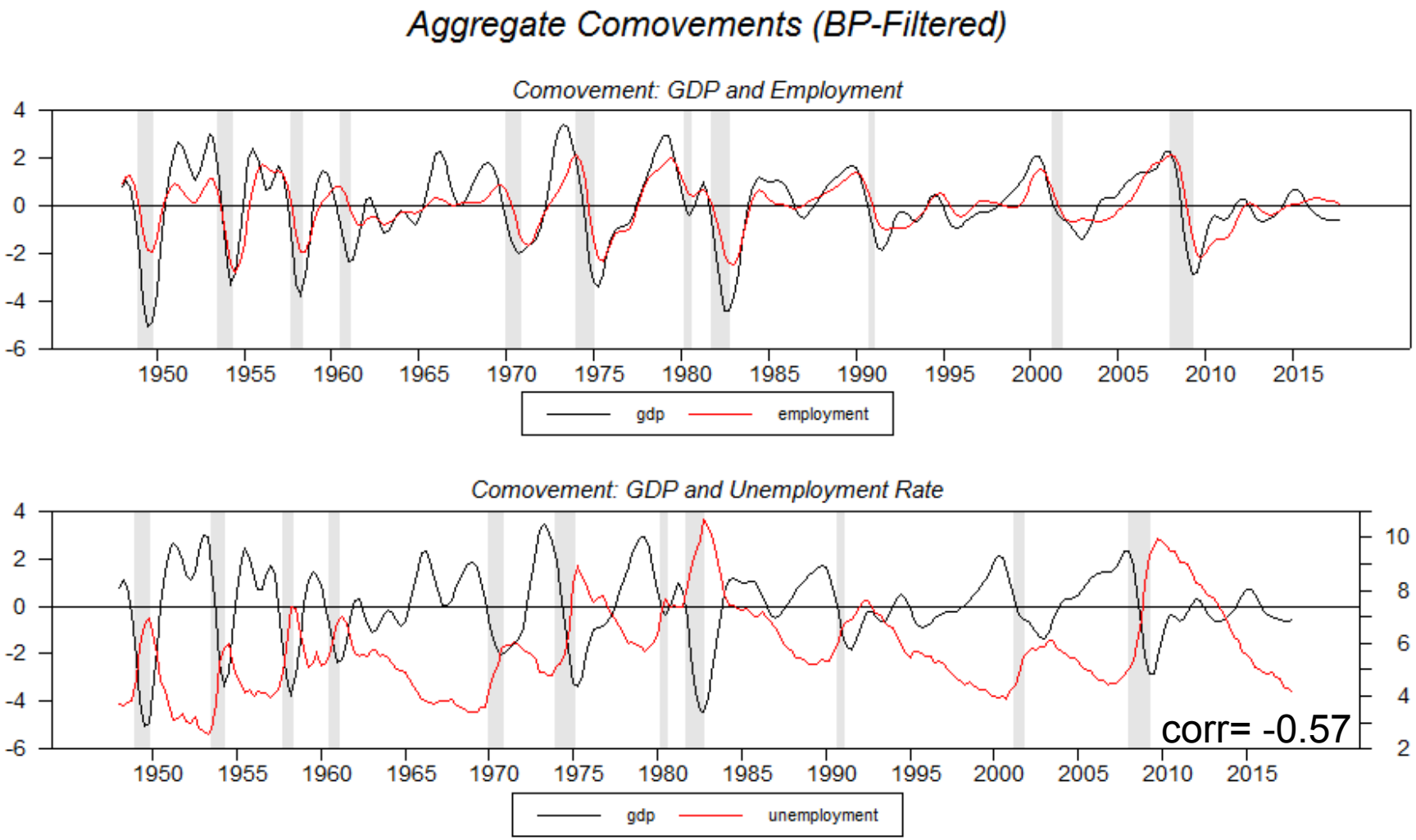
- Cyclicality

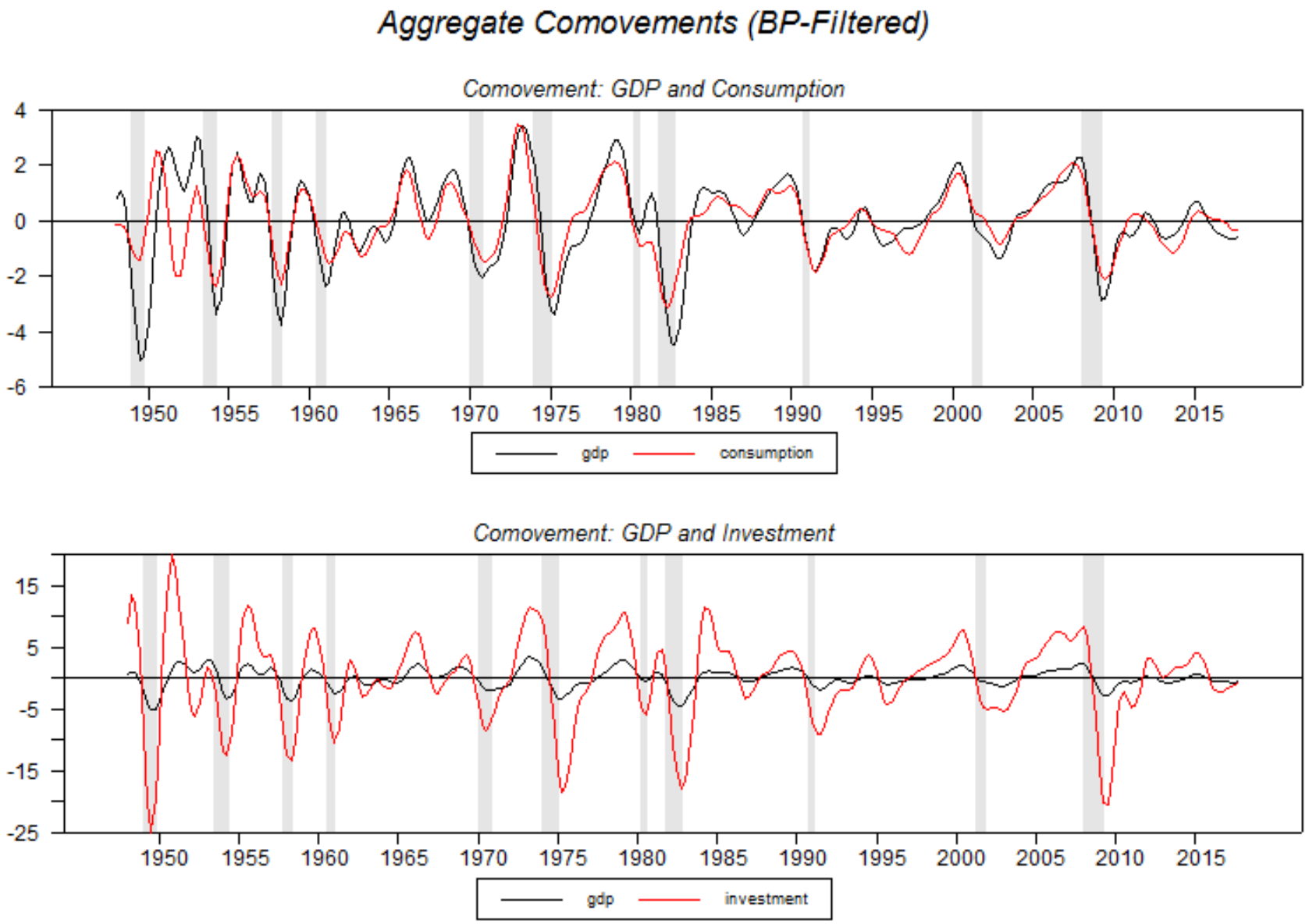
$\rightarrow$ correlation with output: $corr(x_t, y_t) \equiv \frac{cov(x_t, y_t)}{\sigma(x_t)\sigma(y_t)}$ where $cov(x_t, y_t) \equiv (1/T)\sum x_t y_t$
procyclical $(+)$, countercyclical $(-)$, o acyclical $(\simeq 0)$

Evidence for US and Euro Area Economies

Statistical Properties of the U.S. Business Cycle
BP-Filter (6,32), 1948Q1-2017Q4

	$\sigma(\widehat{x}_t)$	$\sigma(\widehat{x}_t)/\sigma(\widehat{y}_t)$	$corr(\widehat{x}_t, \widehat{x}_{t-1})$	$corr(\widehat{x}_t, \widehat{y}_t)$
GDP	1.55	1.0	0.91	1.00
Consumption	1.19	0.8	0.92	0.80
Investment	6.93	4.5	0.89	0.87
Government Purchases	3.15	2.0	0.94	0.15
Employment	1.00	0.6	0.93	0.79
Labor Productivity	0.98	0.6	0.90	0.78
Total Factor Productivity	1.03	0.7	0.89	0.75
Real Wage	0.93	0.6	0.91	0.21
Real Interest Rate	1.24	0.8	0.88	0.00


Aggregate Comovements (BP-Filtered)
Comovement: GDP and Employment
4
2
0
-2
-4
-6
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
gdp
employment
Comovement: GDP and Unemployment Rate
4
2
0
-2
-4
-6
10
8
6
4
2
corr= -0.57
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
gdp
unemployment


Aggregate Comovements (BP-Filtered)
Comovement: GDP and Consumption
4
2
0
-2
-4
-6
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
gdp
consumption
Comovement: GDP and Investment
15
5
-5
-15
-25
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
gdp
investment

Statistical Properties of the Euro Area Business Cycle

BP-Filter (6,32), 1970Q1-2016Q4

	$\sigma(\widehat{x}_t)$	$\sigma(\widehat{x}_t)/\sigma(\widehat{y}_t)$	$corr(\widehat{x}_t, \widehat{x}_{t-1})$	$corr(\widehat{x}_t, \widehat{y}_t)$
GDP	1.09	1.0	0.93	1.00
Consumption	0.76	0.7	0.96	0.80
Investment	2.52	2.3	0.95	0.91
Government Consumption	0.50	0.5	0.95	-0.11
Employment	0.63	0.6	0.96	0.79
Labor Productivity	0.72	0.7	0.90	0.83
Total Factor Productivity	0.81	0.7	0.91	0.94
Real Wage	0.56	0.5	0.94	0.23
Real Interest Rate	0.82	0.8	0.86	0.55

Properties of Economic Fluctuations: Summary

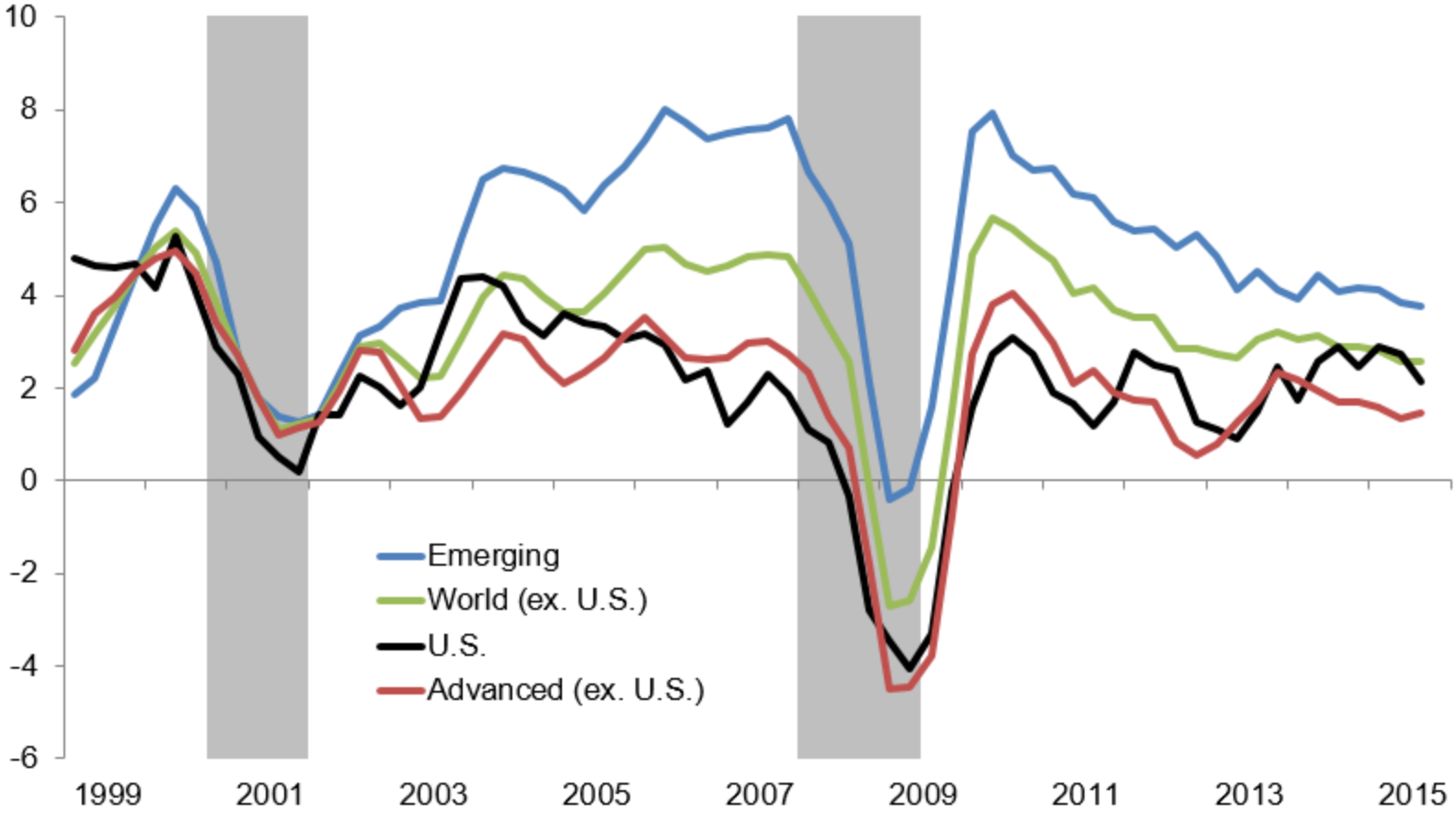
- Consumption and investment
  - highly procyclical
  - volatility ranking: $\sigma(c_t) < \sigma(y_t) < \sigma(i_t)$
- Employment:
  - highly procyclical
  - $\sigma(n_t) \simeq \sigma(y_t)$ in the U.S., $\sigma(n_t) < \sigma(y_t)$ in the euro area
- Productivity (labor and total):
  - procyclical
- Wages and interest rates
  - less volatile than GDP
  - largely acyclical
- Properties "robust" to different detrending methods and across countries.

The International Component of the Business Cycle

- Is there a "global" business cycle?

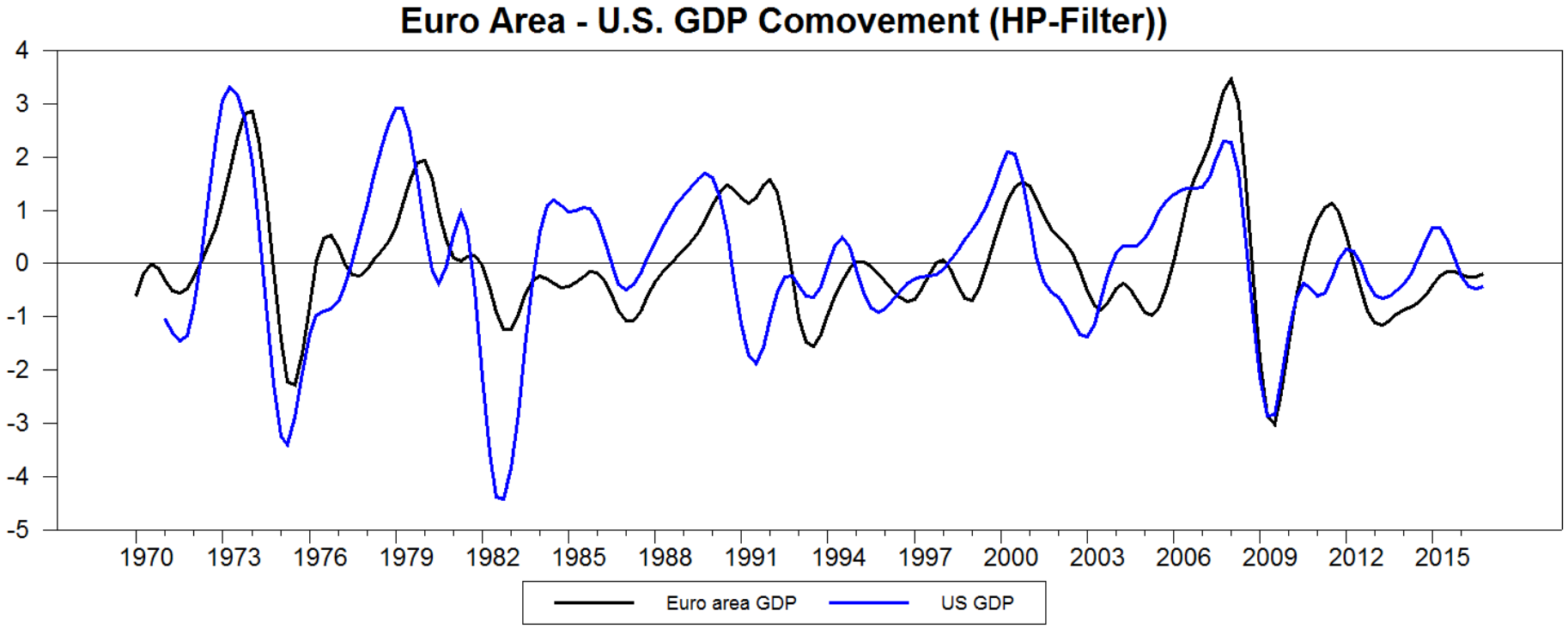
Chart 1
Real GDP Growth

Percent, year/year



NOTES: Calculations are based on a representative sample of 40 countries. Data are aggregated using U.S. trade weights. Shaded bars indicate global recessions.
SOURCES: Database of Global Economic Indicators; Haver Analytics; authors' calculations.

Source: Dallas Fed



$$corr(y_t^{ea}, y_t^{us}) = 0.58 \qquad corr(y_t^{ea}, y_{t-1}^{us}) = 0.65$$

The Evolution of Business Cycles Over Time

- Long term evolution

TABLE 2—PROPERTIES OF OUTPUT FLUCTUATIONS

Country	Standard deviations (percentage)			Relative to postwar	
	Prewar	Interwar	Postwar	Prewar	Interwar
Australia	6.30 (0.72)	4.85 (0.75)	1.93 (0.19)	3.3	2.5
Canada	4.47 (0.43)	9.80 (1.40)	2.22 (0.23)	2.0	4.4
Denmark	3.02 (0.22)	3.41 (0.64)	1.88 (0.20)	1.6	1.8
Germany	3.35 (0.32)	10.19 (1.61)	2.30 (0.28)	1.5	4.4
Italy	2.52 (0.24)	3.59 (0.46)	2.05 (0.17)	1.2	1.8
Japan	2.42 (0.24)	3.13 (0.44)	3.11 (0.32)	0.8	1.0
Norway	1.85 (0.16)	3.49 (0.65)	1.76 (0.17)	1.1	2.0
Sweden	2.43 (0.37)	3.74 (0.59)	1.45 (0.12)	1.7	2.6
United Kingdom	2.12 (0.24)	3.47 (0.37)	1.62 (0.21)	1.3	2.1
United States	4.28 (0.38)	9.33 (1.27)	2.26 (0.18)	1.9	4.1

Notes: Sample moments were computed from Hodrick-Prescott filtered logarithms of real output. Numbers in parentheses are standard errors, computed by GMM as described in the notes to Table 1. Sample periods are also reported in the notes to Table 1.

Source: Backus and Kehoe (1992)

The Great Depression

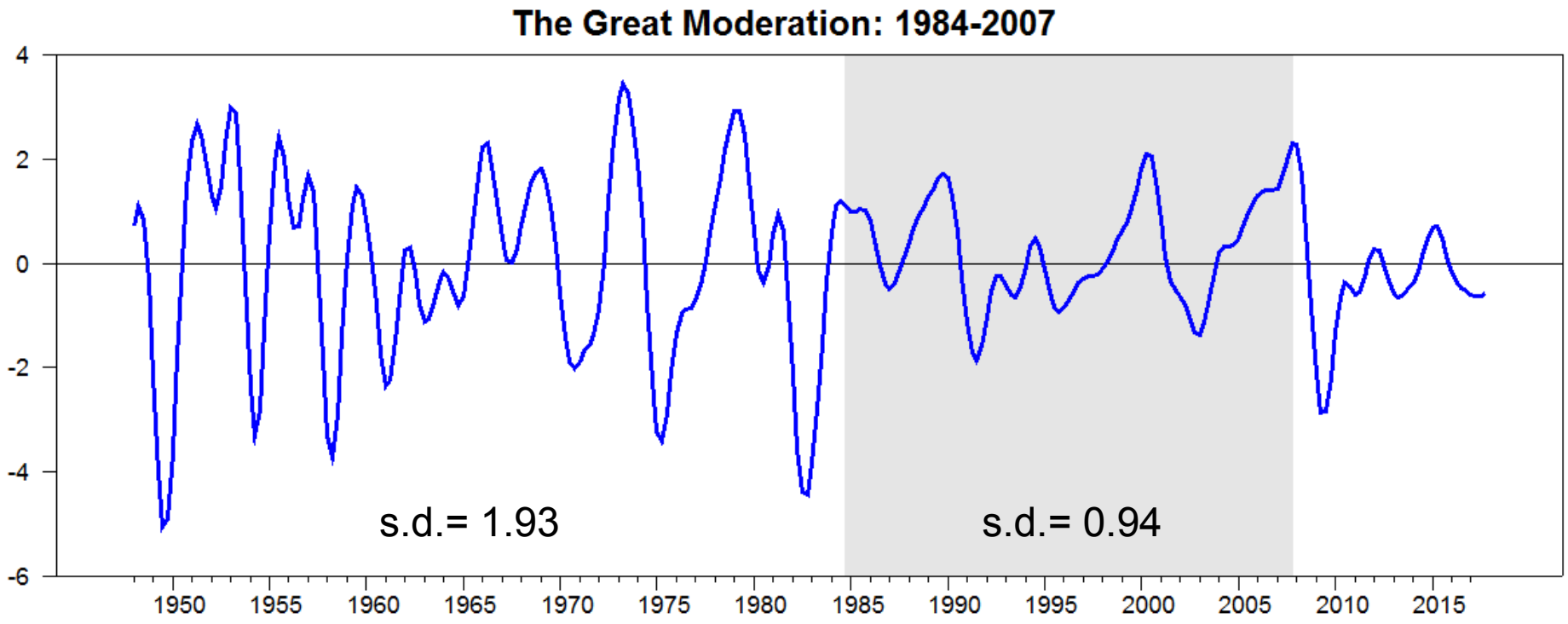
Country	Share of World Output, 1931 (percent)	Economic Activity		Output Loss (percent)[1]
		Peak	Trough	
United States	42.4	1929	1933	–29.4
United Kingdom	13.1	1930	1931	–0.5
Germany	9.5	1928	1932	–26.3
France	7.9	1932	1935	–10.4
Italy	5.4	1928	1933	–13.7
Japan	5.1	1930	1933	–14.9
Spain	4.2	1929	1931	–6.3
Canada	2.5	1929	1933	–29.7
Netherlands	2.1	1930	1934	–14.2
Switzerland	2.0	1930	1932	–6.5
Sweden	1.6	1930	1933	–12.1
Australia	1.4	1926	1931	–24.9
Denmark	1.1	1930	1932	–4.4
Norway	0.9	1930	1931	–8.0
Finland	0.5	1928	1931	–7.2
Portugal	0.4	1935	1936	–0.7

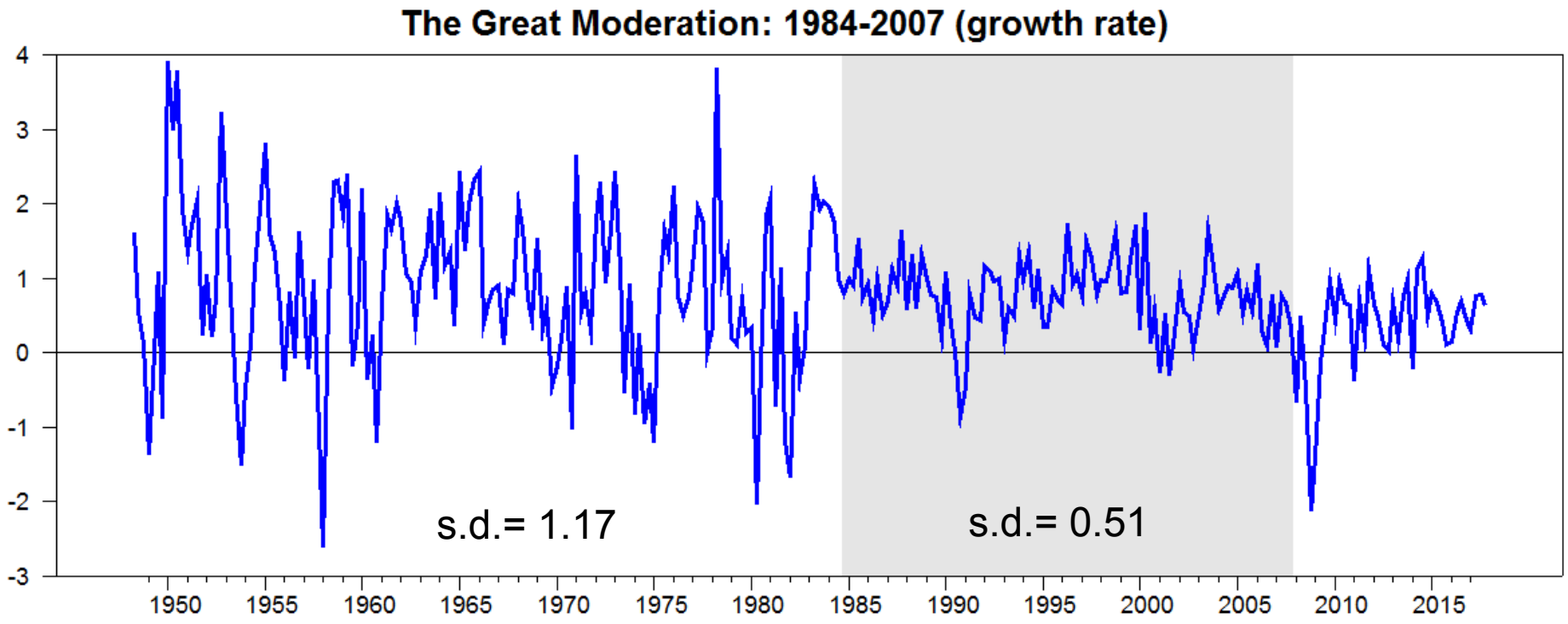
[1]Cumulative loss in output from peak to trough (based on annual data). The peak is defined as the year before real growth turned negative. The trough is defined as the year before real growth turned positive.

Source: WEO April 2002

The Evolution of Business Cycles Over Time

- Long term evolution
- Postwar evolution:
  - the "Great Moderation"
  - the "Great Recession"


The Great Moderation: 1984-2007
4
2
0
-2
-4
-6
s.d.= 1.93
s.d.= 0.94
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015


The Great Moderation: 1984-2007 (growth rate)
4
3
2
1
0
-1
-2
-3
s.d.= 1.17
s.d.= 0.51
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015

The Evolution of Business Cycles Over Time

- Long term evolution
- Postwar evolution:
  - the "Great Moderation"
  - the "Great Recession"
- Explanations

  a) larger weight of services
  b) role of government
    - larger weight in aggregate demand
    - automatic stabilizers
    - countercyclical policies

  c) fewer financial crises (deposit insurance, lender of last resort)
  d) financial development
  e) good luck

Business Cycle Chronologies

Dates that mark the beginning and end of recessions ("peaks" and "troughs")

- *National Bureau of Economic Research* (NBER)

- www.nber.org/cycles.html
- monthly and quarterly chronologies for the U.S.
- recession: significant decline in economic activity, economy wide, lasting longer than a few months, and reflected in aggregate indicators like GDP, employment, personal income, etc.
- 11 complete cycles since 1945.
- average duration of recessions: 11 months.
- average duration of expansions: 58 months.
- last recession: "peak": December 2007 (Q4); "trough": June 2009 (Q2).

- *Centre for Economic Policy Research* (CEPR)

- http://www.cepr.org/content/euro-area-business-cycle-dating-committee
- quarterly chronology for the euro area
- recession: significant decline in economic activity, affecting most countries in the euro area wide, usually reflected in two or more consecutive quarters of GDP and employment decline.
- 5 complete cycles since 1970.
- last recessions:
    "peak": 2008Q1 ; "trough": 2009Q2
    "peak" 2011Q3 ; "trough": 2013Q1

Source of Macroeconomic Data

- Global

- IMF (www.imf.org)
- OECD (www.oecd.org)

- United States

- St. Louis Fed (http://research.stlouisfed.org/fred2)
- Bureau of Labor Statistics (http://www.bls.gov)
- Bureau of Economic Analysis (http://www.bea.gov)

- Europe/Euro area

- Eurostat (http://ec.europa.eu/eurostat)
- European Central Bank (http://www.ecb.int)

- Espanya/Catalunya

- Instituto Nacional de Estadística (http://www.ine.es)
- Banco de España (http://www.bde.es)
- Institut d'Estadística de Catalunya (www.idescat.cat)