# Macroeconomics:  Business Cycle  Analysis

## Introduction to business cycle analysis

## Stylized facts of business cycles

Main features of business *fluctuations* defined as

> recurrent periods of expansion and contraction ("recessions") in the aggregate economic activity

A *recession* is broadly defined (NBER 2003) as

> 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

The **"official" dating** of expansions and recessions in the US provided by the NBER is based on the above definition, which refers to the overall level of economic time series with no reference to deviations from a long-term growth trend.

# The NBER's Recession Dating Procedure

**Business Cycle Dating Committee, National Bureau of Economic Research**

The **National Bureau's Business Cycle Dating Committee** maintains a chronology of U.S. business cycles. **The chronology identifies the dates of peaks and troughs that frame economic recessions and expansions**. A **recession** is the period between a peak of economic activity and its subsequent trough, or lowest point. Between trough and peak, the economy is in an **expansion**. Expansion is the normal state of the economy; most recessions are brief. However, the time that it takes for the economy to return to its previous peak level of activity or its previous trend path may be quite extended. According to the NBER chronology, the most recent peak occurred in February 2020, ending a record-long expansion that began after the trough in June 2009.

The NBER's traditional definition emphasizes that a recession involves a significant decline in economic activity that is spread across the economy and lasts more than a few months. In our modern interpretation of this definition, we treat the three criteria—depth, diffusion, and duration—as at least somewhat interchangeable. That is, while each criterion needs to be met individually to some degree, extreme conditions revealed by one criterion may partially offset weaker indications from another. For example, in the case of the February 2020 peak in economic activity, the committee concluded that the subsequent drop in activity had been so great and so widely diffused throughout the economy that, even if it proved to be quite brief, the downturn should be classified as a recession.

In choosing the dates of business-cycle turning points, the committee follows standard procedures to assure continuity in the chronology. Because a recession must influence the economy broadly and not be confined to one sector, the committee emphasizes **economy-wide measures of economic activity**. It views real gross domestic product (GDP) as the single best measure of aggregate economic activity. This concept is measured two ways by the U.S. Bureau of Economic Analysis (BEA)—from the product side and from the income side. Because the two measures have strengths and weaknesses and differ by a statistical discrepancy, the committee considers real GDP and real gross domestic income (GDI) on an equal footing. It also considers carefully total payroll employment as measured by the Bureau of Labor Statistics (BLS).

The traditional role of the committee is to maintain a **monthly chronology of business cycle turning points**. Because the BEA figures for real GDP and real GDI are only available quarterly, the committee considers a variety of monthly indicators to determine the months of peaks and troughs. It places particular emphasis on two monthly measures of activity across the entire economy: (1) **personal income less transfer payments**, in real terms, which is a monthly measure that includes much of the income included in real GDI; and (2) **payroll employment** from the BLS. Although these indicators are the most important measures considered by the committee in developing its monthly business cycle chronology, it does not hesitate to consider other indicators, such as real personal consumption expenditures, industrial production, initial claims for unemployment insurance, wholesale-retail sales adjusted for price changes, and household employment, as it deems valuable. There is no fixed rule about which other measures contribute information to the process or how they are weighted in the committee's decisions.

The committee's approach to determining the dates of turning points is **retrospective**. It waits until sufficient data are available to avoid the need for major revisions. In particular, in determining the date of a peak in activity, and thus the onset of recession, it waits until the committee members are confident that a recession has occurred, even in the event that activity begins to rise again immediately. As a result, the committee tends to wait to identify a peak until a number of months after it has actually occurred.

# NATIONAL BUREAU OF ECONOMIC RESEARCH

# US Business Cycle Expansions and Contractions

*Contractions (recessions) start at the peak of a business cycle and end at the trough.*

| BUSINESS CYCLE REFERENCE DATES | | DURATION IN MONTHS | | | |
|---|---|---|---|---|---|
| **Peak** | **Trough** | **Contraction** | **Expansion** | **Cycle** | |
| *Quarterly dates are in parentheses* | | *Peak to Trough* | *Previous trough to this peak* | *Trough from Previous Trough* | *Peak from Previous Peak* |
| | December 1854 (IV) | -- | -- | -- | -- |
| June 1857(II) | December 1858 (IV) | 18 | 30 | 48 | -- |
| October 1860(III) | June 1861 (III) | 8 | 22 | 30 | 40 |
| April 1865(I) | December 1867 (I) | 32 | 46 | 78 | 54 |
| June 1869(II) | December 1870 (IV) | 18 | 18 | 36 | 50 |
| October 1873(III) | March 1879 (I) | 65 | 34 | 99 | 52 |
| March 1882(I) | May 1885 (II) | 38 | 36 | 74 | 101 |
| March 1887(II) | April 1888 (I) | 13 | 22 | 35 | 60 |
| July 1890(III) | May 1891 (II) | 10 | 27 | 37 | 40 |
| January 1893(I) | June 1894 (II) | 17 | 20 | 37 | 30 |
| December 1895(IV) | June 1897 (II) | 18 | 18 | 36 | 35 |
| June 1899(III) | December 1900 (IV) | 18 | 24 | 42 | 42 |
| September 1902(IV) | August 1904 (III) | 23 | 21 | 44 | 39 |
| May 1907(II) | June 1908 (II) | 13 | 33 | 46 | 56 |
| January 1910(I) | January 1912 (IV) | 24 | 19 | 43 | 32 |
| January 1913(I) | December 1914 (IV) | 23 | 12 | 35 | 36 |
| August 1918(III) | March 1919 (I) | 7 | 44 | 51 | 67 |
| January 1920(I) | July 1921 (III) | 18 | 10 | 28 | 17 |
| May 1923(II) | July 1924 (III) | 14 | 22 | 36 | 40 |
| October 1926(III) | November 1927 (IV) | 13 | 27 | 40 | 41 |
| August 1929(III) | March 1933 (I) | 43 | 21 | 64 | 34 |
| May 1937(II) | June 1938 (II) | 13 | 50 | 63 | 93 |
| February 1945(I) | October 1945 (IV) | 8 | 80 | 88 | 93 |
| November 1948(IV) | October 1949 (IV) | 11 | 37 | 48 | 45 |
| July 1953(II) | May 1954 (II) | 10 | 45 | 55 | 56 |
| August 1957(III) | April 1958 (II) | 8 | 39 | 47 | 49 |
| April 1960(II) | February 1961 (I) | 10 | 24 | 34 | 32 |
| December 1969(IV) | November 1970 (IV) | 11 | 106 | 117 | 116 |
| November 1973(IV) | March 1975 (I) | 16 | 36 | 52 | 47 |
| January 1980(I) | July 1980 (III) | 6 | 58 | 64 | 74 |
| July 1981(III) | November 1982 (IV) | 16 | 12 | 28 | 18 |
| July 1990(III) | March 1991(I) | 8 | 92 | 100 | 108 |
| March 2001(I) | November 2001 (IV) | 8 | 120 | 128 | 128 |
| December 2007 (IV) | June 2009 (II) | 18 | 73 | 91 | 81 |
| February 2020 (2019 IV) | **April 2020 (II)** | 2 | 128 | 130 | 146 |

# NBER Determination of the February 2020 Peak in US Economic Activity

Cambridge, **June 8, 2020** -- The Business Cycle Dating Committee of the **National Bureau of Economic Research** maintains a **chronology of the peaks and troughs of U.S. business cycles**. The committee has determined that a peak in monthly economic activity occurred in the U.S. economy in February 2020. The peak marks the end of the expansion that began in June 2009 and the beginning of a recession. The expansion lasted 128 months, the longest in the history of U.S. business cycles dating back to 1854. The previous record was held by the business expansion that lasted for 120 months from March 1991 to March 2001.

The committee also determined that a peak in quarterly economic activity occurred in 2019Q4. Note that the monthly peak (February 2020) occurred in a different quarter (2020Q1) than the quarterly peak. The committee determined these peak dates in accord with its long-standing policy of identifying the months and quarters of peak activity separately, without requiring that the monthly peak lie in the same quarter as the quarterly peak. Further comments on the difference between the quarterly and monthly dates are provided below.

A **recession** is a significant decline in economic activity spread across the economy, normally visible in production, employment, and other indicators. A recession begins when the economy reaches a peak of economic activity and ends when the economy reaches its trough. Between trough and peak, the economy is in an expansion.

Because a recession is a broad contraction of the economy, not confined to one sector, the committee emphasizes **economy-wide indicators of economic activity**. The committee believes that domestic production and employment are the primary conceptual measures of economic activity.

**The Month of the Peak**

In determining the date of the monthly peak, the committee considers a number of indicators of employment and production. The committee normally views the payroll employment measure, which is based on a large survey of employers, as the most reliable comprehensive estimate of employment. This series reached a clear peak in February. The committee recognized that this survey was affected by special circumstances associated with the pandemic of early 2020. In the survey, individuals who are paid but not at work are counted as employed, even though they are not in fact working or producing. Workers on paid furlough, who became more numerous during the pandemic, thus resulted in an overcount of people working in recent months. Accordingly, the committee also considered the employment measure from the Bureau of Labor Statistics household survey, which excludes individuals who are paid but on furlough. This series plateaued from December 2019 through February 2020, and then fell steeply from February to March. Because both series measure employment during the week or pay period containing the 12$^{th}$ of the month, they understate the collapse of employment during the second half of March, as indicated by unprecedented levels of new claims for unemployment insurance. The committee concluded that both employment series were thus consistent with a business cycle peak in February.

The committee believes that the two most reliable comprehensive estimates of aggregate production are the quarterly estimates of real Gross Domestic Product (GDP) and of real Gross Domestic Income (GDI), both produced by the Bureau of Economic Analysis (BEA). These measures estimate production that occurred over an entire quarter and are not available monthly. The most comprehensive monthly measure of aggregate expenditures, which includes roughly 70 percent of real GDP, is monthly real personal consumption expenditures (PCE), published by the BEA. This series reached a clear peak in February 2020. The most comprehensive monthly measure of aggregate real income is real personal income less transfers, from the BEA. The deduction of transfers is necessary because transfers are included in personal income but do not arise from production. This measure also reached a well-defined peak in February 2020.

**The Quarter of the Peak**

In dating the quarterly peak, the committee relies on real GDP and real GDI as published by the BEA, and on quarterly averages of key monthly indicators. Quarterly real GDP and real GDI peaked in 2019Q4.

The quarterly average of employment as measured by the payroll series rose from 2019Q4 to 2020Q1. However, the committee concluded that the special factor noted above implies that the series should not play a significant role in determining the quarterly peak. The quarterly average as measured by the household survey reached a clear peak in 2019Q4. The committee concluded that like GDP and GDI, the number of people working also reached its quarterly peak in 2019Q4.

The fact that the monthly peak of February occurred in the middle of 2020Q1 while the quarterly peak occurred in 2019Q4 reflects the unusual nature of this recession. The economy contracted so sharply in March (the final month of the quarter) that in 2020Q1, GDP, GDI, and employment were significantly below their levels of 2019Q4.

**Further Comments**

The usual definition of a recession involves "a decline in economic activity that lasts more than a few months." However, in deciding whether to identify a recession, the committee weighs the depth of the contraction, its duration, and whether economic activity declined broadly across the economy (the diffusion of the downturn). The committee recognizes that the pandemic and the public health response have resulted in a downturn with different characteristics and dynamics than prior recessions. Nonetheless, it concluded that the unprecedented magnitude of the decline in employment and production, and its broad reach across the entire economy, warrants the designation of this episode as a recession, even if it turns out to be briefer than earlier contractions.

Committee members participating in the decision were: Robert Hall, Stanford University (chair); Robert Gordon, Northwestern University; James Poterba, MIT and NBER President; Valerie Ramey, University of California, San Diego; Christina Romer, University of California, Berkeley; David Romer, University of California, Berkeley; James Stock, Harvard University; Mark Watson, Princeton University.

# Determination of the April 2020 Trough in US Economic Activity

Cambridge, July 19, 2021 - The Business Cycle Dating Committee of the National Bureau of Economic Research maintains a chronology of the peaks and troughs of US business cycles. The committee has determined that a trough in monthly economic activity occurred in the US economy in April 2020. The previous peak in economic activity occurred in February 2020. The recession lasted two months, which makes it the shortest US recession on record.

The NBER chronology does not identify the precise moment that the economy entered a recession or expansion. In the NBER's convention for measuring the duration of a recession, the first month of the recession is the month following the peak and the last month is the month of the trough. Because the most recent trough was in April 2020, the last month of the recession was April 2020, and May 2020 was the first month of the subsequent expansion.

In determining that a trough occurred in April 2020, the committee did not conclude that the economy has returned to operating at normal capacity. An expansion is a period of rising economic activity spread across the economy, normally visible in real GDP, real income, employment, industrial production, and wholesale-retail sales. Economic activity is typically below normal in the early stages of an expansion, and it sometimes remains so well into the expansion.

The committee decided that any future downturn of the economy would be a new recession and not a continuation of the recession associated with the February 2020 peak. The basis for this decision was the length and strength of the recovery to date.

**The Month of the Trough**

In determining the date of a monthly peak or trough, the committee considers a number of indicators of employment and production. In the current case, all of those indicators point clearly to April 2020 as the month of the trough. On the employment side, the committee normally views the payroll employment measure produced by the Bureau of Labor Statistics (BLS), which is based on a large survey of employers, as the most reliable comprehensive estimate of employment. This series reached a clear trough in April before rebounding strongly the next few months and then settling into a more gradual rise. However, the committee recognized that this survey was affected by special circumstances associated with the COVID-19 pandemic in early 2020.

In the survey, individuals who are paid but not at work are counted as employed, even though they are not in fact working or producing. Workers on paid furlough, who became more numerous during the pandemic, thus resulted in an overcount of people working. Accordingly, the committee also considered the employment measure from the BLS household survey, which excludes individuals who are paid but on furlough. This series also shows a clear trough in April. The committee concluded that both employment series were thus consistent with a business cycle trough in April.

The committee believes that the two most reliable comprehensive estimates of aggregate production are the quarterly estimates of real Gross Domestic Product (GDP) and of real Gross Domestic Income (GDI), both produced by the Bureau of Economic Analysis (BEA). Both series attempt to measure the same underlying concept, but GDP does so using data on expenditure while GDI does so using data on income. These measures estimate production that occurred over an entire quarter and are not available monthly. The most comprehensive income-based monthly measure of aggregate production is real personal income less transfers, from the BEA. The deduction of transfers is necessary because transfers are included in personal income but do not arise from production. This measure reached a clear trough in April 2020. The most comprehensive expenditure-based monthly measure of aggregate production is monthly real personal consumption expenditures (PCE), published by the BEA. This series also reached a clear trough in April 2020.

**The Quarter of the Trough**

In determining the date of a quarterly peak or trough, the committee relies on real GDP and real GDI as published by the BEA, and on quarterly averages of key monthly indicators. As with the monthly trough, there is strong agreement across the indicators about the timing of the quarterly trough: the indicators all point strongly to 2020Q2. Quarterly real GDP and real GDI both reached clear troughs in 2020Q2, as did quarterly averages of both the monthly payroll and household employment series.

**Further Comments**

The NBER's traditional definition of a recession involves a decline in economic activity that lasts more than a few months. For example, the previous shortest recession occurred in the first half of 1980 and lasted six months.  However, in deciding whether to identify a recession, the committee weighs the depth of the contraction, its duration, and whether economic activity declined broadly across the economy (the diffusion of the downturn). The recent downturn had different characteristics and dynamics than prior recessions. Nonetheless, the committee concluded that the unprecedented magnitude of the decline in employment and production, and its broad reach across the entire economy, warranted the designation of this episode as a recession, even though the downturn was briefer than earlier contractions.
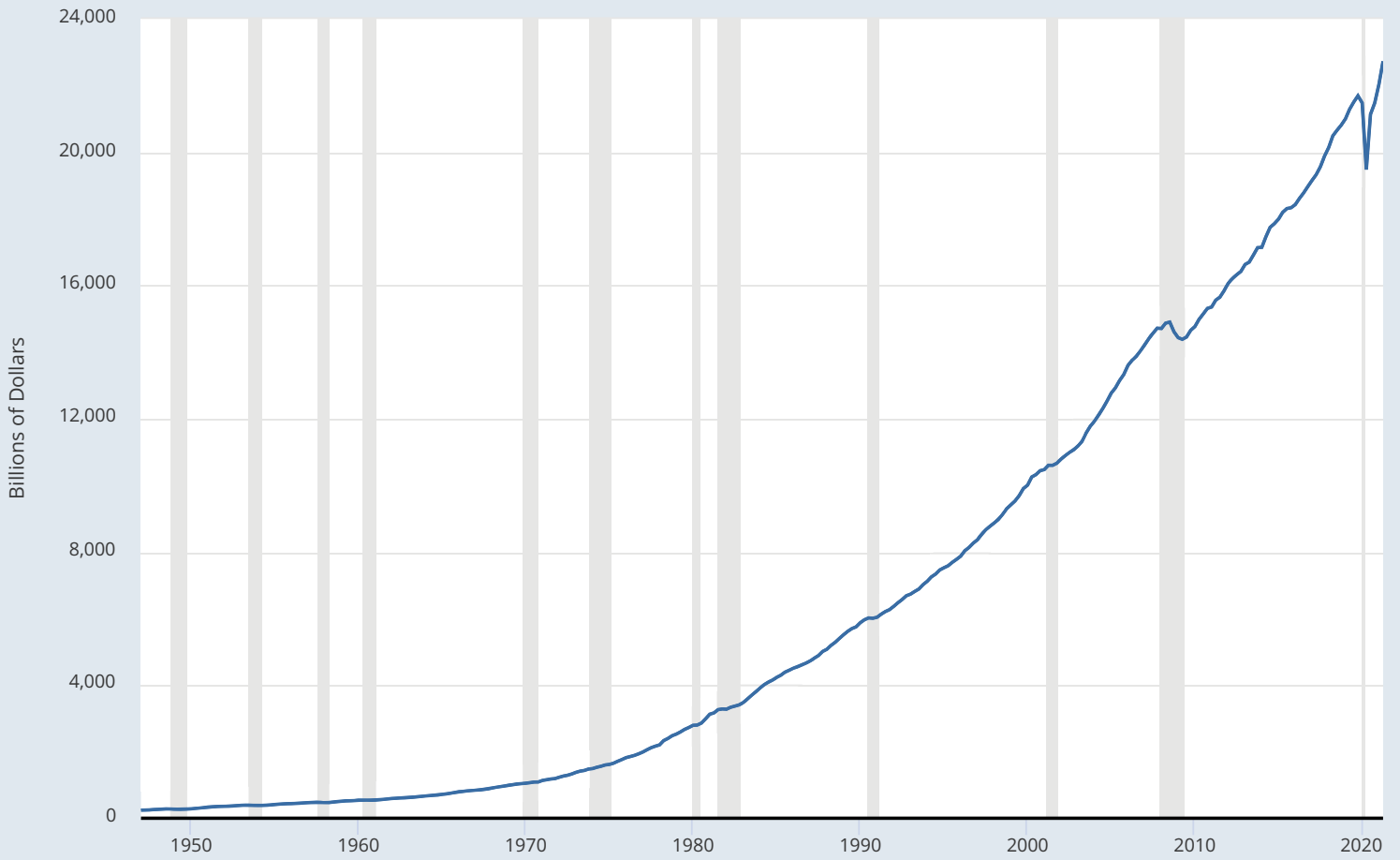
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FRED 〰 — Gross Domestic Product    **United States  1947(1)-2021(2) with NBER recessions**

Billions of Dollars

24,000

20,000

16,000

12,000

8,000

4,000

0

1950    1960    1970    1980    1990    2000    2010    2020
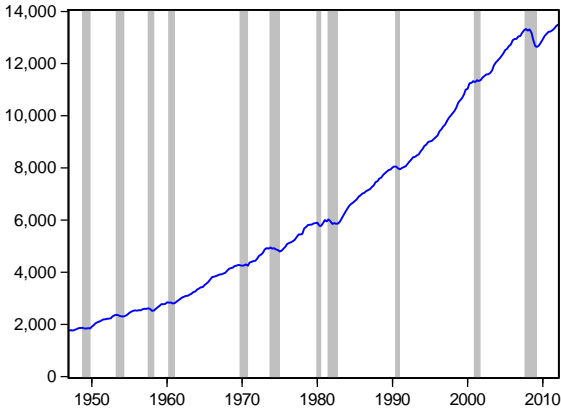
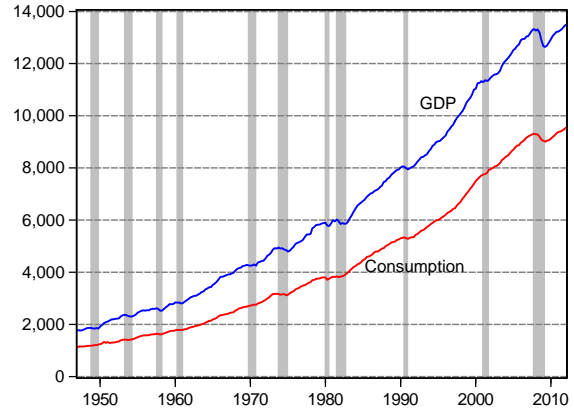*Shaded areas indicate U.S. recessions.*    Source: U.S. Bureau of Economic Analysis    fred.stlouisfed.org
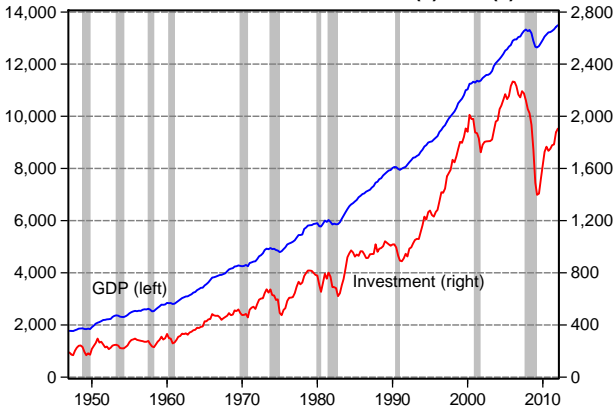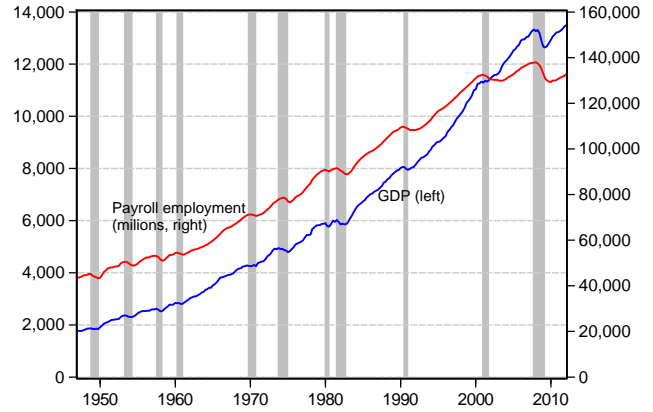
**US: GDP 1947(1)-2012(1) with NBER recessions**
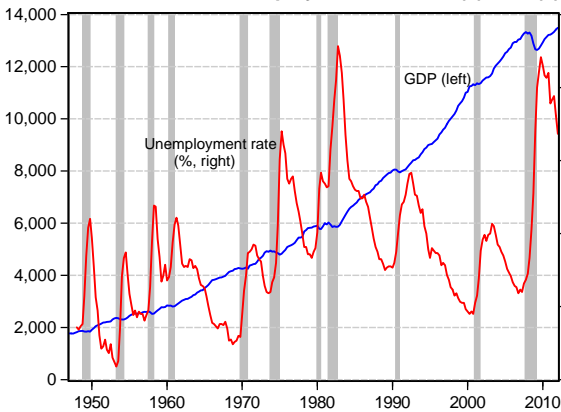
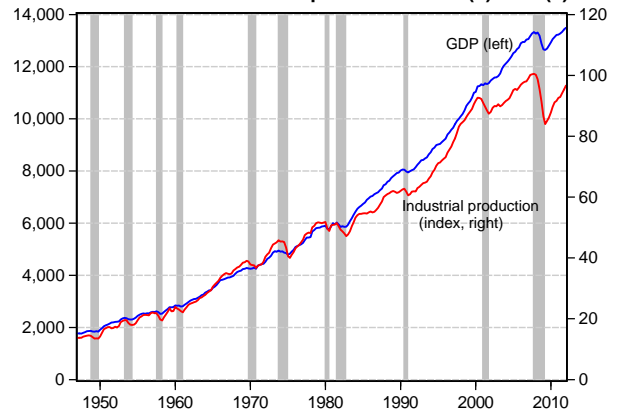**US: GDP and Consumption 1947(1)-2012(1)**

**US: GDP and Investment 1947(1)-2012(1)**

**US: GDP and Payroll employment 1947(1)-2012(1)**

**US: GDP and Unemployment rate 1948(1)-2012(1)**

**US: GDP and Industrial production 1947(1)-2012(1)**

## Euro Area: GDP 1970(1)-2013(2) with CEPR recessions
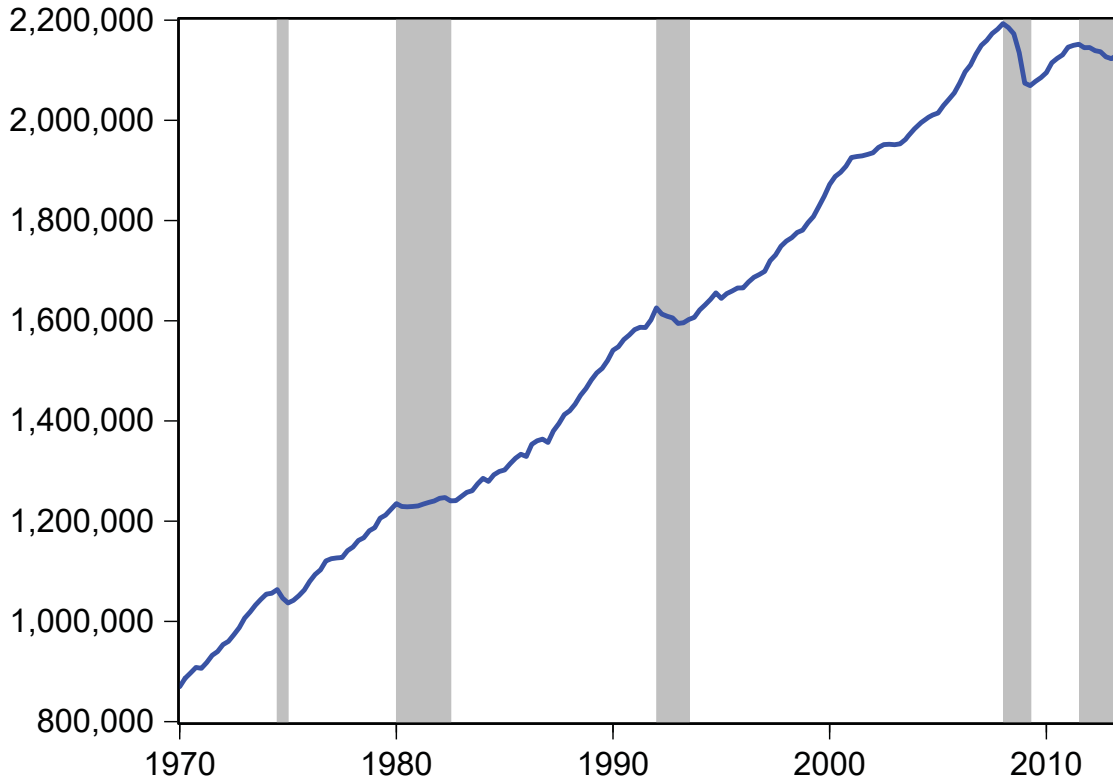




Evolution of the **EA GDP from 2011Q1 to 2021Q4**. The blue line is the GDP represented as quantity index with **base year and quarter 2020Q2 = 100**. The gray areas represent the recession periods as dated by the Committee.

**Euro Area: GDP 1970(1)-2012(1) with CEPR recessions**
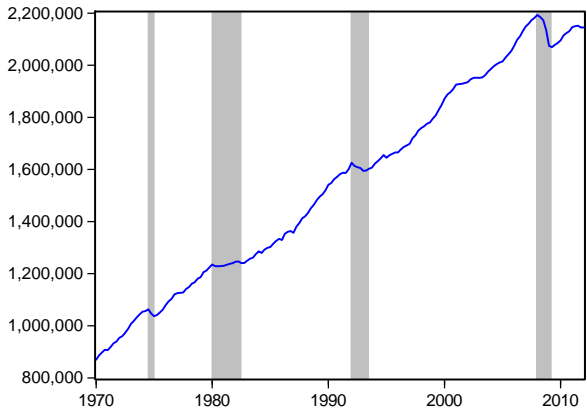
**Euro Area: GDP and Private Consumption 1970(1)-2012(1)**
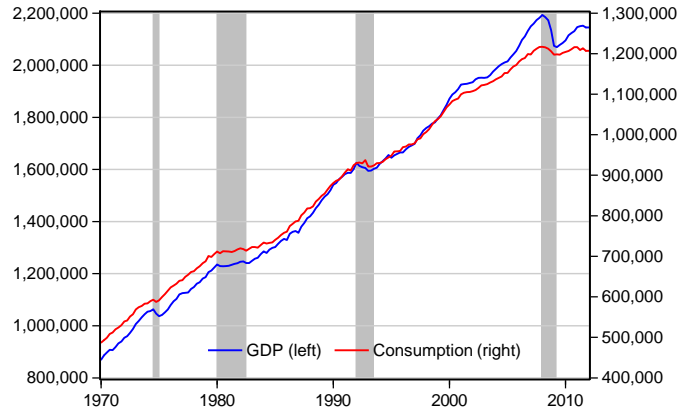
**Euro Area: GDP and Investment 1970(1)-2012(1)**
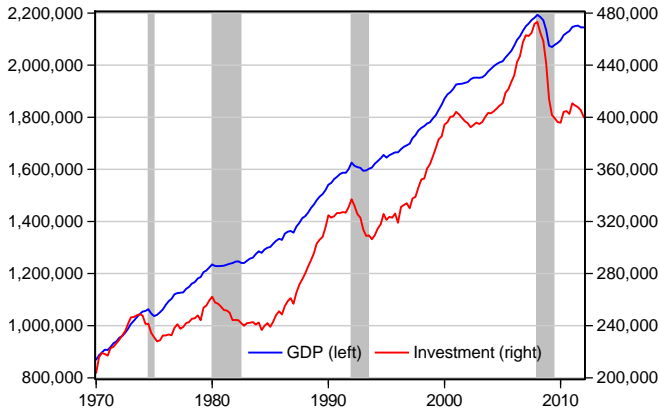
**Euro Area: GDP and Employment 1970(1)-2012(1)**
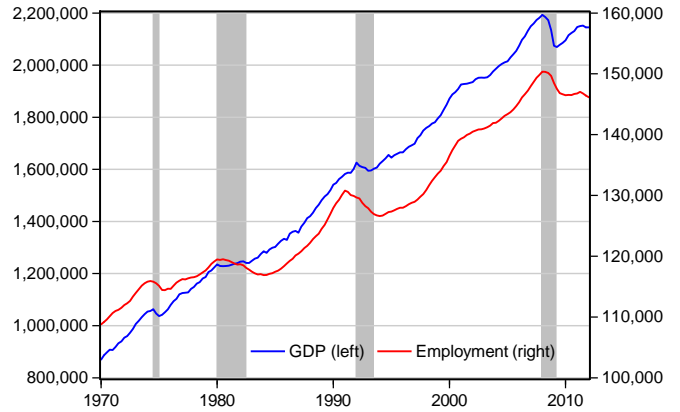
**Euro Area: GDP and Unemployment rate 1970(1)-2012(1)**
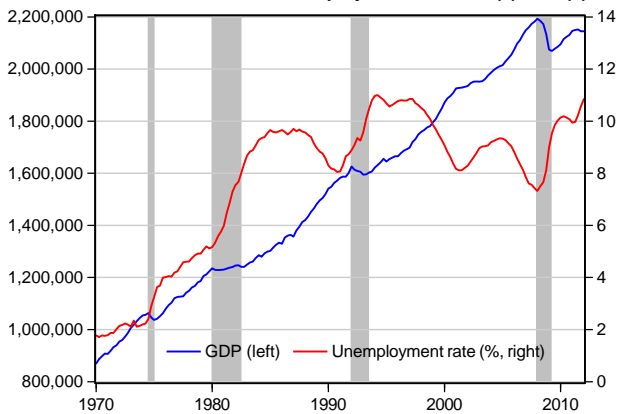
The **approach of modern studies** of business cycle properties views business cycle facts as the *statistical properties* of the *deviations from a long-term growth trend* of a large set of macroeconomic aggregates, including output (GDP), its main components (consumption, investment), employment, labor productivity, real wages, the inflation rate. The implementation of this approach requires a method for decomposing a series into a trend and a cyclical component.

**Trend and cycle determination**. To distinguish between the *trend* and the *cyclical* components of time series various "filtering" techniques are used. One widely used technique is based on the *Hodrick-Prescott (HP) filter* [from Hodrick R.J. and E.C. Prescott (1997) "Postwar US business cycles: an empirical investigation", *Journal of money,credit and banking*, 29, 1]

In general, given a series $y_t$:

$$y_t = \underset{\text{TREND}}{y_t^{TR}} + \underset{\text{CYCLE}}{y_t^{C}} \qquad t = 1, ..., T$$

the trend component can be obtained for each time date $t$ by applying a *two-sided linear filter* (i.e. applying a set of weights $a_i$ to all -past, present, and future- values of the series):

$$y_t^{TR} = \sum_{i=-\infty}^{i=\infty} a_i \, y_{t-i}$$

(if the weights are applied only to past and present values of the series, i.e. $a_i$ is defines only for $i = 0, ...\infty$, the filter is called *one-sided*).

The Hodrick-Prescott filter is based on the underlying assumption (suggested by neoclassical growth theory) that the trend component of aggregate economic time series varies smoothly over time. Operationally, trend values $y_t^{TR}$ are obtained from the solution of the following minimization problem:

$$\min_{\{y_t^{TR}\}} \sum_{t=1}^{T} \left\{ \left(y_t - y_t^{TR}\right)^2 + \lambda \left[ \left(y_t^{TR} - y_{t-1}^{TR}\right) - \left(y_{t-1}^{TR} - y_{t-2}^{TR}\right) \right]^2 \right\}$$

where the "smoothing"parameter $\lambda \geq 0$ captures the relative weight in the objective function of changes in the trend over time and penalizes variations in the growth rate of the trend component. If $\lambda \to 0$ then $y_t^{TR} \to y_t$ (no cycle), whereas if $\lambda \to \infty$ then $y_t^{TR}$ tends to a simple linear trend. Conventionally, a value of $\lambda = 1600$ is used for quarterly data.
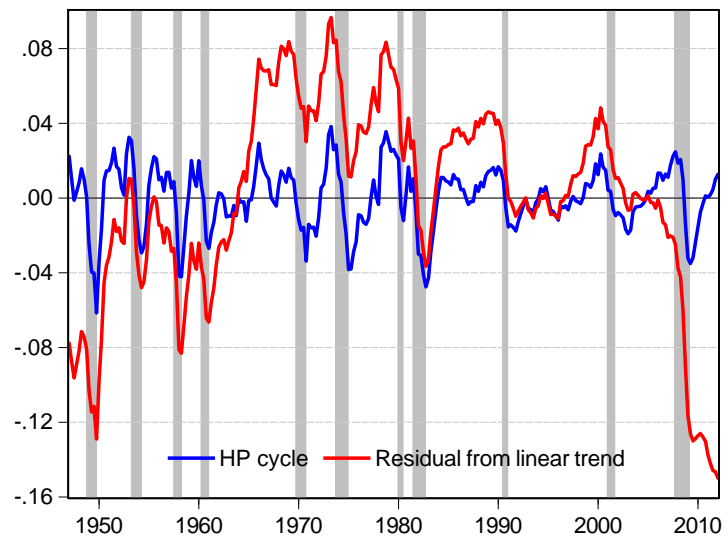
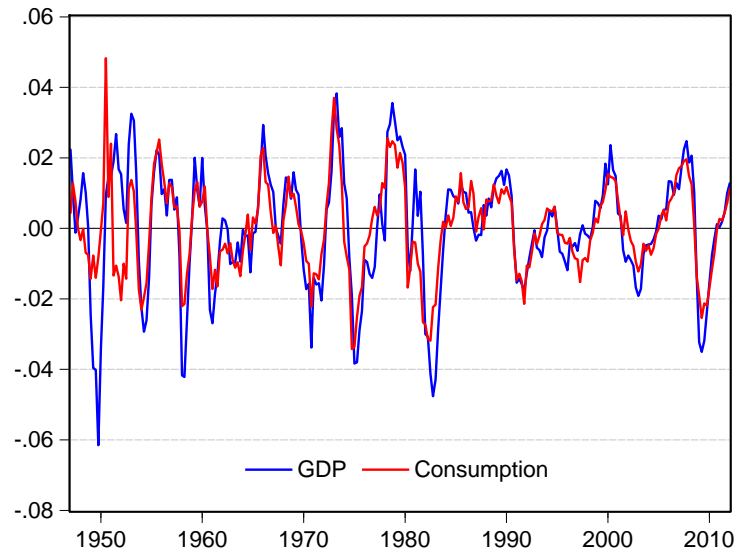## US: GDP 1947-2012 and Hodrick-Prescott trend with NBER recessions



Legend: GDP (logs) — HP trend in GDP
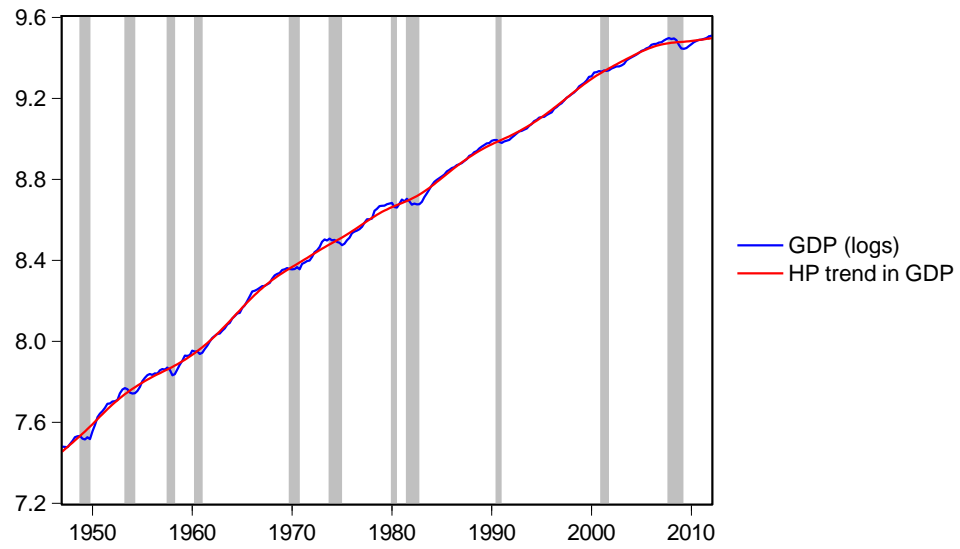
## US: Hodrick-Prescott cyclical component 1947-2012 with NBER recessions
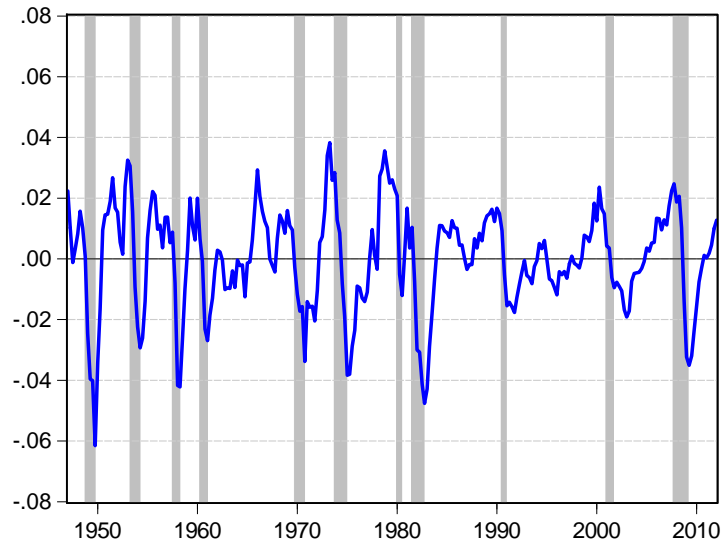


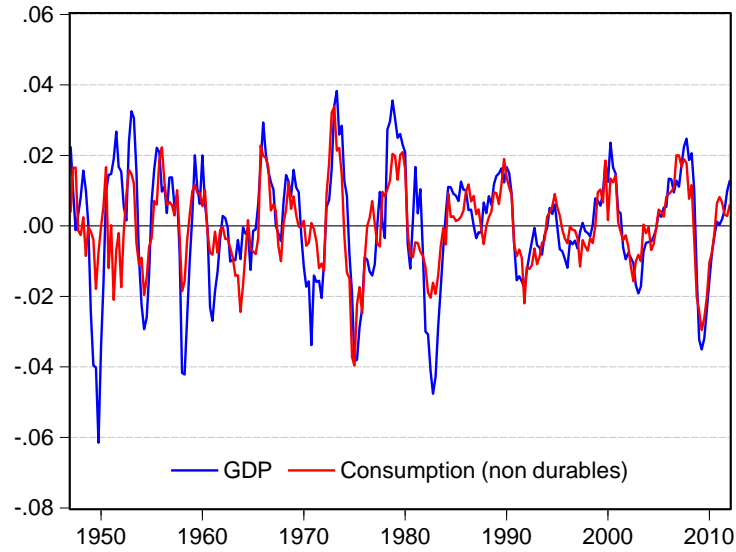## US: HP cyclical component and linear trend residual 1947-2012 with NBER recessions
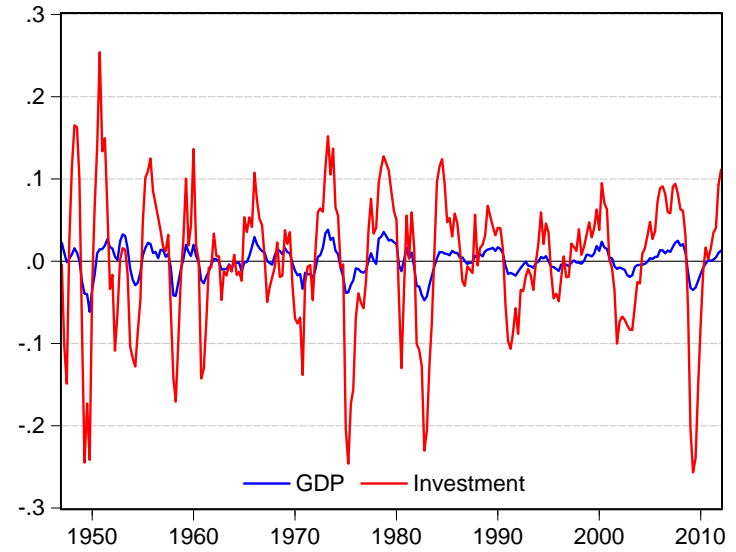


Legend: HP cycle — Residual from linear trend

**US: Cyclical components in GDP and Consumption (HP filter)**

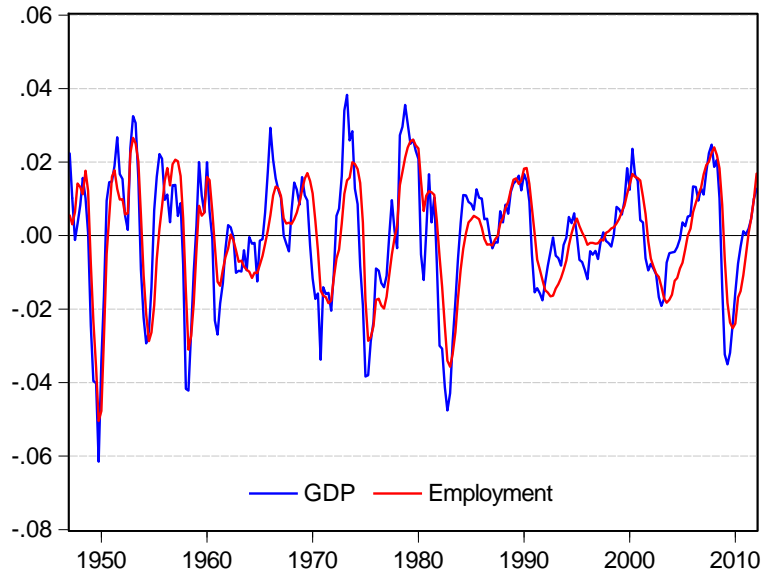**US: Cyclical components in GDP and Consumption (durables)**
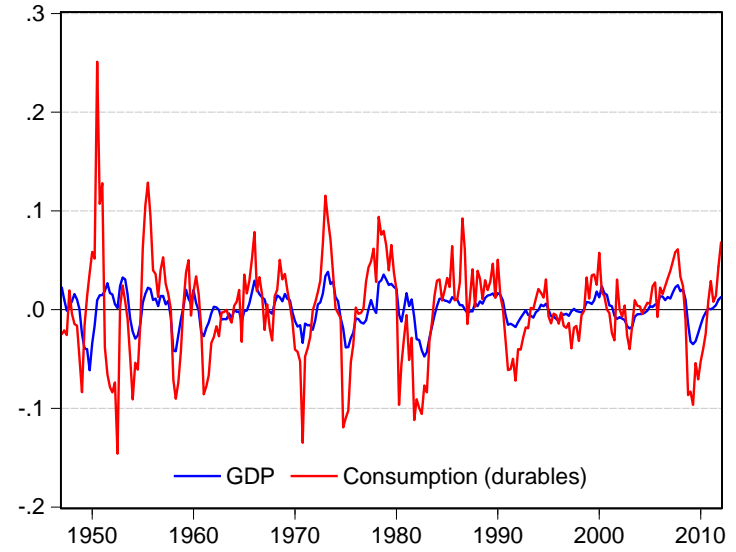
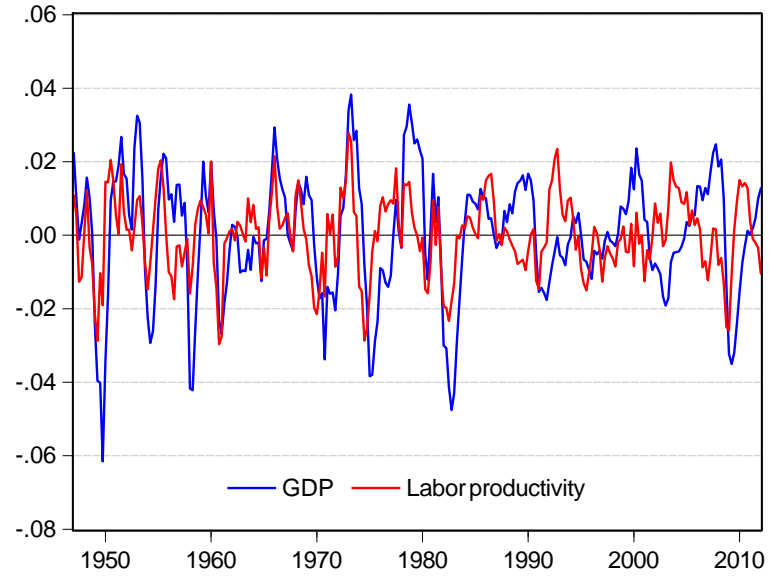**US: Cyclical components in GDP and Consumption (non dur.)**

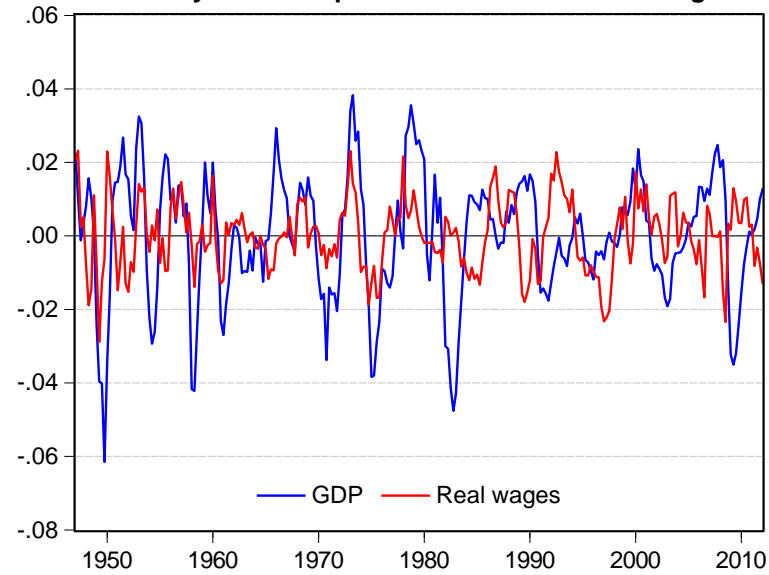**US: Cyclical components in GDP and Investment**

**US: Cyclical components in GDP and Employment**

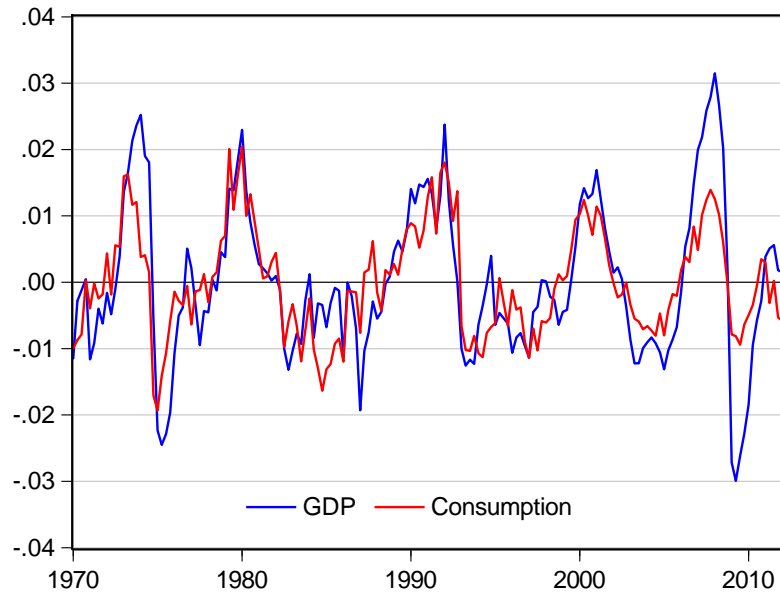**US: Cyclical components in GDP and Labor productivity**

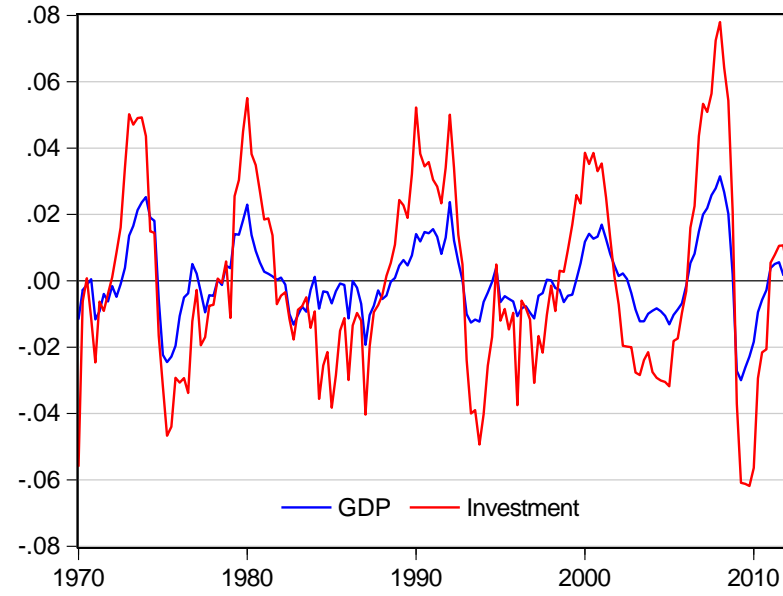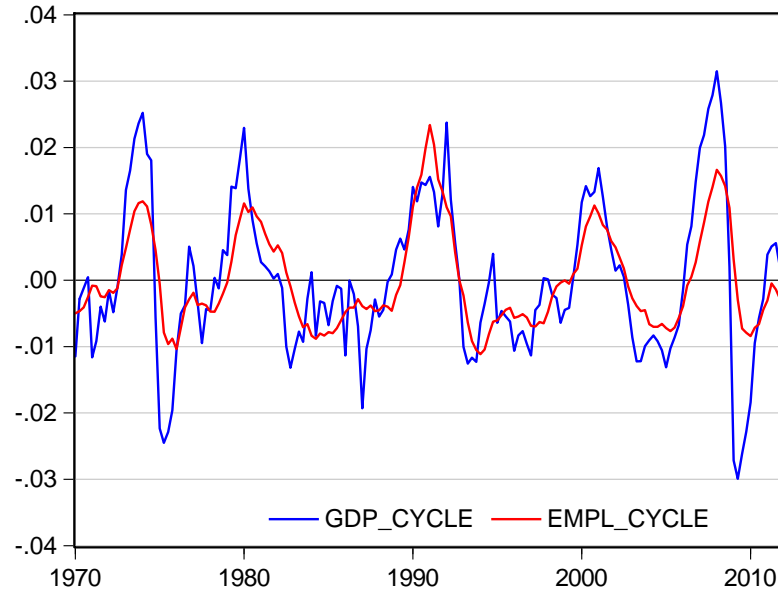**US: Cyclical components in GDP and Real wages**

**Euro Area: Cyclical components in GDP and Consumption (HP filter)**

**Euro Area: Cyclical components in GDP and Investment**

**Euro Area: Cyclical components in GDP and Employment**

Main business cycle "stylized facts" (USA 1947-2012)

- **comovements**:

    (a) the main components of aggregate demand are strongly *procyclical* (their cyclical components show a large contemporaneous correlation with the cyclical component of GDP): *consumption* (durable and non-durable goods), *investiment*

    (b) *employment* is strongly *procyclical*, as well as *labor productivity* (though less strongly)

    (c) *real wages* do *not* show a strong cyclical pattern

    (d) the *inflation rate* and output move mainly in the same direction *in the short run*

- **persistence:**

    high autocorrelation of the cyclical component of most aggregate series (around 0.8/0.9 at a one-quarter lag)

- **volatility:**

    (a) *consumption* of *non durables* is *less* volatile than GDP whereas consumption of *durables* is *more*

    (b) *investment* is much *more* volatile than output

    (c) volatility of *employment* is close to that of GDP

    (d) *real wages* show *lower* volatility than GDP

## Business cycle statistics:

## US 1947(1)-2012(1)

| | St. dev. (%) | Rel. st. dev. | Autoc(1). | Corr. with GDP |
|---|---|---|---|---|
| **GDP** | 1.69 | 1 | 0.84 | 1 |
| **Cons.** | 1.30 | 0.77 | 0.81 | 0.78 |
| dur. | 4.99 | 2.95 | 0.73 | 0.63 |
| non dur. | 1.16 | 0.69 | 0.79 | 0.73 |
| **Invest.** | 8.29 | 4.91 | 0.79 | 0.85 |
| **Empl.** | 1.46 | 0.86 | 0.91 | 0.82 |
| **Lab. prod.** | 1.08 | 0.64 | 0.69 | 0.43 |
| **Real wage** | 0.96 | 0.57 | 0.65 | 0.15 |

**Note:** The table shows descriptive statistics for the *cyclical* components of the listed series obtained from the application of the Hodrick-Prescott filter to quarterly data (after taking logarithms). The first column shows the standard deviation of the cyclical components is expressed in percentage points; in the second column the standard deviations are reported relative to the st. dev. of GDP. The first-order autocorrelation coefficient is shown in the third column. The last column reports the contemporaneous (i.e. within the same quarter) correlation coefficients of each series with GDP.

## Euro Area 1970(1)-2012(1)

| | St. dev. (%) | Rel. st. dev. | Autoc(1). | Corr. with GDP |
|---|---|---|---|---|
| **GDP** | 1.17 | 1 | 0.87 | 1 |
| **Cons.** | 0.82 | 0.70 | 0.83 | 0.79 |
| **Invest.** | 2.92 | 2.50 | 0.88 | 0.92 |
| **Empl.** | 0.74 | 0.63 | 0.95 | 0.78 |

**Note:** See Note for the US