CHAPTER 1

INTRODUCTION

TO MACROECONOMIC THEORY

Objectives of the chapter

- To describe the key variables used to build macroeconomic models
- To analyze the key empirical facts concerning business cycles
  - Theoretical results vs. observed data

PART 1

INTRODUCTION

What is Macroeconomics

- Macroeconomics vs. Microeconomics
  - Analysis of the choices concerning the society as a whole
    - Analysis of the structure and the evolution of national economies
    - Analysis of the effects of economic policies
- Main objectives of the Macroeconomic Theory

1) Definition of the aggregates that characterize national economies
   - Production
   - Consumption, savings and investment
   - Employment and unemployment
   - Money, prices and inflation
   - Foreign trade
2) Analysis of the relationships between the economic aggregates
3) Analysis of the major imbalances concerning the economic aggregates
   - Inflation, unemployment, public deficit, deficit of the trade balance
4) Analysis of the economic policies to correct these imbalances and thus to achieve certain objectives

Economic models

- Macroeconomic analysis is carried out using economic models
- An economic model is a simplified and formalized representation of the economic reality
  - Simplified representation of the economic reality
    - Assumptions that allow to simplify the analysis
    - An economic model focuses only on some aspects of the economic reality
  - Formalized representation of the economic reality
    - System of equations describing the relationships between the economic aggregates
    - Can be solved analytically and/or graphically

GDP, economic growth and business cycles

- GDP: indicator of the economic situation of a country
- Rate of change of GDP: indicator of the economic growth of a country
- GDP measures

1) The value of output produced in the economy during a year
   - Value added created by all firms
   - Value of all final goods produced
     → Intermediate goods are not included in GDP
     → Inventory investment is included in GDP
2) The total income received by the economic agents during a year
   - Compensation of employees, profits, interests, taxes less subsidies on production, capital depreciation, ...
3) The total expenditure for the acquisition of goods and services produced in the economy during a year

$$GDP = C + I + G + NX$$

   - Income-expenditure identity

- For an economy that produces N different types of goods and services

$$\text{Nominal GDP} = \sum_{i=1}^{N} P_t^i \cdot Y_t^i$$

$$\text{Real GDP} = \sum_{i=1}^{N} P_{t_0}^i \cdot Y_t^i$$

$$\text{Implicit GDP deflator} = \text{Nominal GDP} \;/\; \text{Real GDP}$$

$$\text{CPI} = \frac{\sum_{i=1}^{N} P_t^i \cdot C_{t_0}^i}{\sum_{i=1}^{N} P_{t_0}^i \cdot C_{t_0}^i}$$

$$\text{Per capita real GDP} = \text{Real GDP} \;/\; \text{Total population}$$

- Per capita real GDP adjusts for inflation and population growth

Computation of real GDP using the chain-weighted method

	Y_1	P_1	Y_2	P_2
t	100	1.00	10	1.00
$t+1$	105	1.05	12	0.95
$t+2$	110	1.20	18	0.90

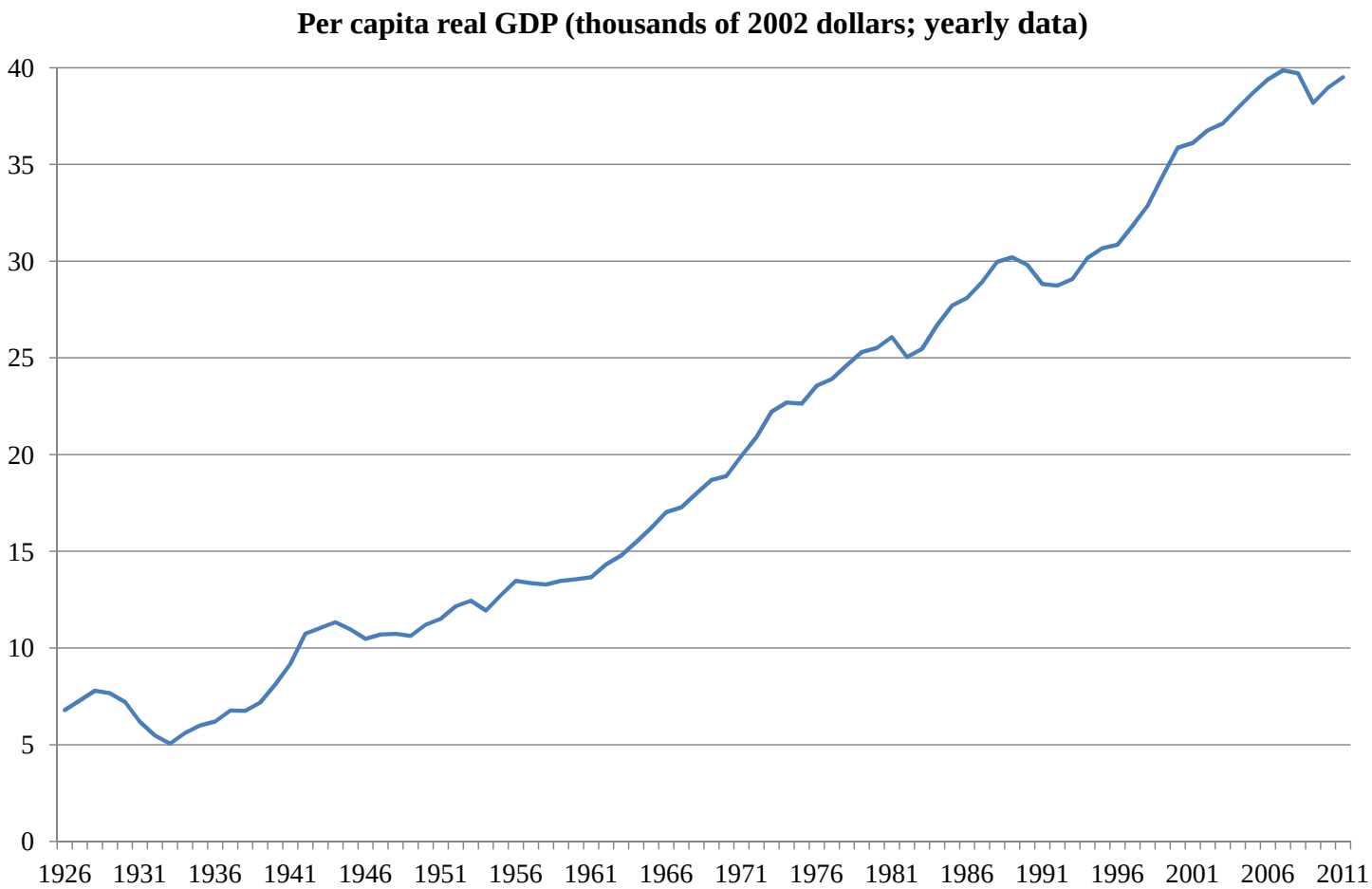
	Nominal GDP	Real GDP (t)	Real GDP $(t+1)$	Real GDP $(t+2)$
t	110.00	110.00	114.50	129.00
$t+1$	121.65	117.00	121.65	136.80
$t+2$	148.20	128.00	132.60	148.20

	Real GDP (t)	Real GDP $(t+1)$	Real GDP $(t+2)$
$t+1/t$	1.064	1.062	1.060
$t+2/t+1$	1.094	1.090	1.083

	average ratio	Real GDP
t		110.00
$t+1$	1.063	116.93
$t+2$	1.087	127.07

$1.063 = (1.064 \cdot 1.062)^{0.5}$ and $1.087 = (1.090 \cdot 1.083)^{0.5}$

$116.93 = 110 \cdot 1.063$ and $127.07 = 116.93 \cdot 1.087$


Per capita real GDP (thousands of 2002 dollars; yearly data)
40
35
30
25
20
15
10
5
0
1926
1931
1936
1941
1946
1951
1956
1961
1966
1971
1976
1981
1986
1991
1996
2001
2006
2011

- Some observations
  - Sustained growth (1926-2011): +482.5%
  - The growth is not steady

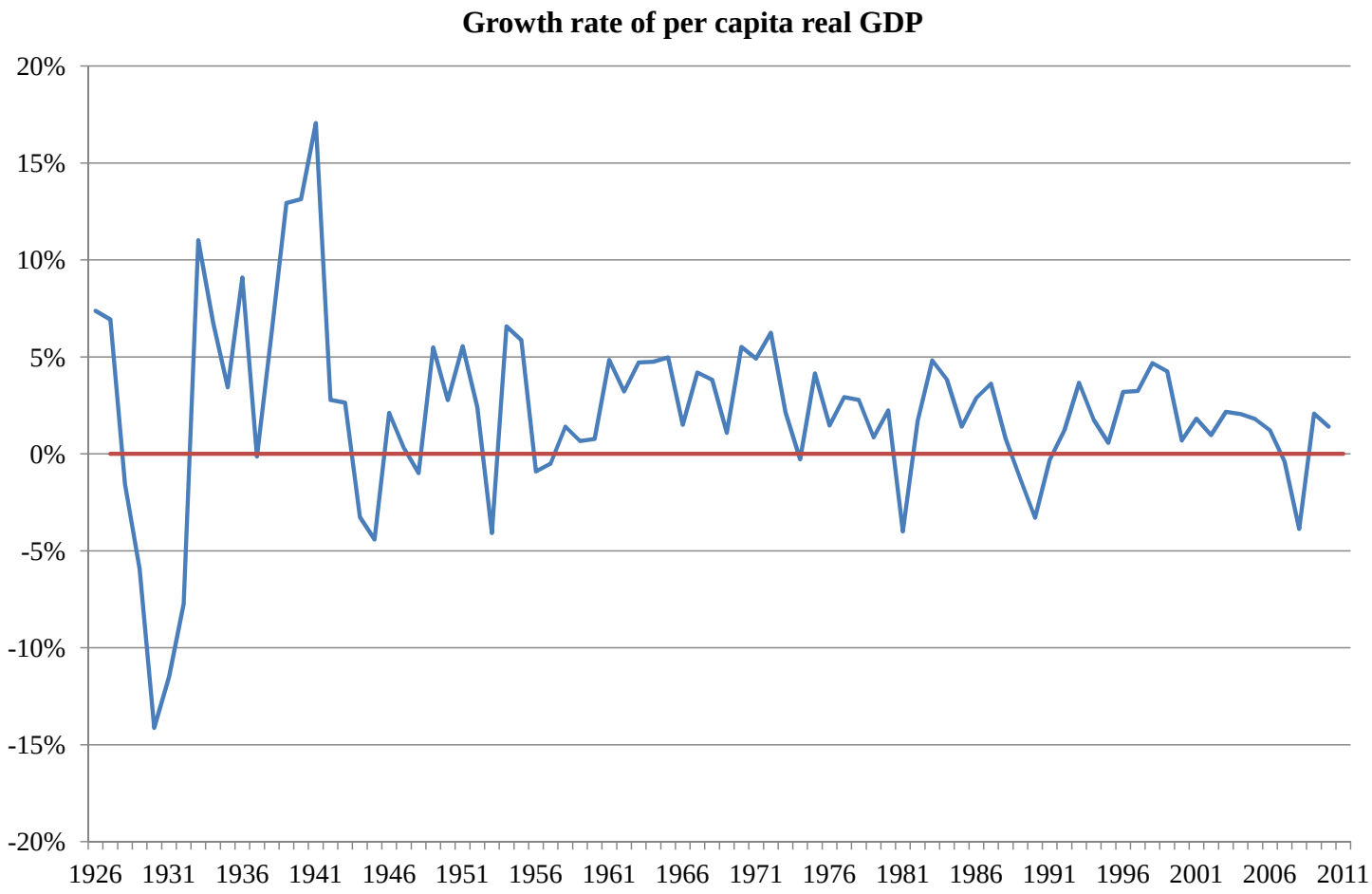
    $\rightarrow$ Important economic fluctuations
    - During the Great Depression (1928-1933): -35.1%
    - During the 2^{nd} World War (1933-1944): +124.1%
    - Other recessions: 1981-1982, 1990-1992, 2008-2009 (-4.3%)

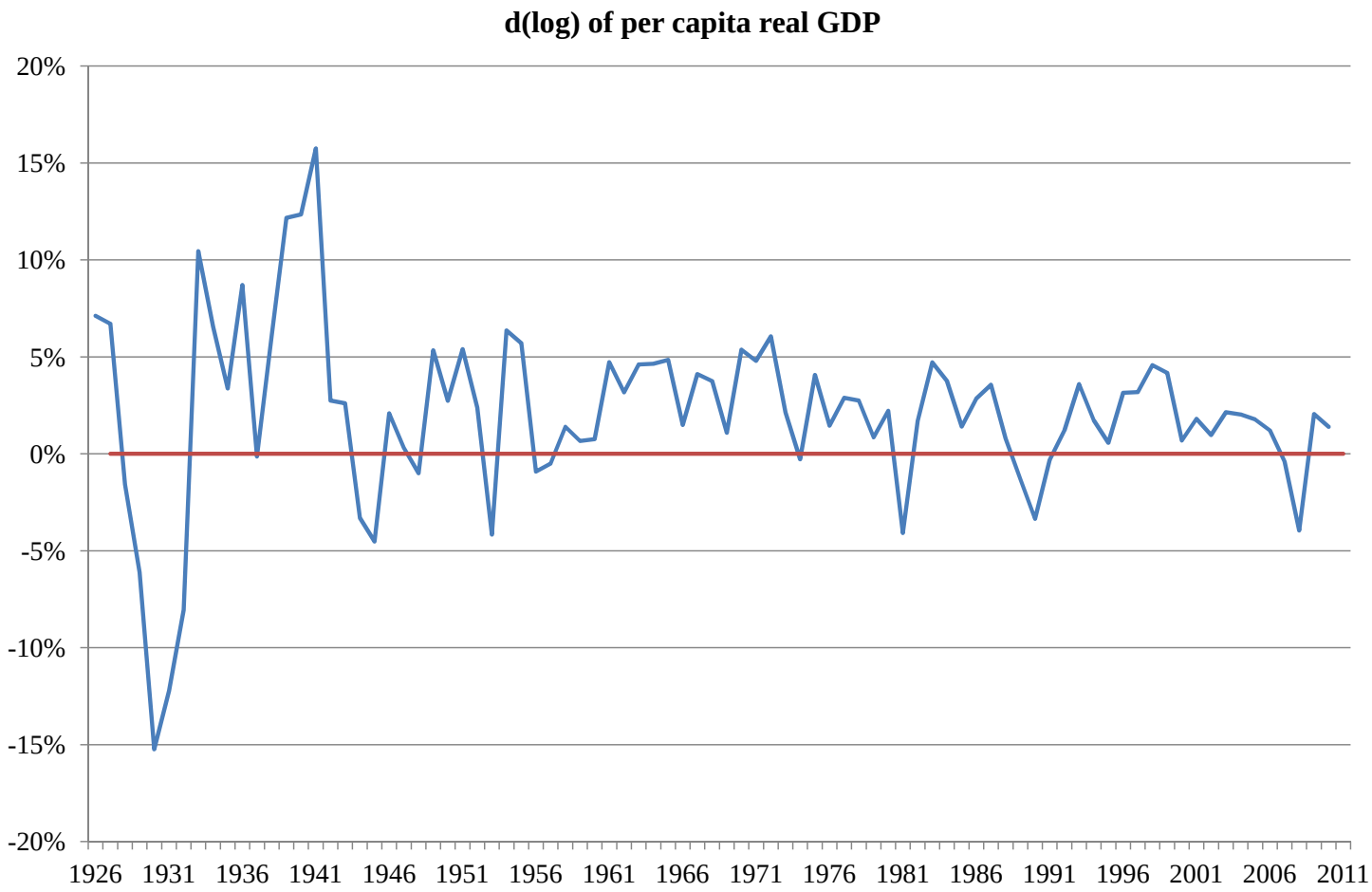
- Growth rate of a (discrete-time) variable x

$$g_{x_t} = \frac{x_t}{x_{t-1}} - 1$$

- Approximation of the growth rate

$$g_t \simeq \ln x_t - \ln x_{t-1} \quad \text{with} \quad g_t \to 0$$


Growth rate of per capita real GDP
20%
15%
10%
5%
0%
-5%
-10%
-15%
-20%
1926
1931
1936
1941
1946
1951
1956
1961
1966
1971
1976
1981
1986
1991
1996
2001
2006
2011

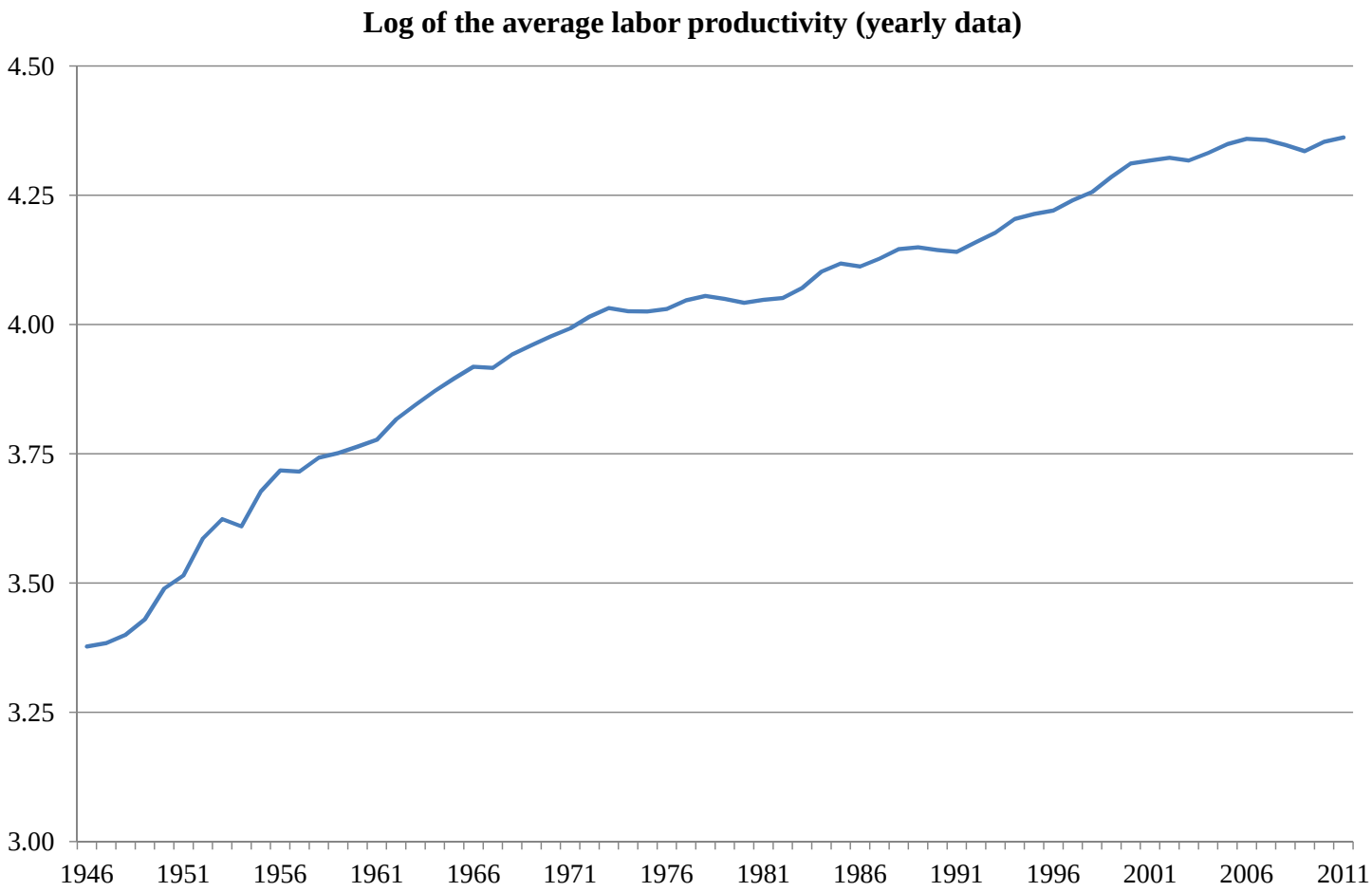

d(log) of per capita real GDP
20%
15%
10%
5%
0%
-5%
-10%
-15%
-20%
1926
1931
1936
1941
1946
1951
1956
1961
1966
1971
1976
1981
1986
1991
1996
2001
2006
2011

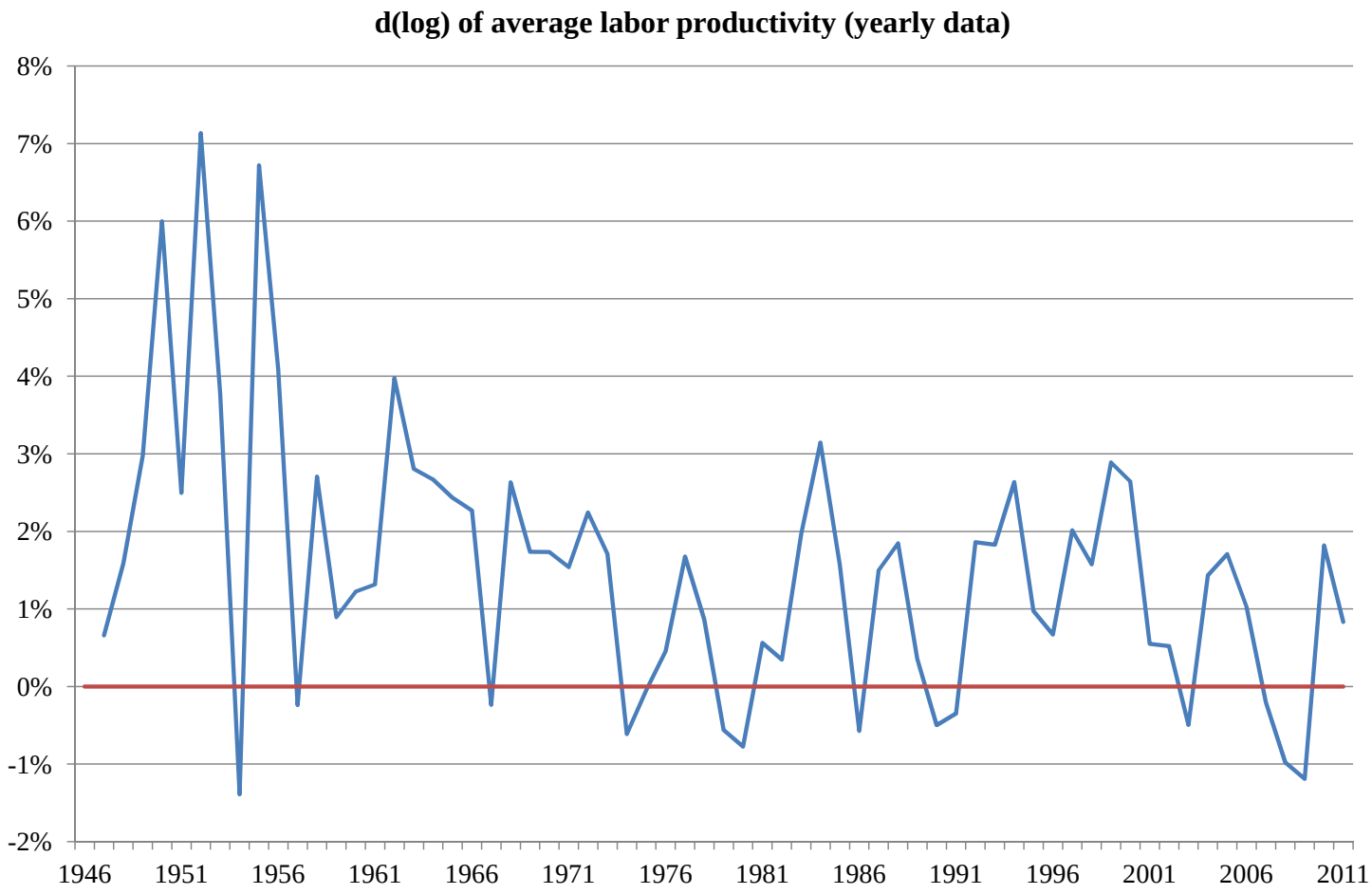
Productivity

- Average labor productivity (or real GDP per worker)

$$\frac{Y}{N} \qquad Y = \text{real GDP}, \quad N = \text{employment}$$

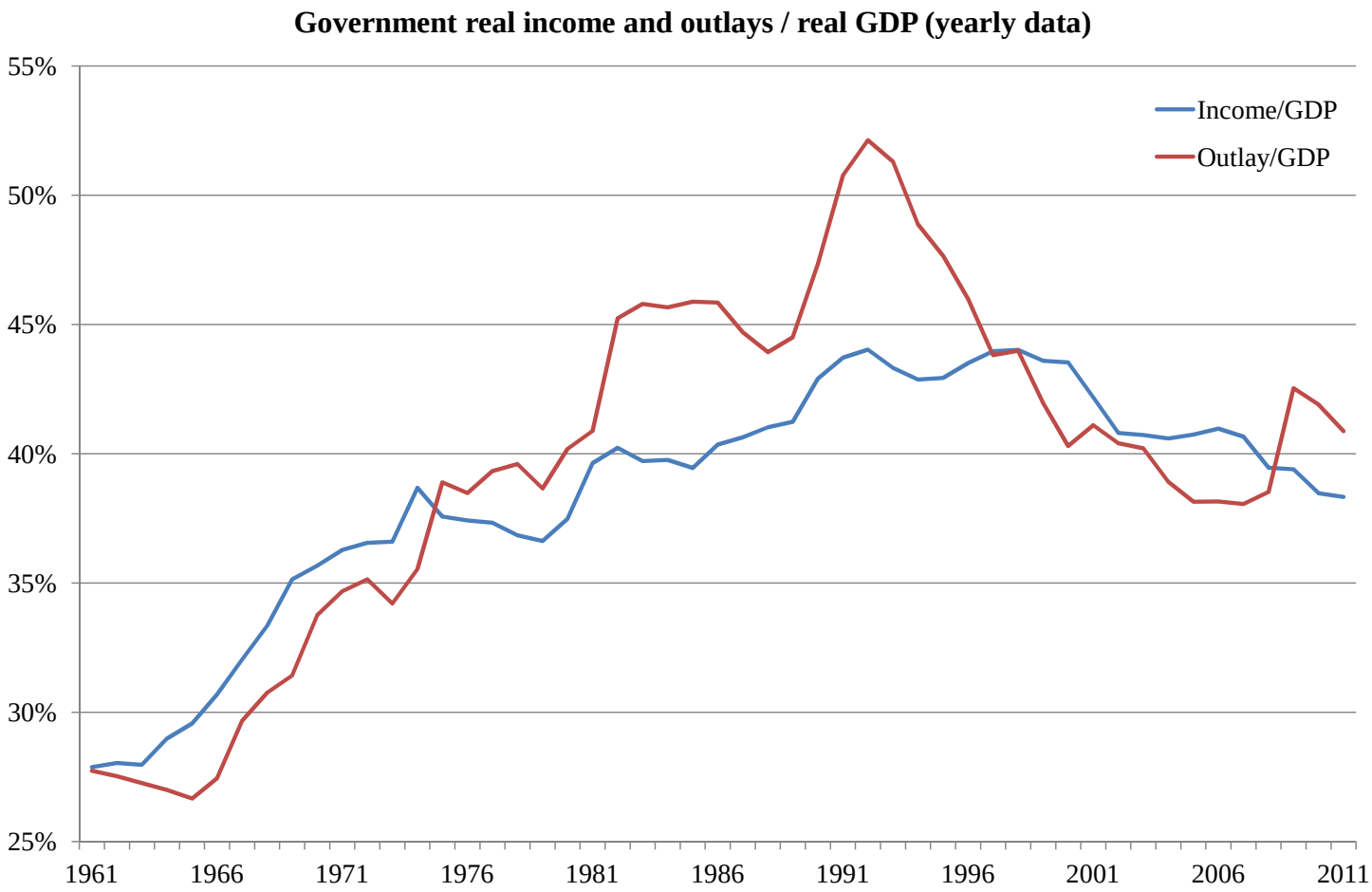
- In growth theory:
  - The growth of productivity is the most important element affecting the growth in living standards in the long run
- In business cycle theory:
  - The change in productivity is one of the most important elements affecting short-run fluctuations

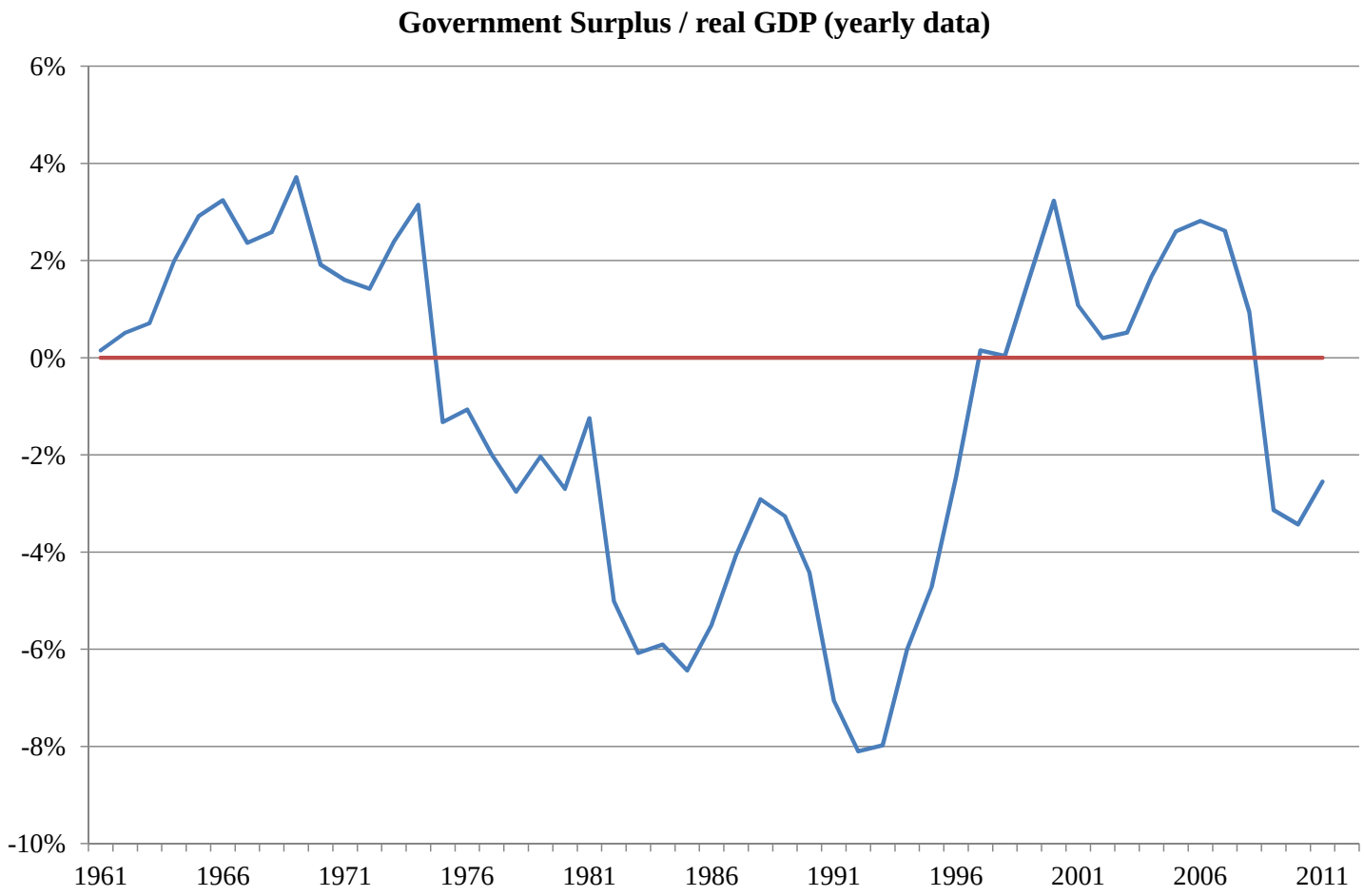

Log of the average labor productivity (yearly data)
4.50
4.25
4.00
3.75
3.50
3.25
3.00
1946
1951
1956
1961
1966
1971
1976
1981
1986
1991
1996
2001
2006
2011


d(log) of average labor productivity (yearly data)
8%
7%
6%
5%
4%
3%
2%
1%
0%
-1%
-2%
1946
1951
1956
1961
1966
1971
1976
1981
1986
1991
1996
2001
2006
2011

Government (revenues, outlays and deficit)

- Government revenues: Direct and indirect taxes
- Government outlays: Expenditures on goods and services, transfers, interest on public debt
- Government savings
  - S_G = Government revenues - Government outlays
  - If $S_G < 0 \quad \rightarrow \quad$ Public deficit
- Government debt
  - $B_{t+1} = B_t$ - S_G


Government real income and outlays / real GDP (yearly data)
55%
50%
45%
40%
35%
30%
25%
1961
1966
1971
1976
1981
1986
1991
1996
2001
2006
2011
Income/GDP
Outlay/GDP


Government Surplus / real GDP (yearly data)
6%
4%
2%
0%
-2%
-4%
-6%
-8%
-10%
1961
1966
1971
1976
1981
1986
1991
1996
2001
2006
2011

Unemployment

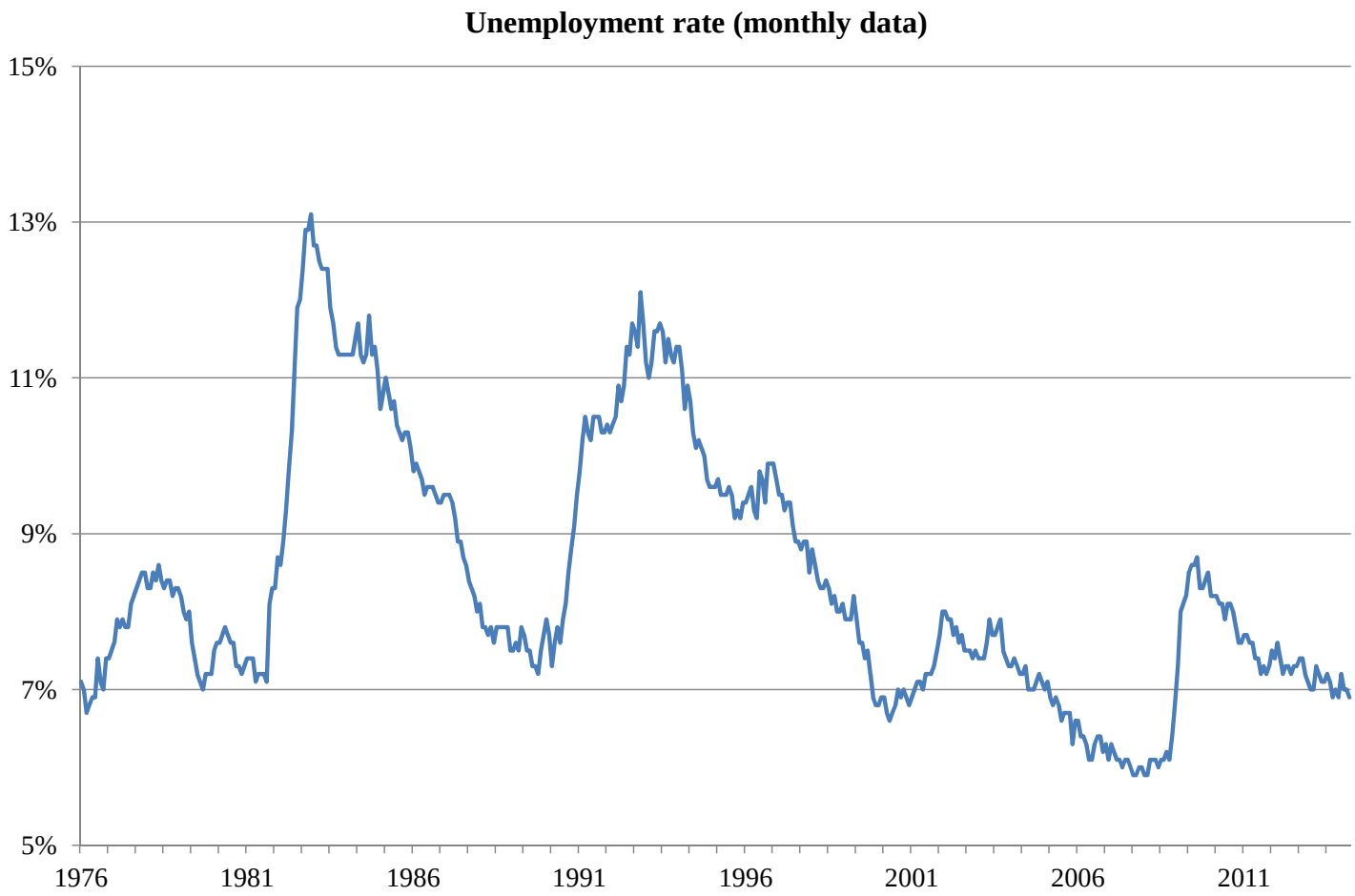
- Definitions of the Statistics Canada (monthly survey)
  - Employed: A person who worked part-time or full-time during the last week before the survey
  - Unemployed: A person who was not employed during the last week before the survey and searches for a job during the last four weeks
  - Not in the labor force: A person who is neither employed or unemployed

$$\text{Labor force} = N_{\text{employed}} + N_{\text{unemployed}}$$

$$\text{Unemployment rate} = \frac{N_{\text{unemployed}}}{\text{Labor force}}$$

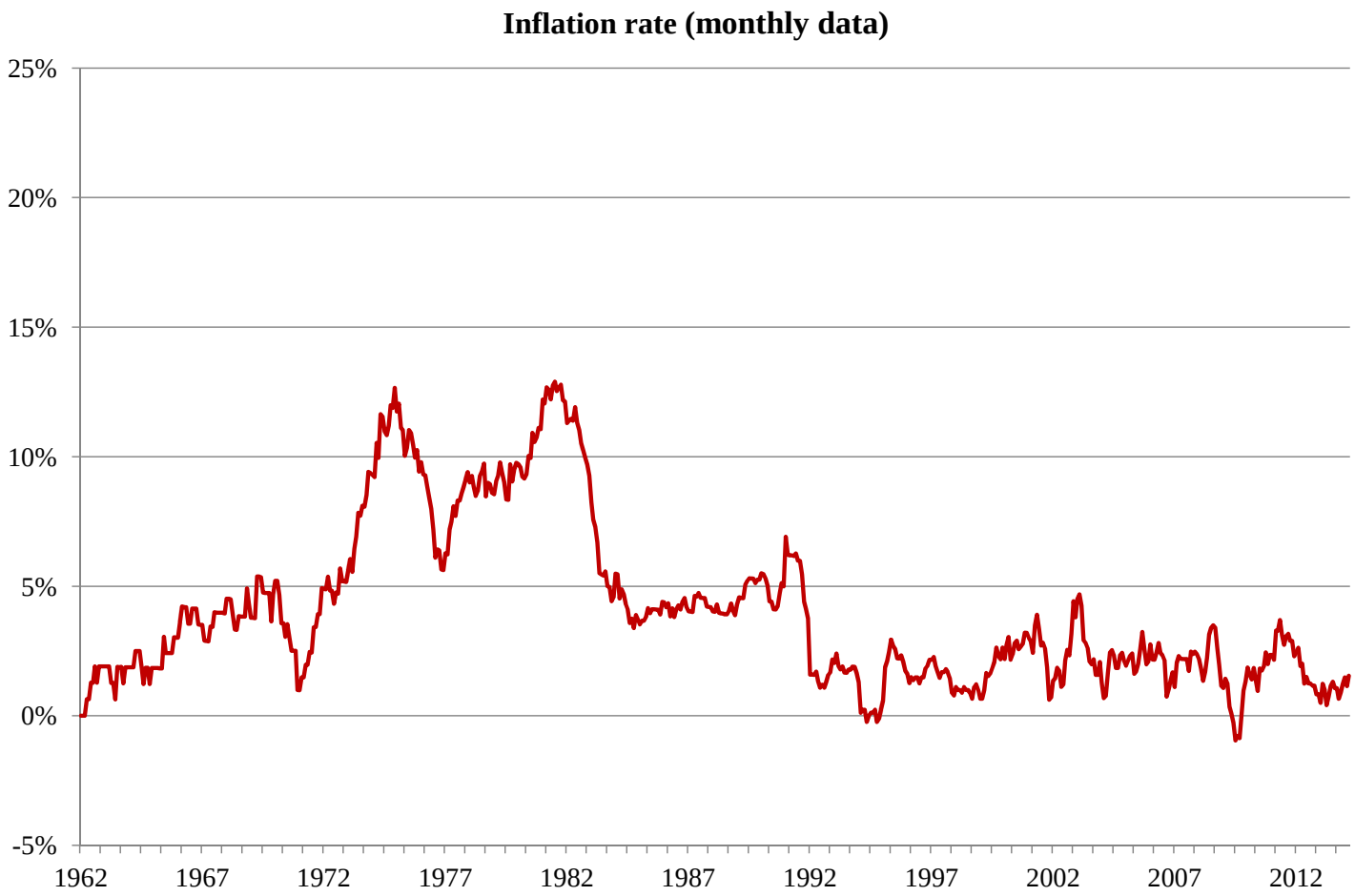
$$\text{Participation rate} = \frac{\text{Labor force}}{\text{Pop}_{15-64}}$$

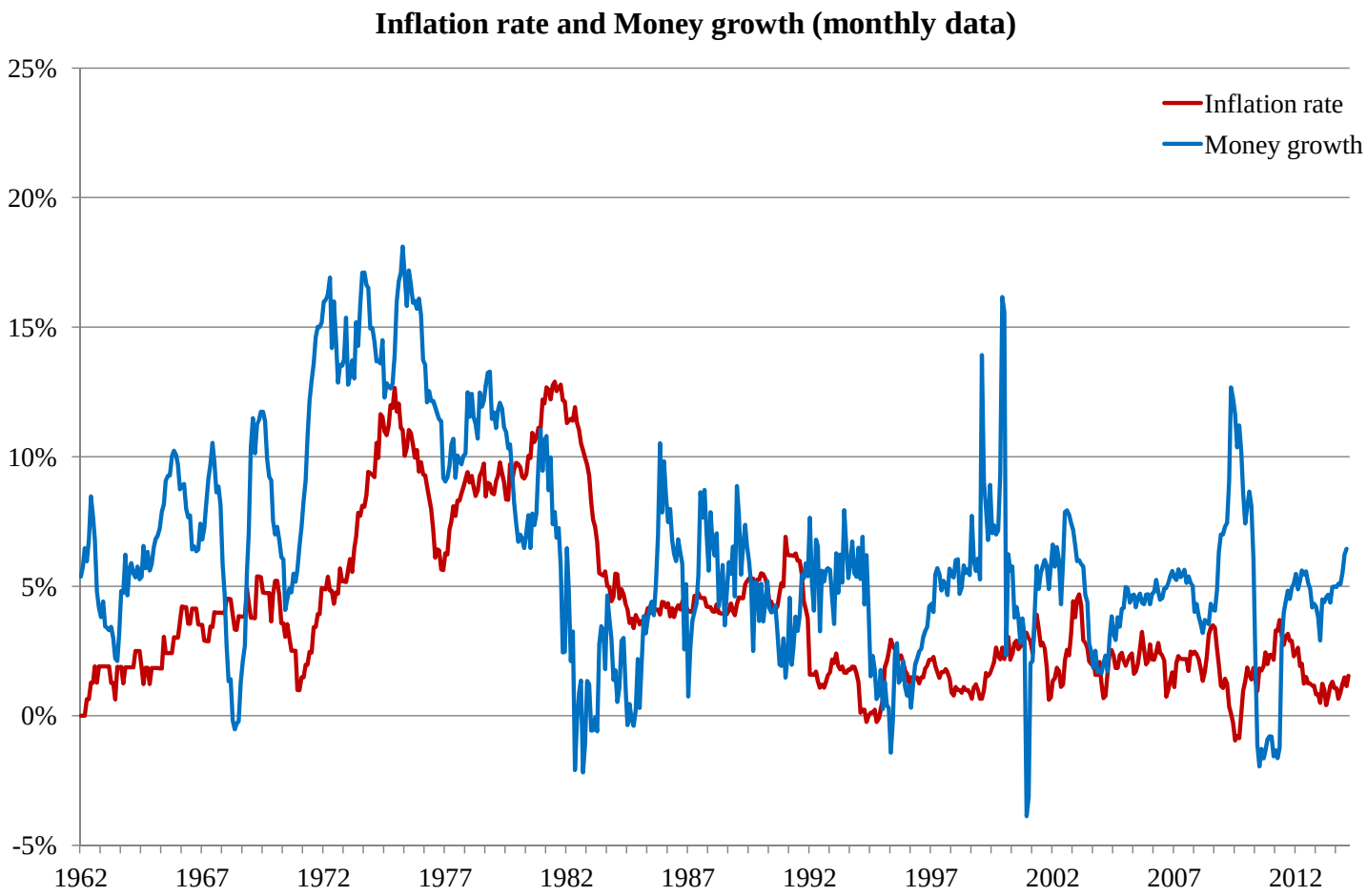
$$\text{Employment rate} = \frac{N_{\text{employed}}}{\text{Pop}_{15-64}}$$


Unemployment rate (monthly data)
15%
13%
11%
9%
7%
5%
1976
1981
1986
1991
1996
2001
2006
2011

Inflation

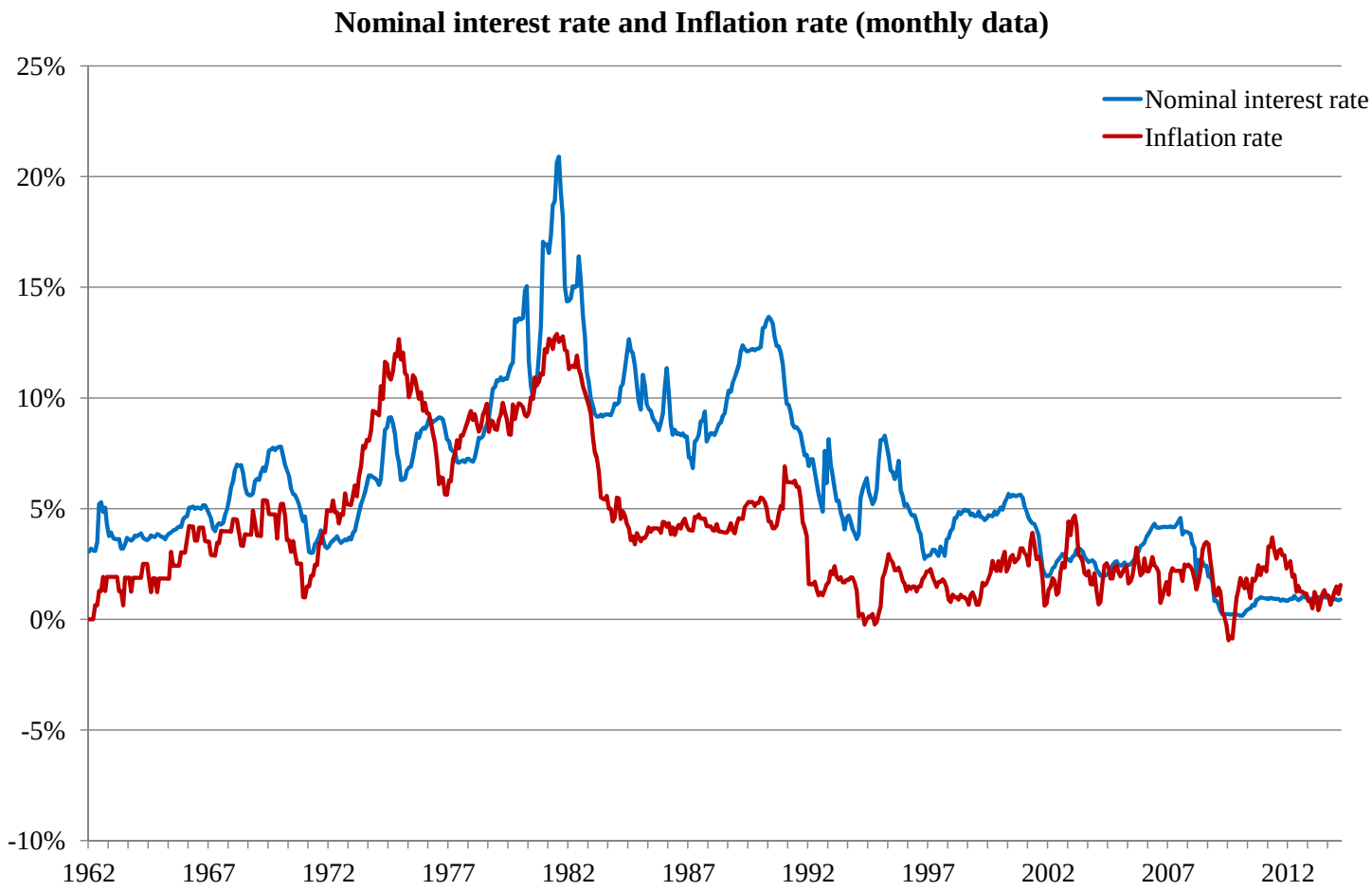
- Inflation rate: Rate of change of the general price level
  - Computed starting from the implicit GDP deflator or the CPI
- In the long run, inflation is explained by the rate of growth of money supply
  - Money neutrality
  - Quantity Theory of Money (with constant velocity of money, the money supply growth rate determines the inflation rate)
- In the short run, inflation is explained by other factors
  - Business cycles
  - Price of oil and raw materials
  - Exchange rates

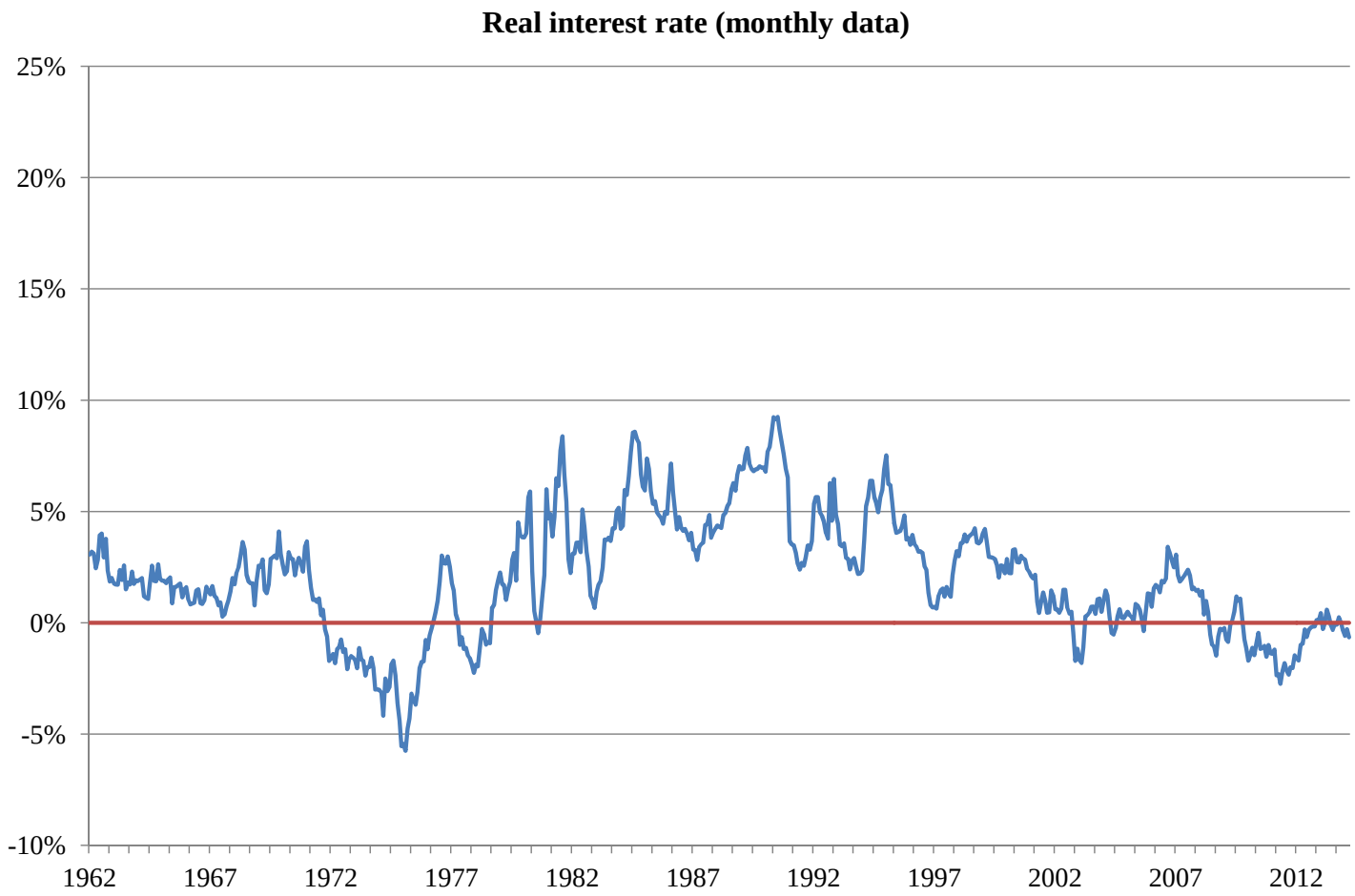

Inflation rate (monthly data)
25%
20%
15%
10%
5%
0%
-5%
1962
1967
1972
1977
1982
1987
1992
1997
2002
2007
2012


Inflation rate and Money growth (monthly data)
25%
20%
15%
10%
5%
0%
-5%
1962
1967
1972
1977
1982
1987
1992
1997
2002
2007
2012
Inflation rate
Money growth

Interest rates

- Interest rates affect
  - The consumption/savings decisions of households
  - The investment decisions of firms
- The nominal interest rate is the rate applied to loans and deposits
  - It depends on the monetary policy
- The real interest rate is equal to the nominal interest rate minus the expected inflation rate
  - Economic decisions are based on the value of the real interest rate
  - It is determined in order to equilibrate the credit market


Nominal interest rate and Inflation rate (monthly data)
25%
20%
15%
10%
5%
0%
-5%
-10%
1962
1967
1972
1977
1982
1987
1992
1997
2002
2007
2012
Nominal interest rate
Inflation rate


Real interest rate (monthly data)
25%
20%
15%
10%
5%
0%
-5%
-10%
1962
1967
1972
1977
1982
1987
1992
1997
2002
2007
2012

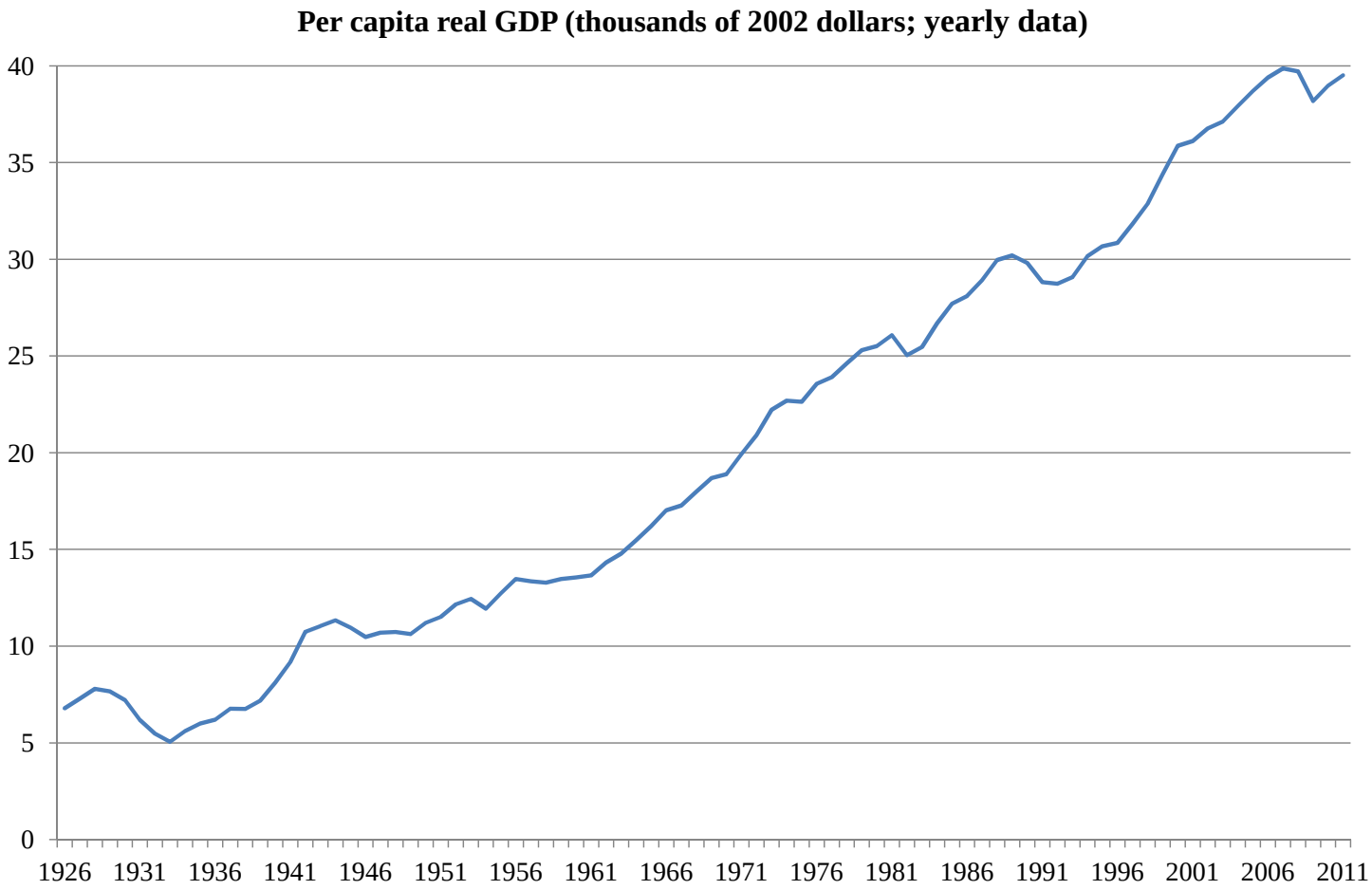
PART 2

BUSINESS CYCLE FACTS

- Any economic variable can be decomposed in two elements
  - The trend component

    $\rightarrow$ Long-term evolution of the variable
    - Hodrick-Prescott filter (non-linear approximation of the variable)
    - Analyzed in Growth theory
  - The cyclical component

    $\rightarrow$ Fluctuations from trend
    - Analyzed in Business Cycle theory


Per capita real GDP (thousands of 2002 dollars; yearly data)
40
35
30
25
20
15
10
5
0
1926
1931
1936
1941
1946
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1956
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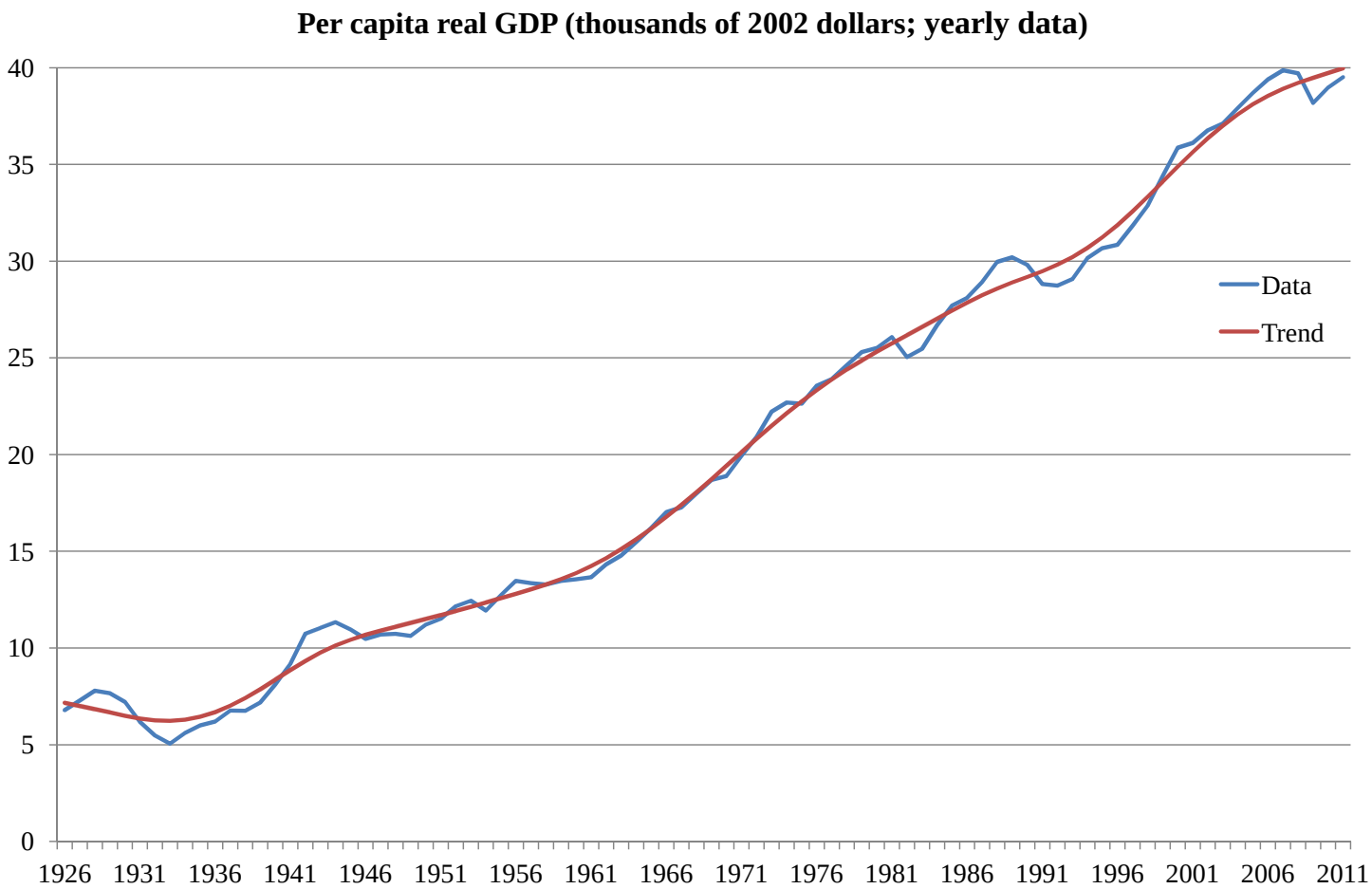
1996
2001
2006
2011


Per capita real GDP (thousands of 2002 dollars; yearly data)
40
35
30
25
20
15
10
5
0
1926
1931
1936
1941
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1961
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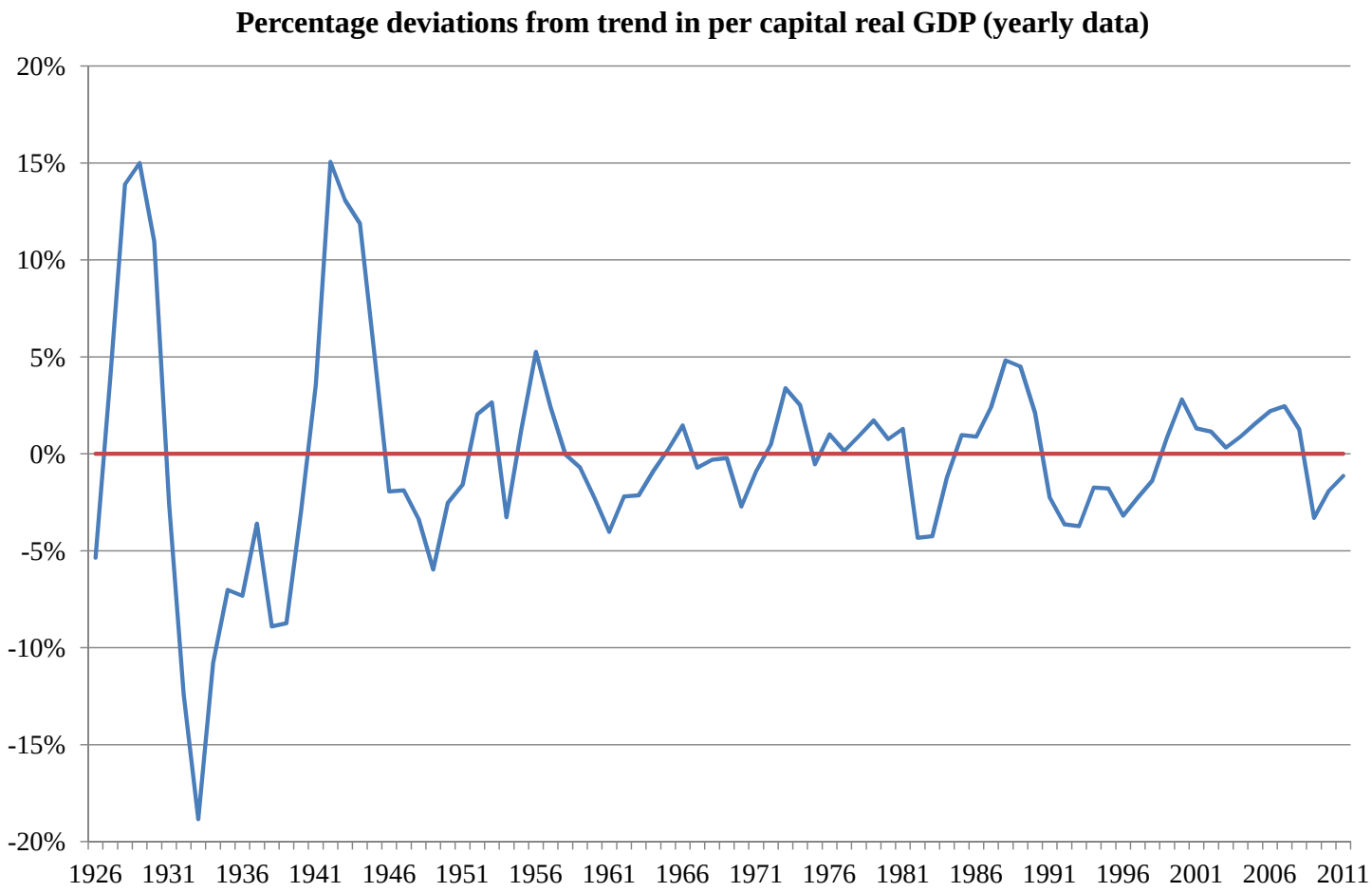
1996
2001
2006
2011
Data
Trend


Percentage deviations from trend in per capital real GDP (yearly data)
20%
15%
10%
5%
0%
-5%
-10%
-15%
-20%
1926
1931
1936
1941
1946
1951
1956
1961
1966
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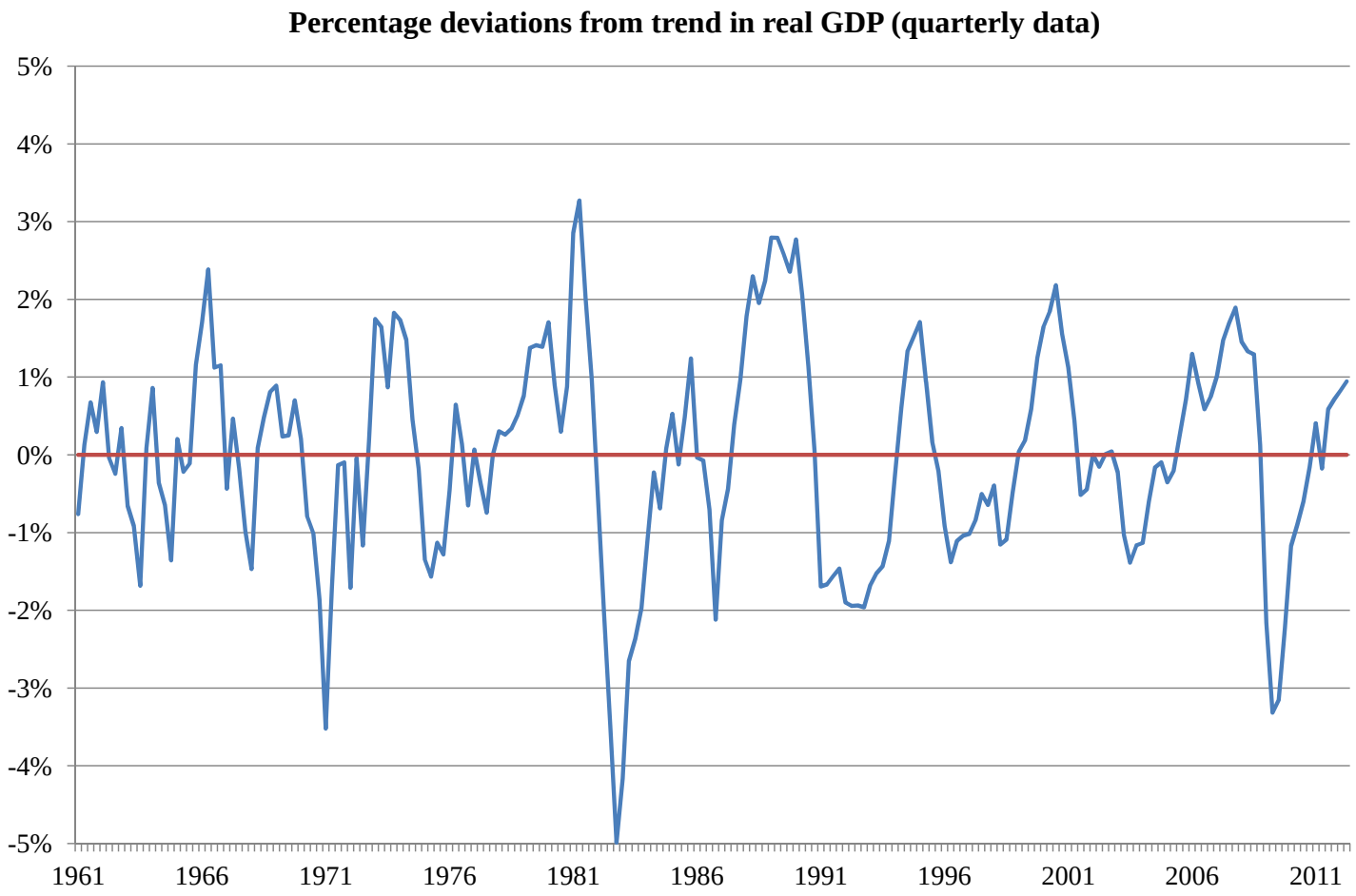
2006
2011


Percentage deviations from trend in real GDP (quarterly data)
5%
4%
3%
2%
1%
0%
-1%
-2%
-3%
-4%
-5%
1961
1966
1971
1976
1981
1986
1991
1996
2001
2006
2011

- Some observations

  i) Several peaks and troughs in real GDP

  ii) The amplitudes of business cycles (maximum deviation from trend) are not regular

  iii) The frequencies of business cycles (length of time between peaks and troughs) are not regular

  iv) Deviations from trend are persistent
    - When real GDP is above trend it tends to stay above trend, and vice versa
    - The short-run economic forecasting is quite easy

  v) Business cycles are very irregular
    - Difficulty to make long-run forecasts
    - Difficulty to predict the timing of upturn or downturn of the business cycle

- Forecasting vs. Predictions
  - Forecasting
    - Based on statistical methods (VAR models, Christopher Sims, 1980) using past values of GDP and other relevant variables
    - Has little to do with the economic theory
  - Predictions
    - Economic models built on the basis of the macroeconomic theory
    - The macroeconomic model must be structural

      $\rightarrow$ Lucas critique: Reduced-form econometric models lead to wrong evaluations of economic policies

- The ability to forecast future events is not a test to judge the validity of the macroeconomic theory

- Business cycles are quite regular in terms of comovements

  $\rightarrow$ Macroeconomic variables move together in a highly predictable way

- Comovements can be analyzed (after removing trends):

  1) Statistically, by computing the correlation coefficient between:
  x (percentage deviations from trend in the variable X)
  y (percentage deviations from trend in real GDP)

$$\rho(x, y) = \frac{cov(x, y)}{\sigma_x \sigma_y}$$

  - $-1 \leq \rho \leq +1$
  - $\rho > 0$ Positive correlation $\rightarrow$ X is procyclical
  - $\rho < 0$ Negative correlation $\rightarrow$ X is countercyclical
  - $\rho = 0$ No correlation $\rightarrow$ X is acyclical
  - σ_x : standard deviation of the percentage deviations from trend; it measures the cyclical variability of X

  2) Graphically

  - Time series plot (time on the horizontal axis; x and y on the vertical axis)
  - Scatter plot (x on the vertical axis; y on the horizontal axis)

- X is a leading variable if the peaks and troughs of the variable x come before those of y (percentage deviations from trend in real GDP)

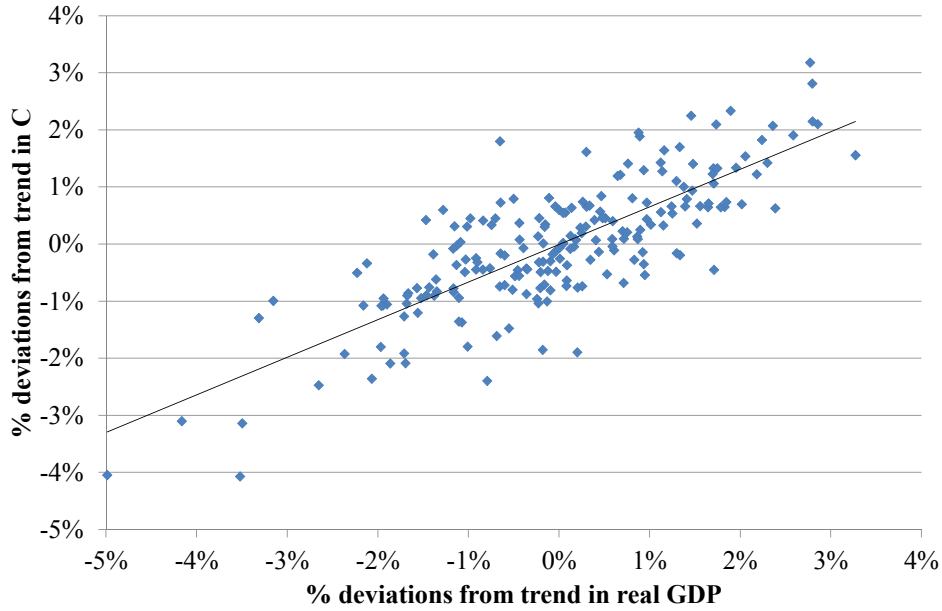
  $\rightarrow$ X can be used in forecasting real GDP

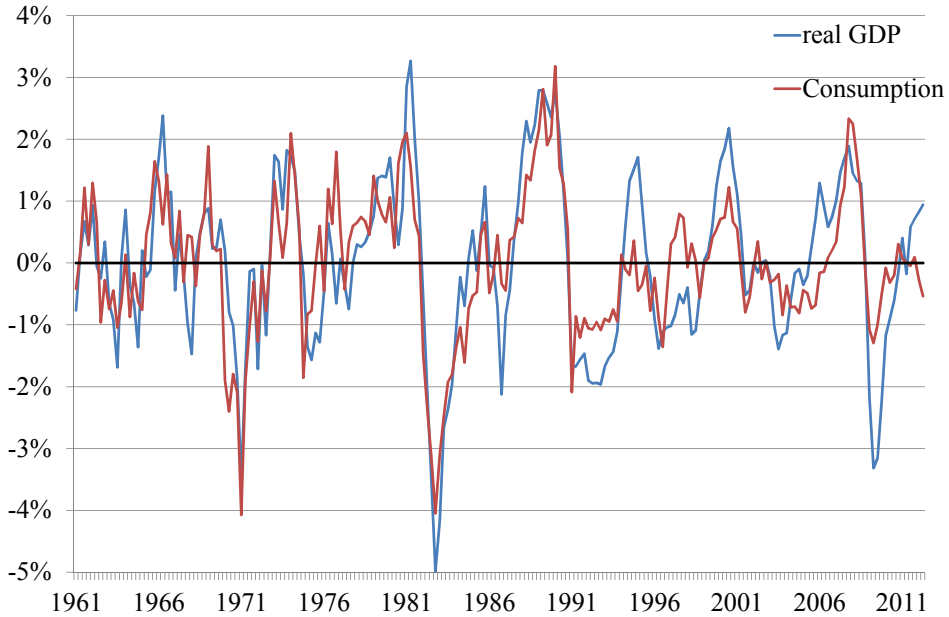
- X is a lagging variable if the peaks and troughs of the variable x come after those of y (percentage deviations from trend in real GDP)

  $\rightarrow$ Real GDP can be used in forecasting variable X

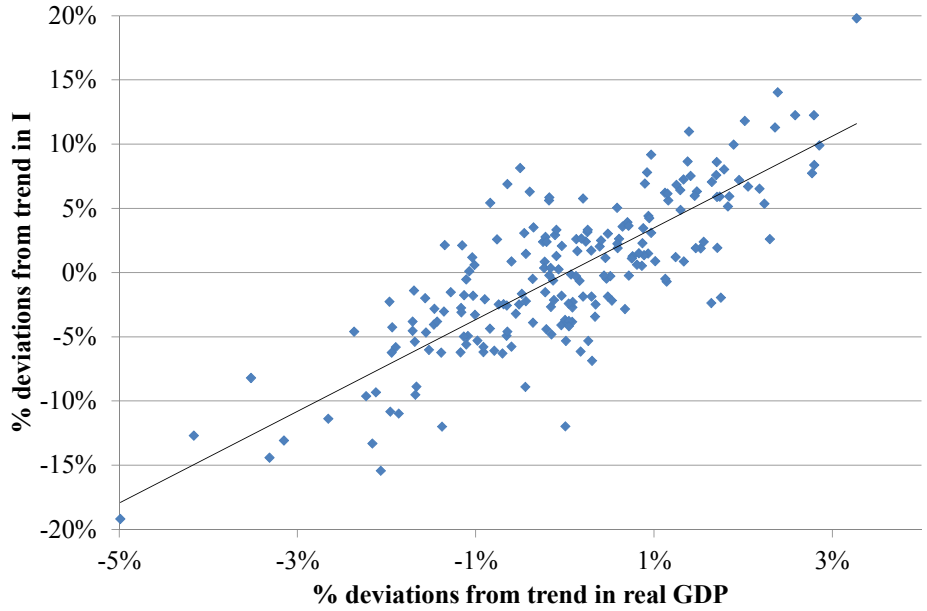
- X is a coincident variable if x neither leads nor lags y (percentage deviations from trend in real GDP)

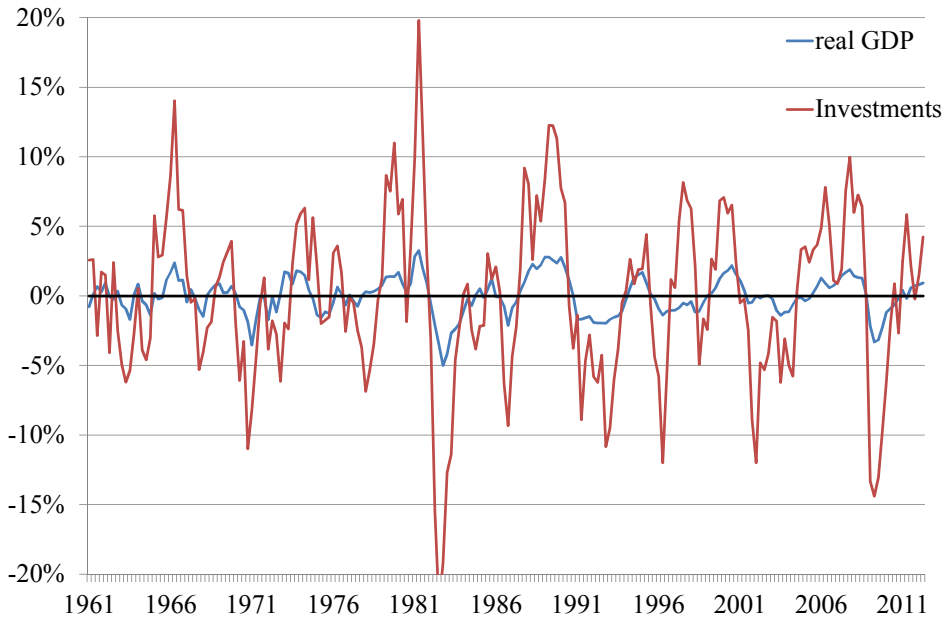
GDP and Consumption



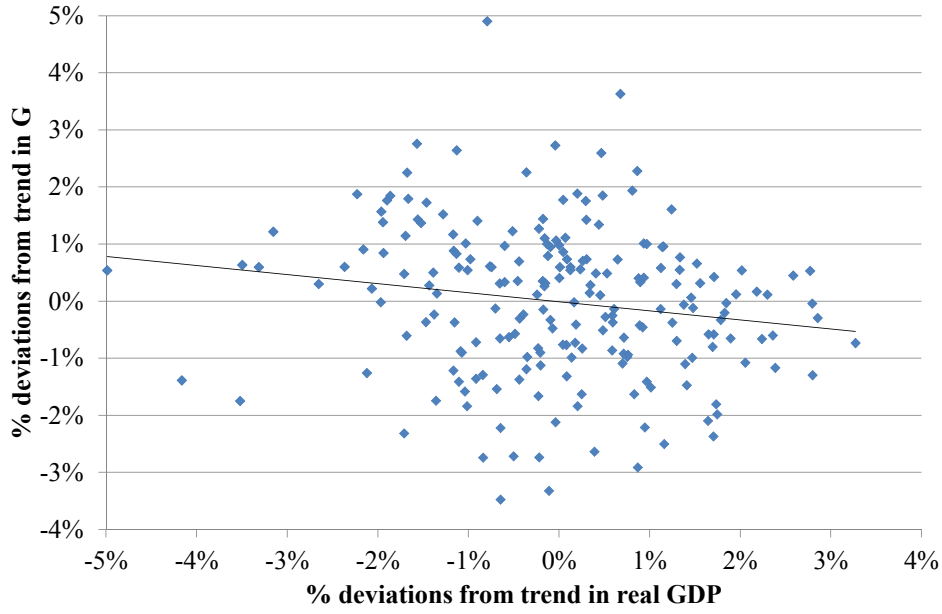


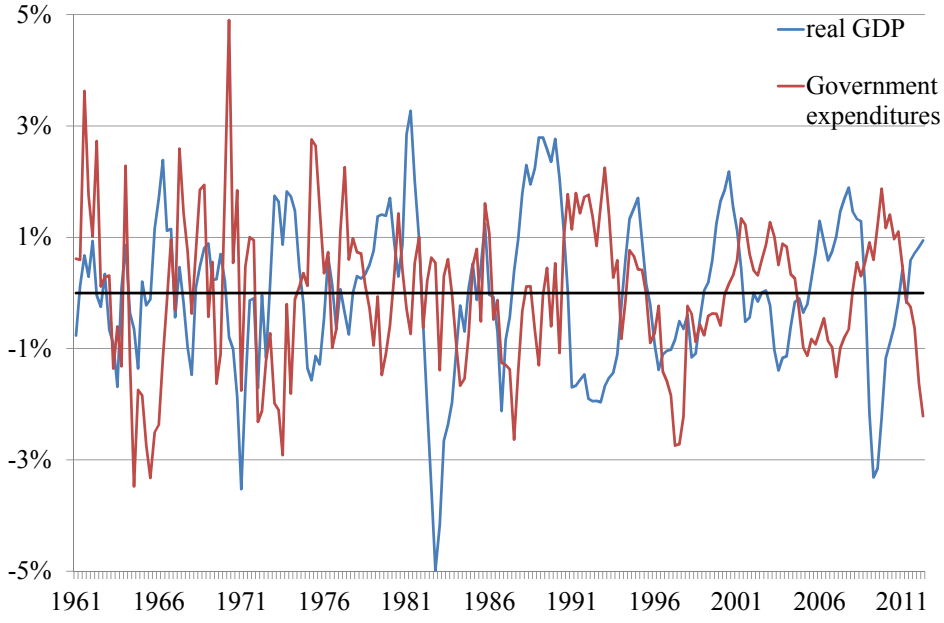
GDP and Investments



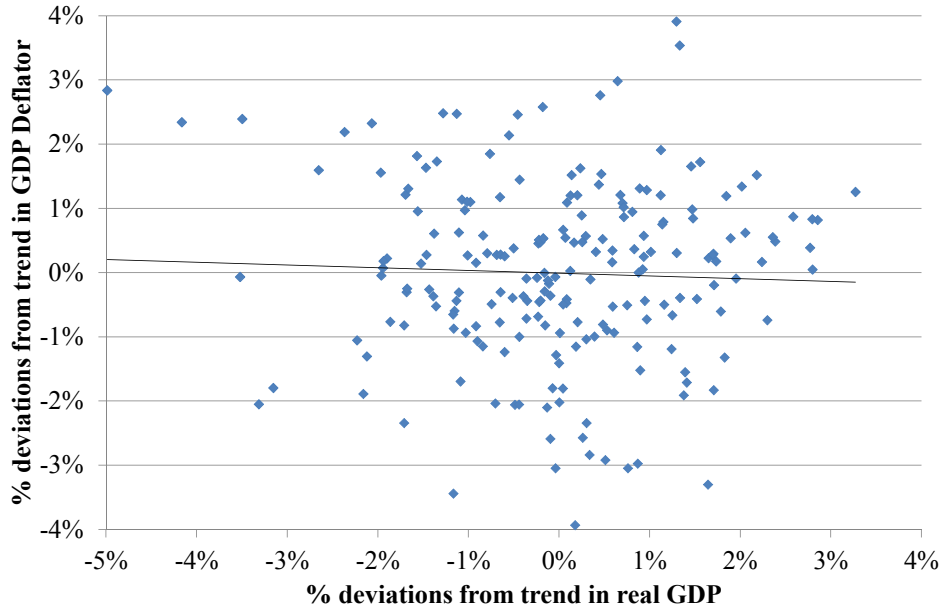


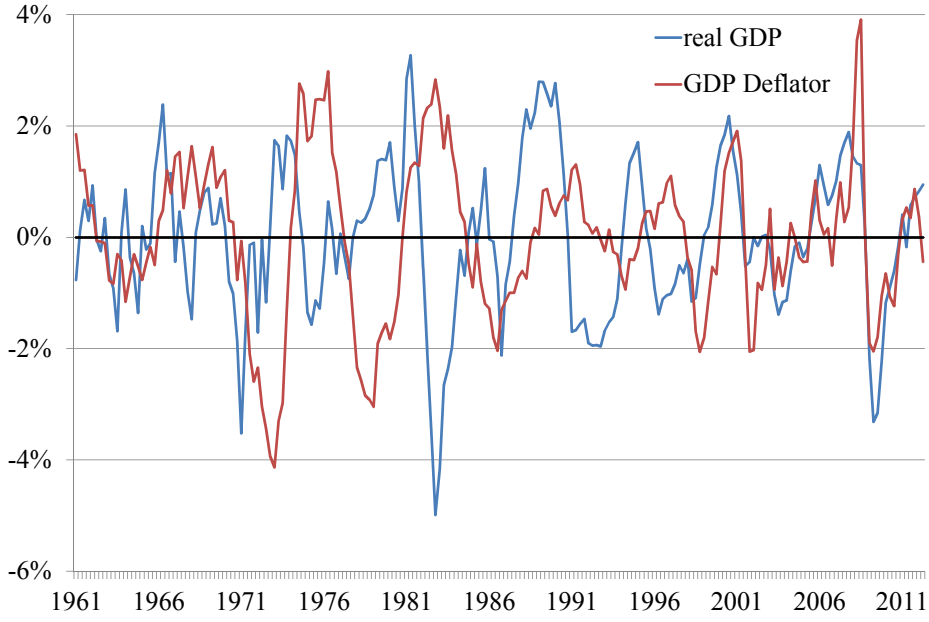
GDP and Government expenditures



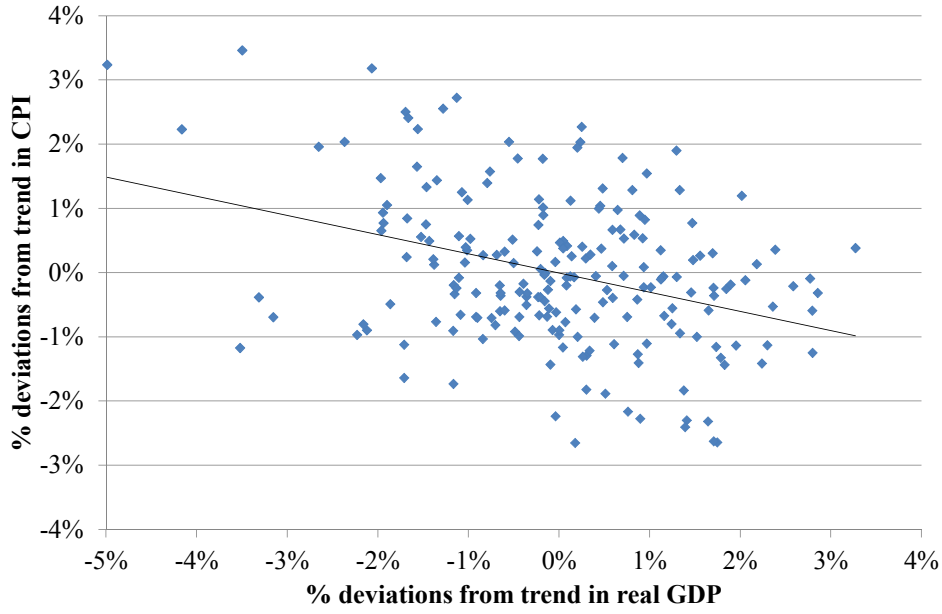


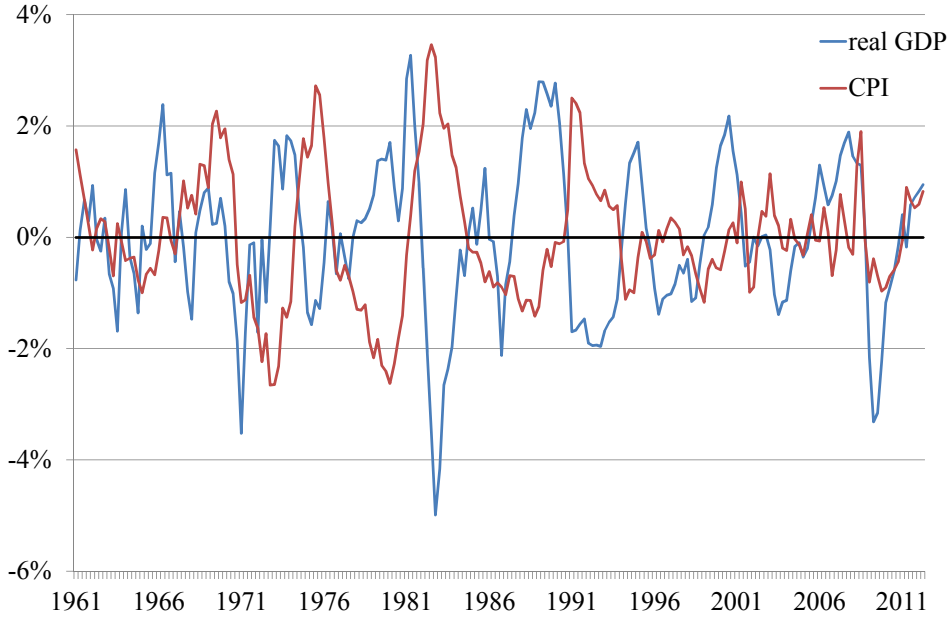
GDP and GDP deflator (Price level)



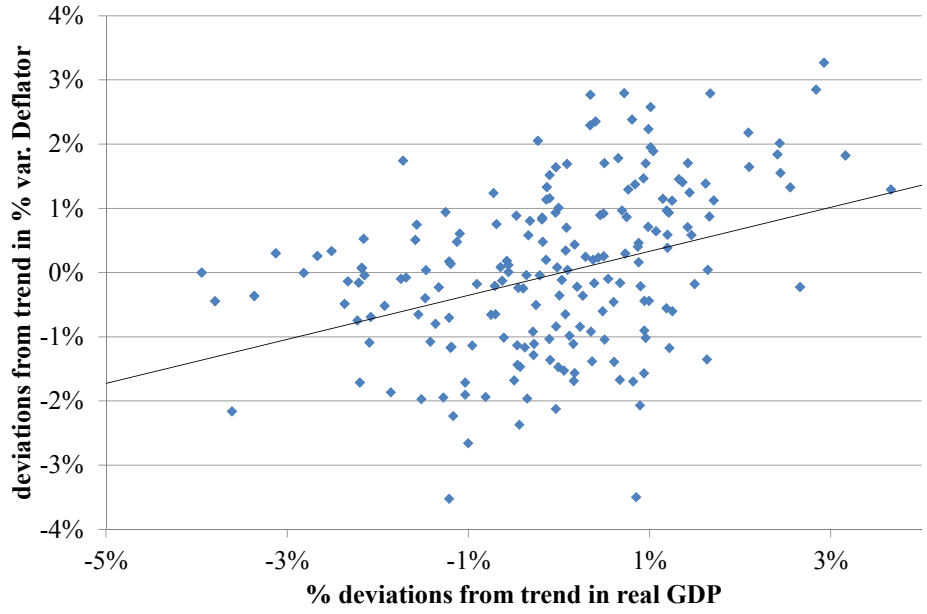


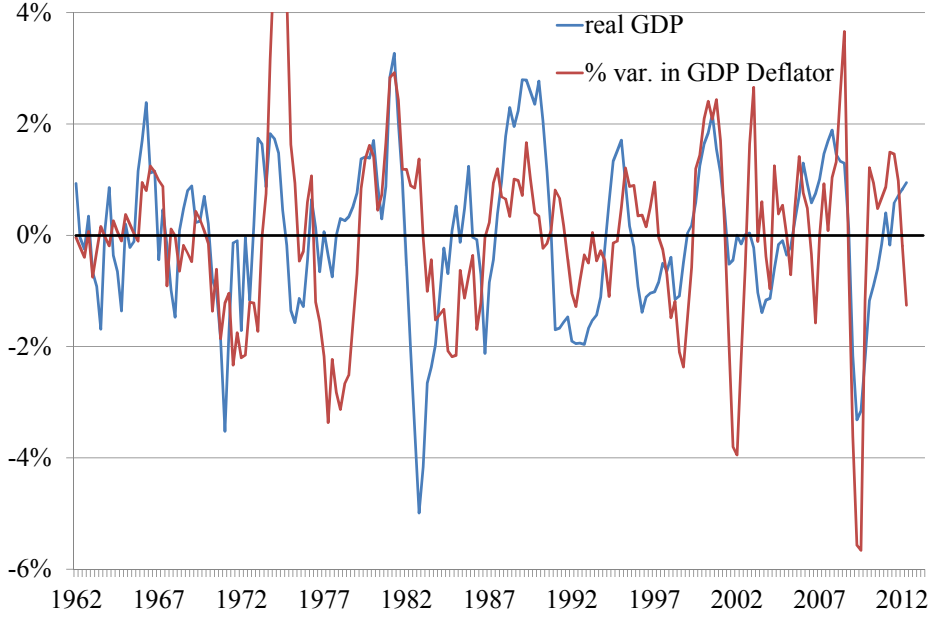
GDP and CPI (Price level)



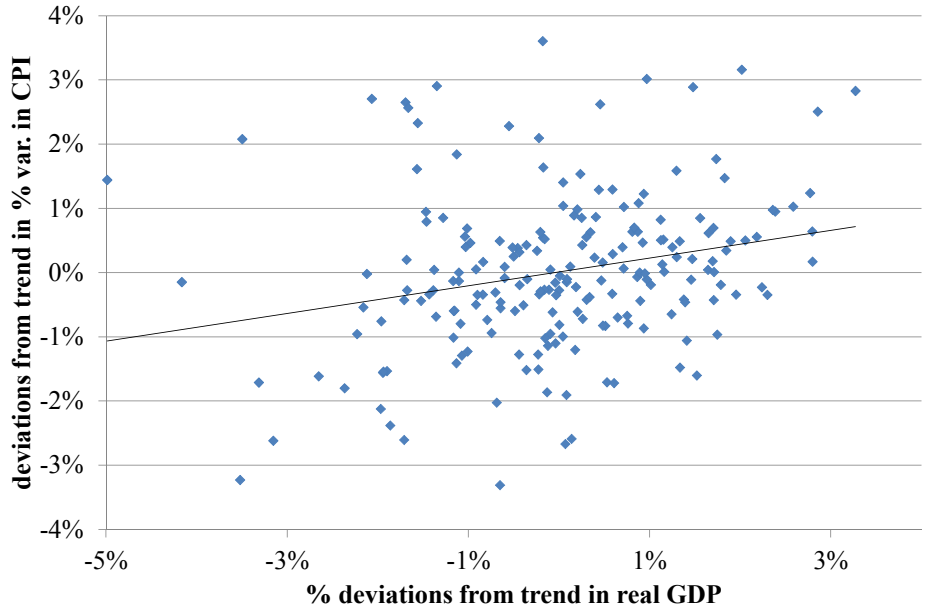


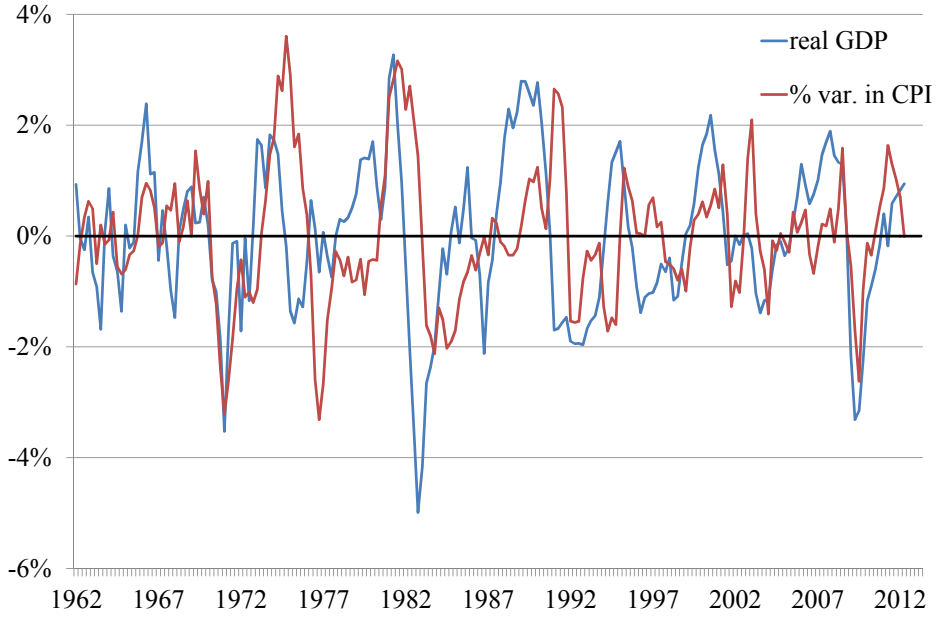
GDP and Growth rate of GDP deflator (Inflation)



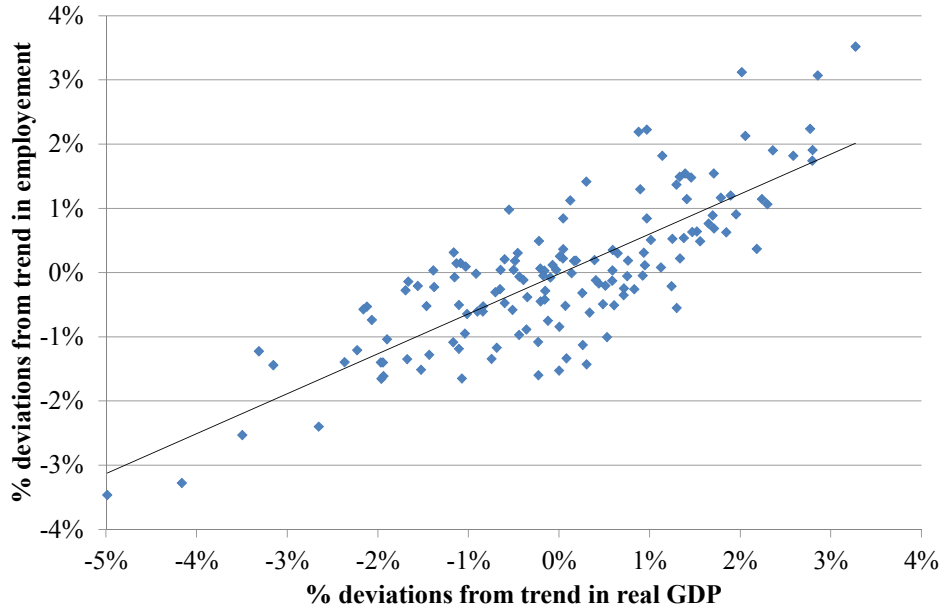


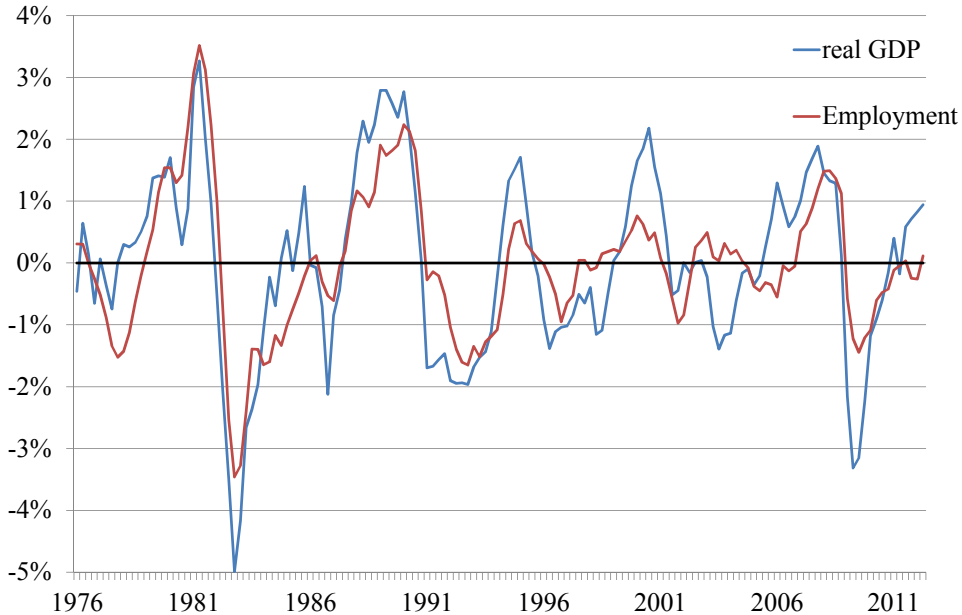
GDP and Growth rate of CPI (Inflation)



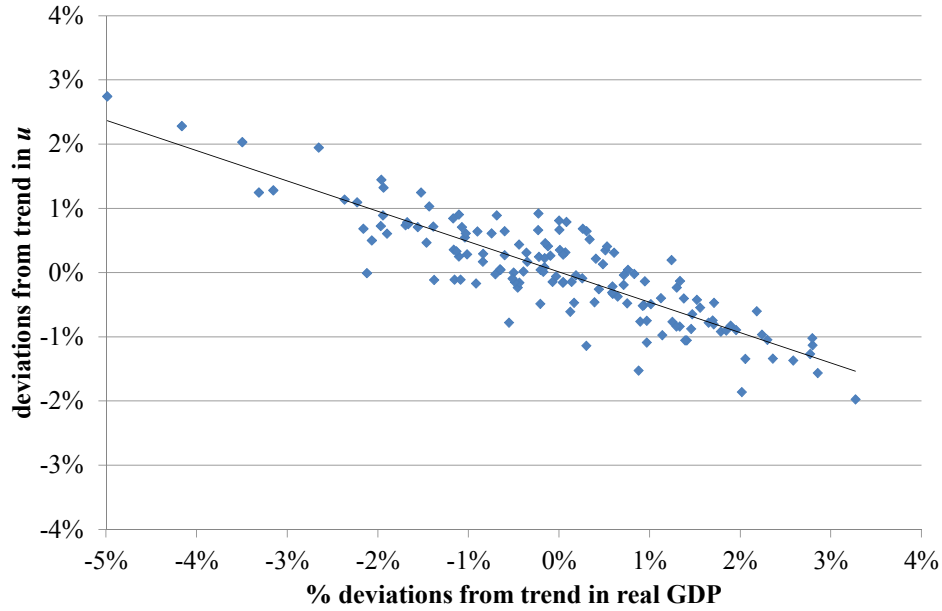


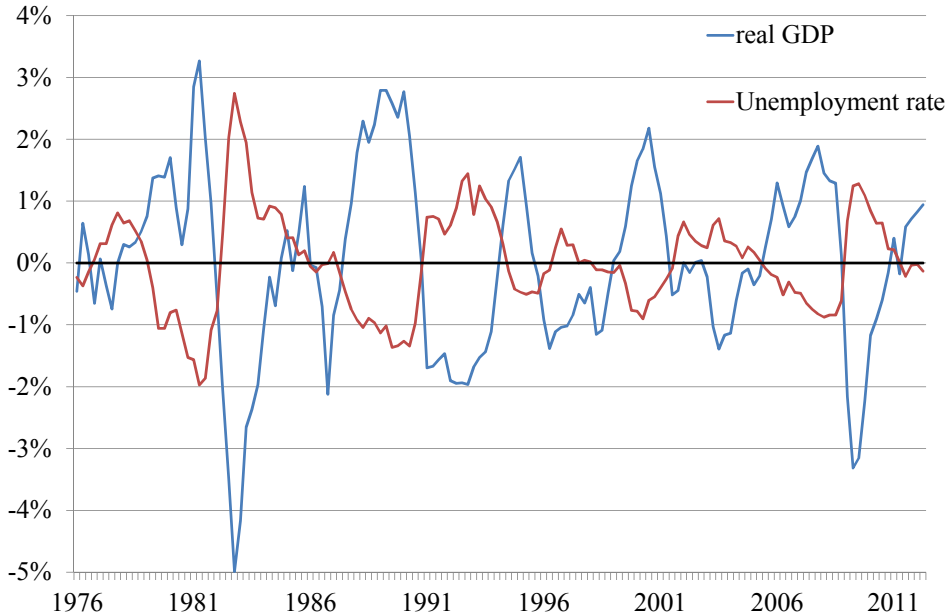
GDP and Employment



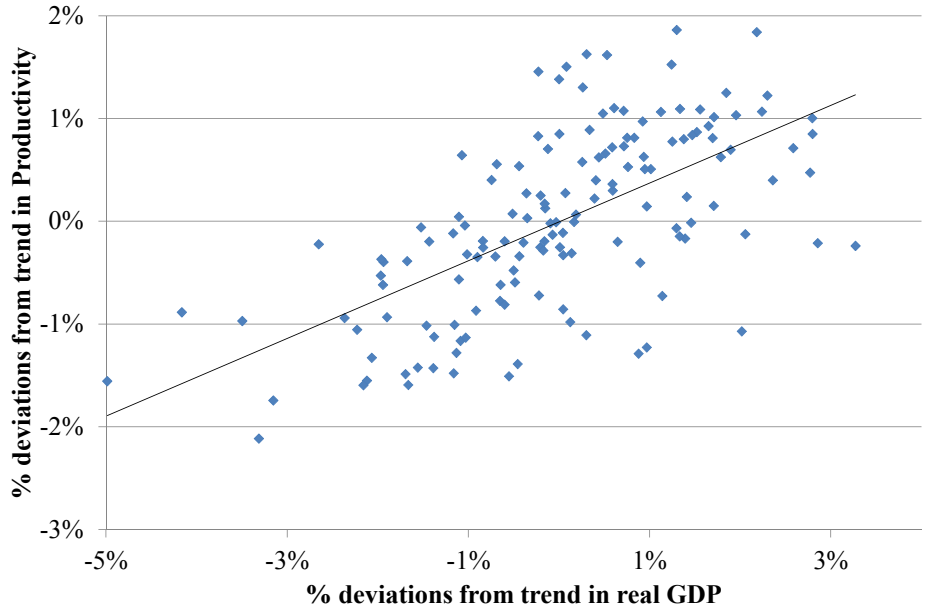


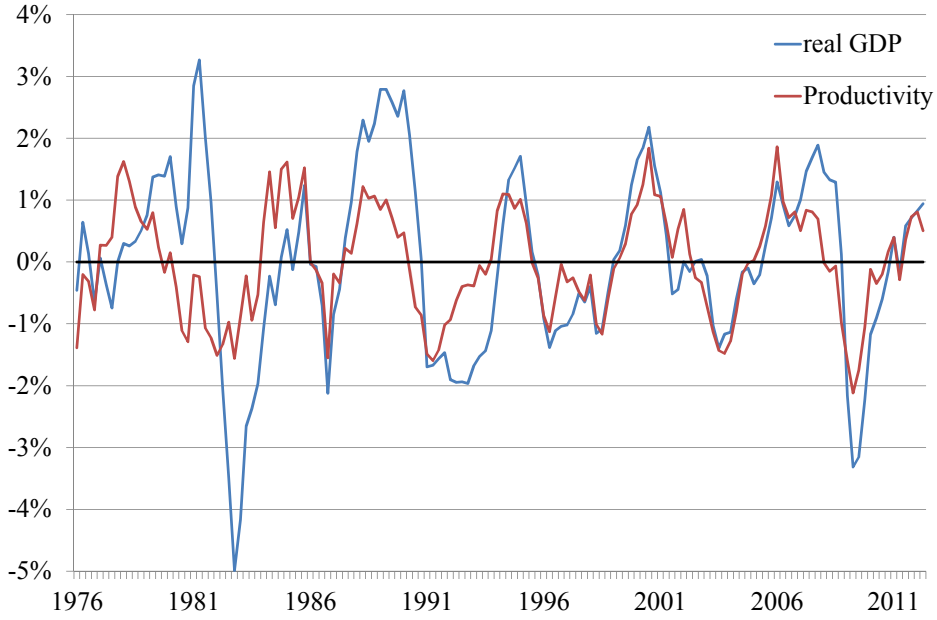
GDP and Unemployment rate



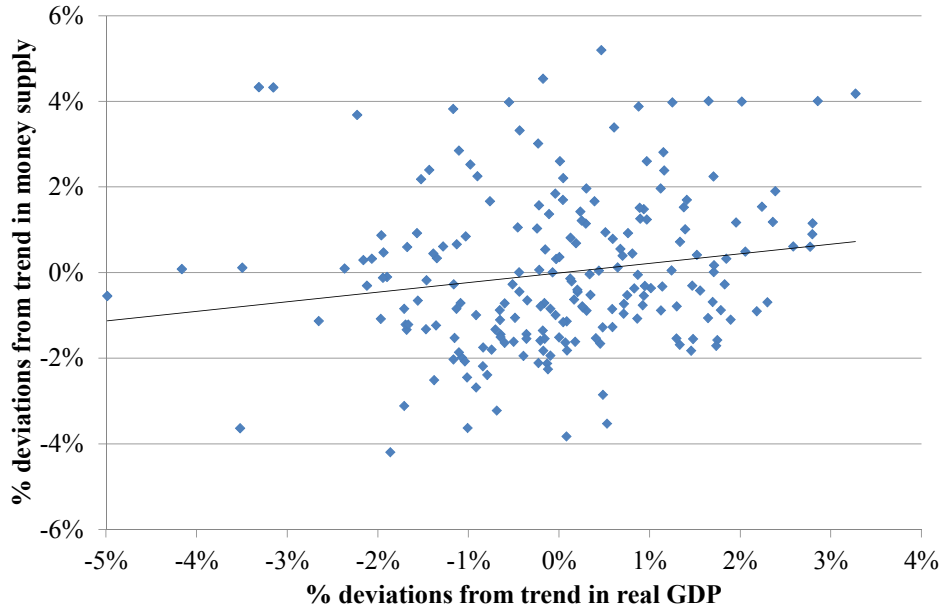


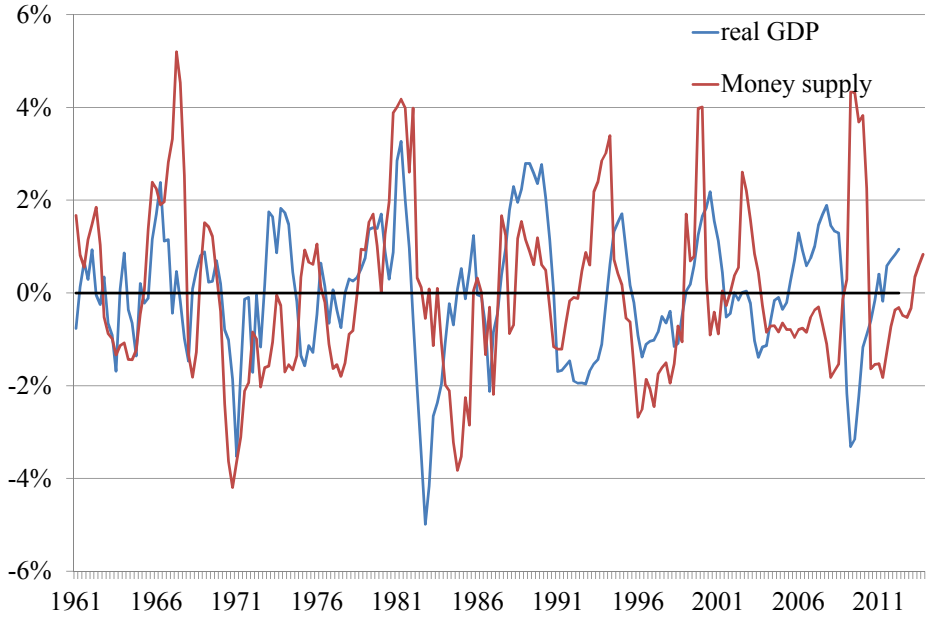
GDP and Average Labor Productivity



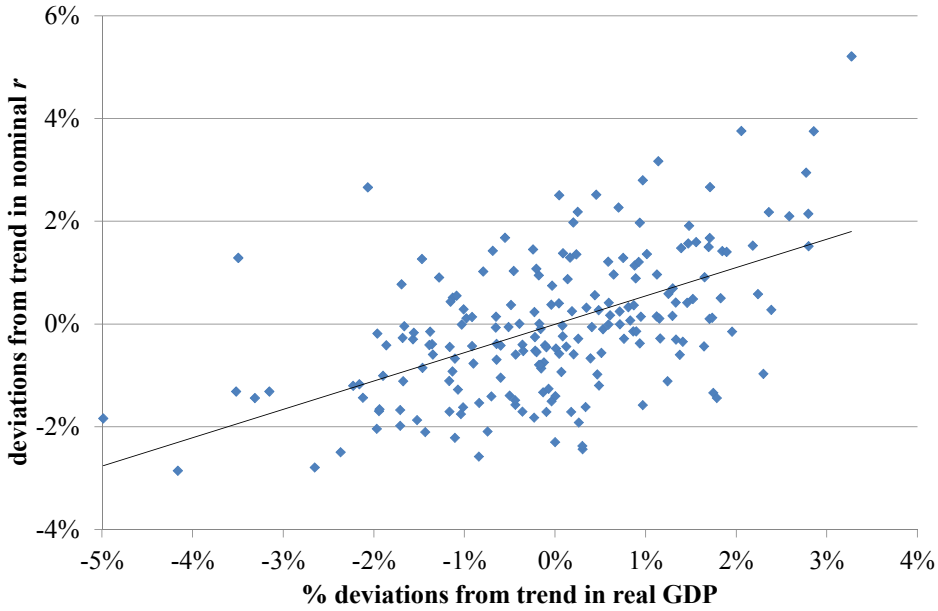


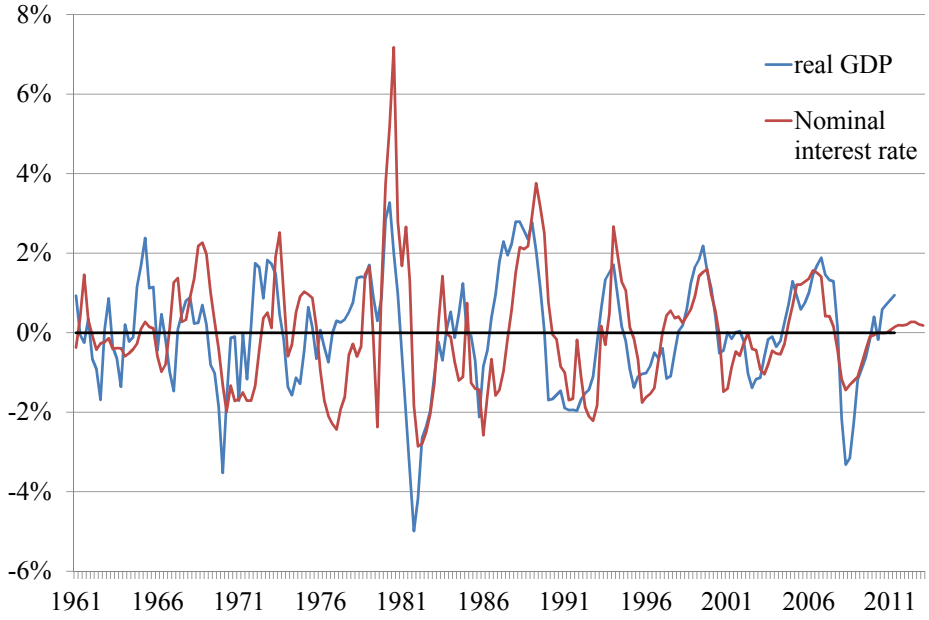
GDP and Money supply



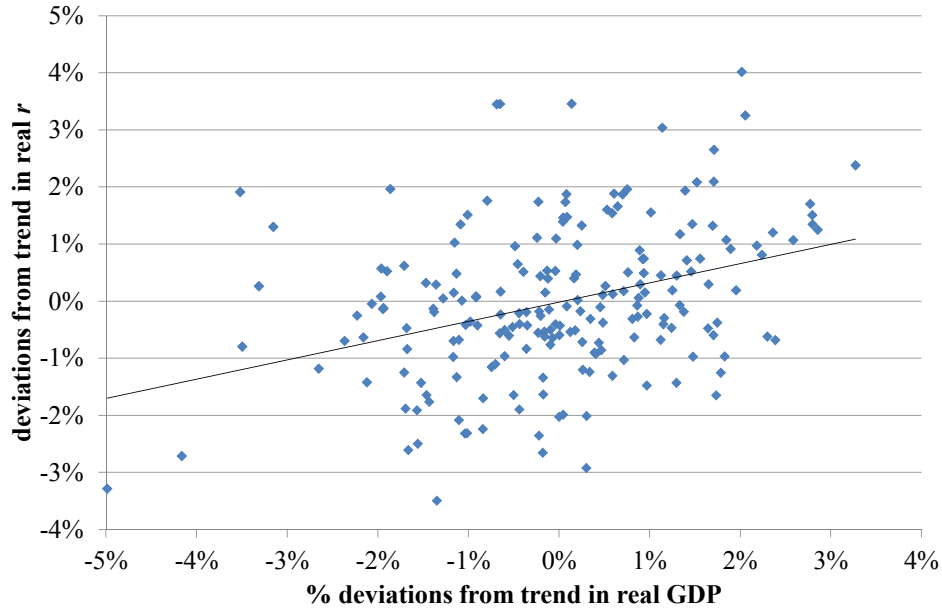


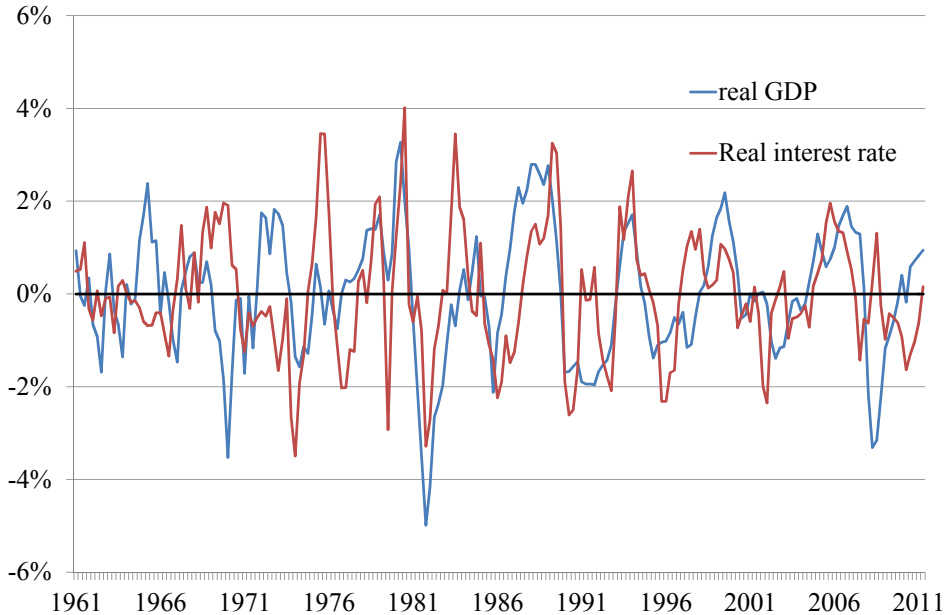
GDP and Nominal interest rate



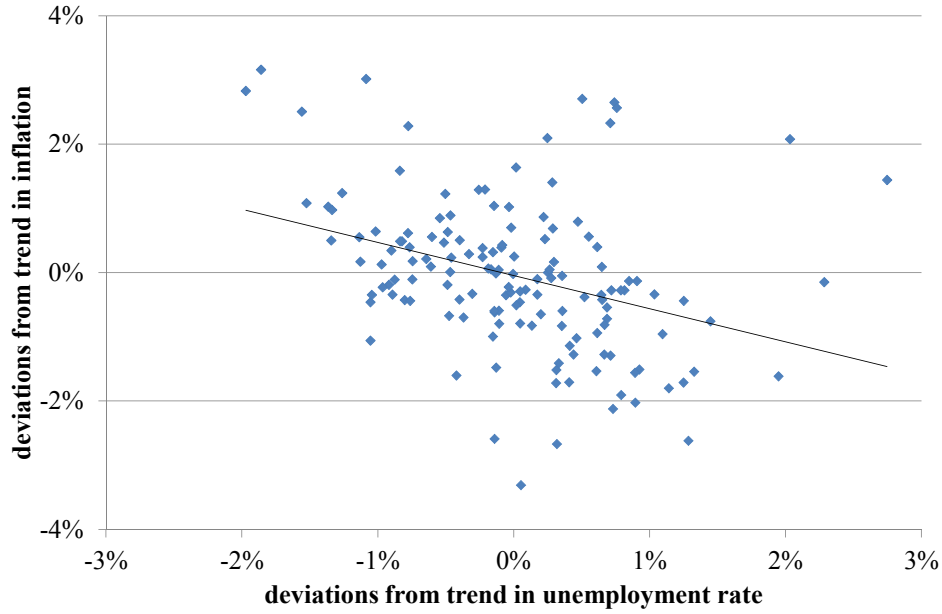


GDP and Real interest rate





Inflation rate and Unemployment rate



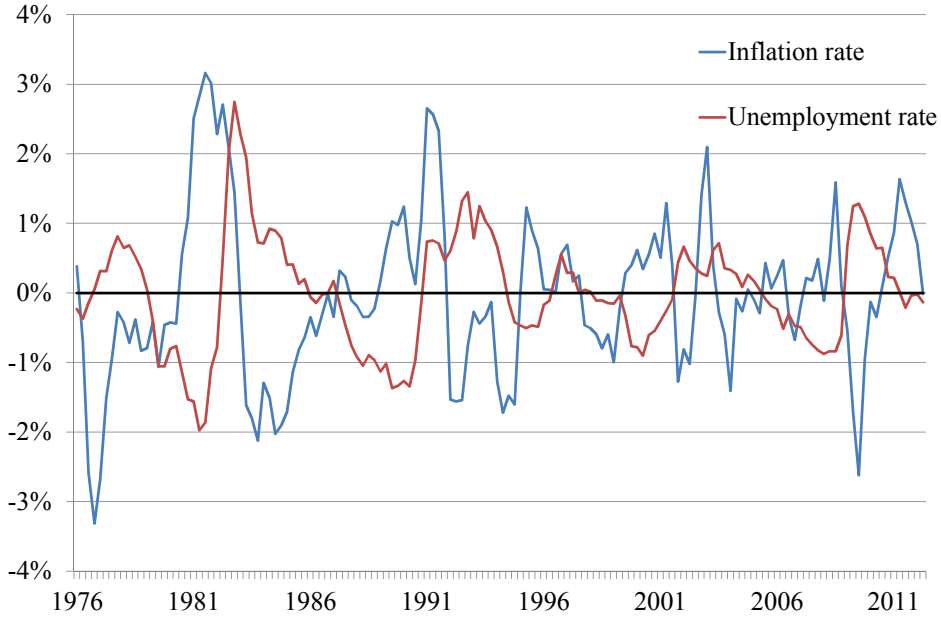


Table of correlation coefficients and relative variability

	GDP	C	G	I	E	M
GDP	1.00	**0.80**	**-0.16**	**0.81**	**0.67**	**0.76**
Consumption		1.00	-0.15	0.66	0.41	0.70
Public Expenditures			1.00	-0.29	-0.20	-0.14
Investments				1.00	0.39	0.82
Exports					1.00	0.65
Imports						1.00
Std. Dev. / Std. Dev. of GDP		**0.83**	**0.95**	**4.42**	**2.89**	**3.47**

Table of correlation coefficients and relative variability

	GDP	GDP deflator	Growth rate of GDP Deflator	CPI	Growth rate of CPI	Unemployment rate
GDP	1.00	**-0.04**	**0.40**	**-0.36**	**0.25**	**-0.87**
GDP Deflator		1.00	0.51	0.80	0.45	-0.06
Growth rate of GDP Deflator			1.00	0.21	0.70	**-0.49**
CPI				1.00	0.45	0.38
Growth rate of CPI					1.00	**-0.35**
Unemployment						1.00
Std. Dev. / Std. Dev. of GDP		**1.02**	**1.18**	**0.84**	**0.88**	**0.58**

Table of correlation coefficients and relative variability

	GDP	Productivity	Employment	Unemployment rate	Money	Nominal r	Real r
GDP	1.00	**0.63**	**0.80**	**-0.87**	**0.17**	**0.53**	**0.35**
Productivity		1.00	0.05	-0.24	-0.20	0.06	0.22
Employment			1.00	-0.94	0.29	0.71	0.42
Unemployment rate				1.00	-0.18	-0.66	-0.45
Money supply					1.00	0.18	0.00
Nominal interest rate						1.00	0.62
Real interest rate							1.00
Std. Dev. / Std. Dev. of GDP		**0.64**	**0.83**	**0.58**	**1.31**	**1.06**	**0.97**