

# The Slowdown in GDP Growth: Decomposition and Some Implications

Jim Stock

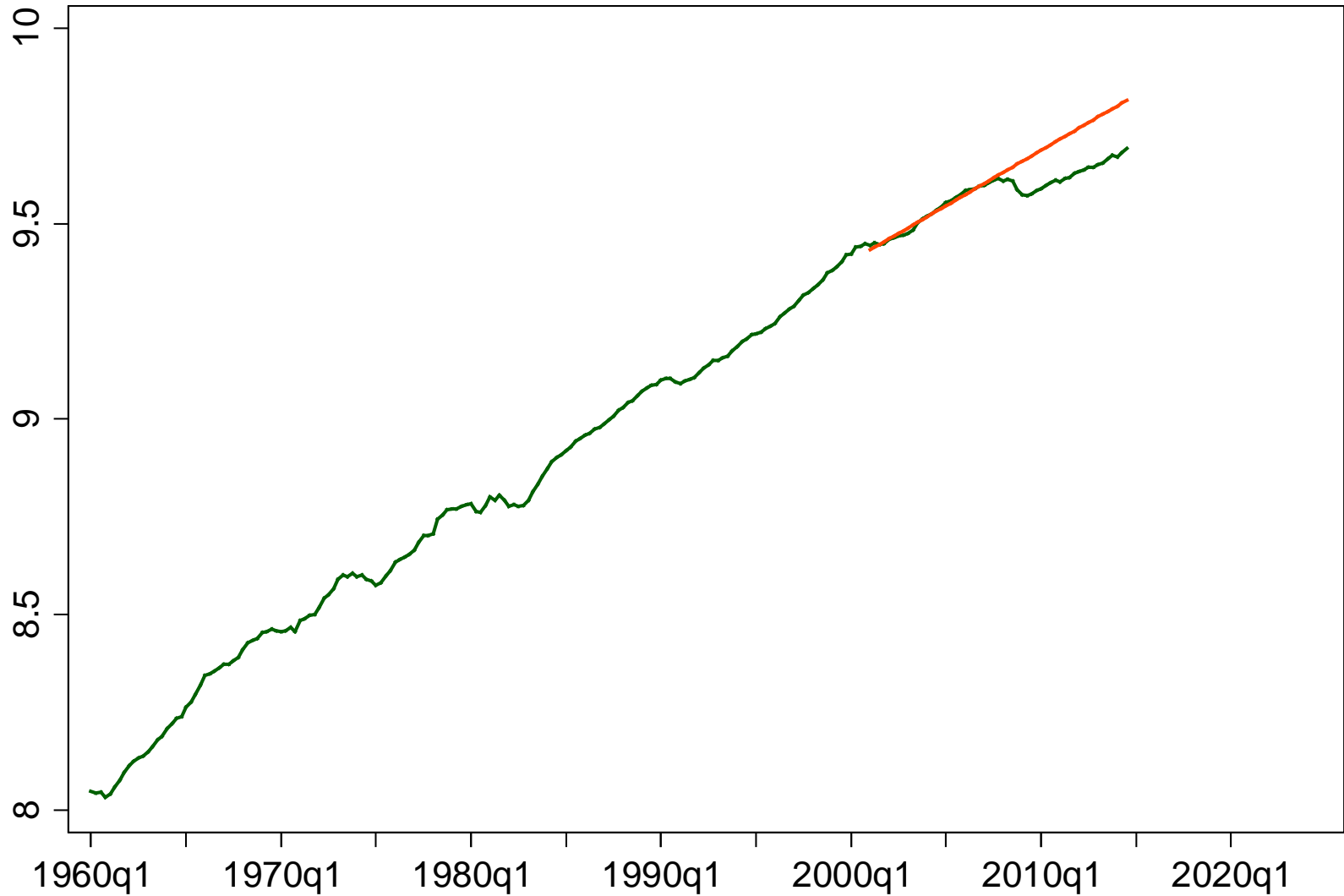
Harvard University

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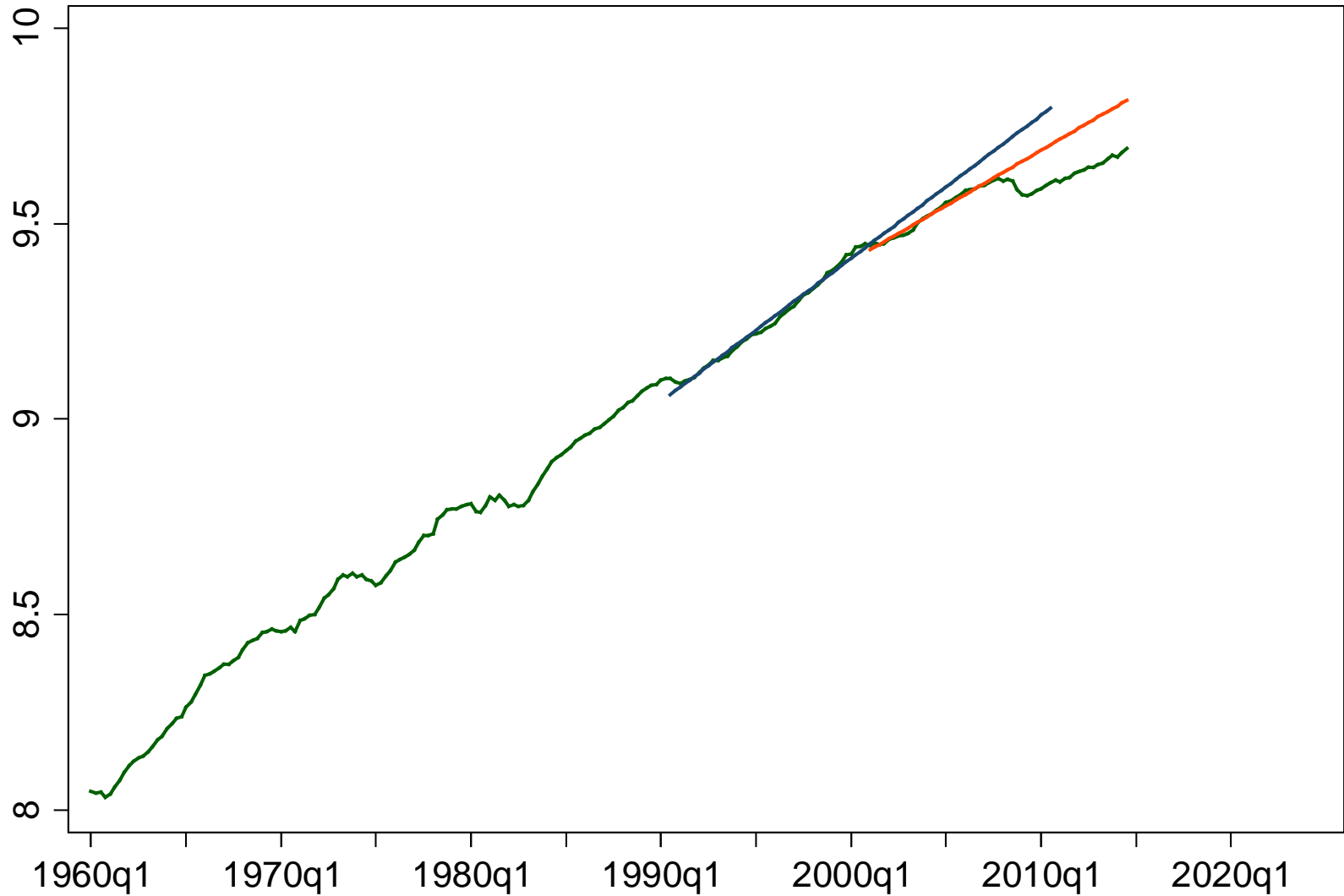
# The Slow Recovery

Real GDP (log) and NBER peak-to-peak trend



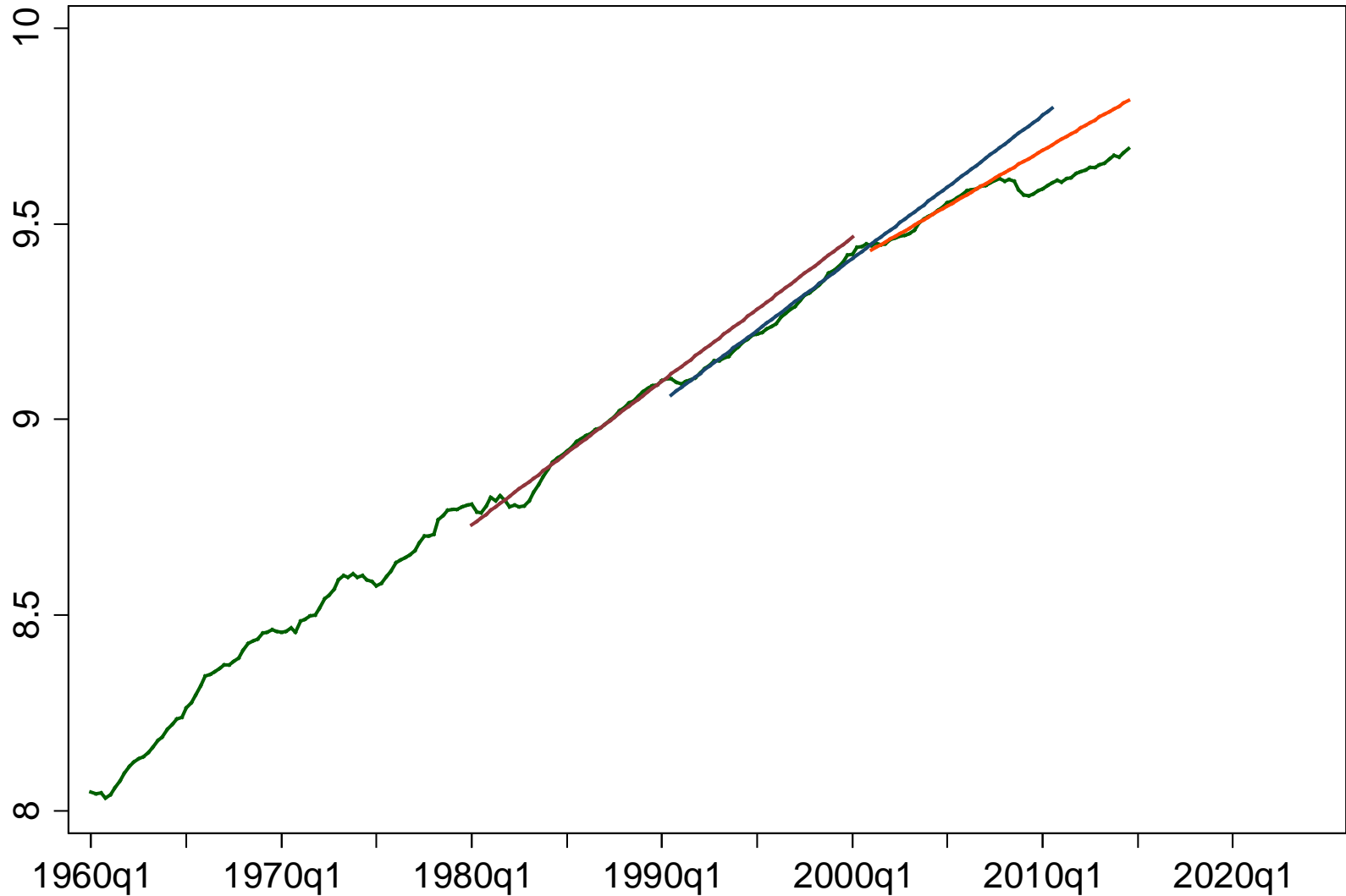
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Real GDP (log) and NBER peak-to-peak trend



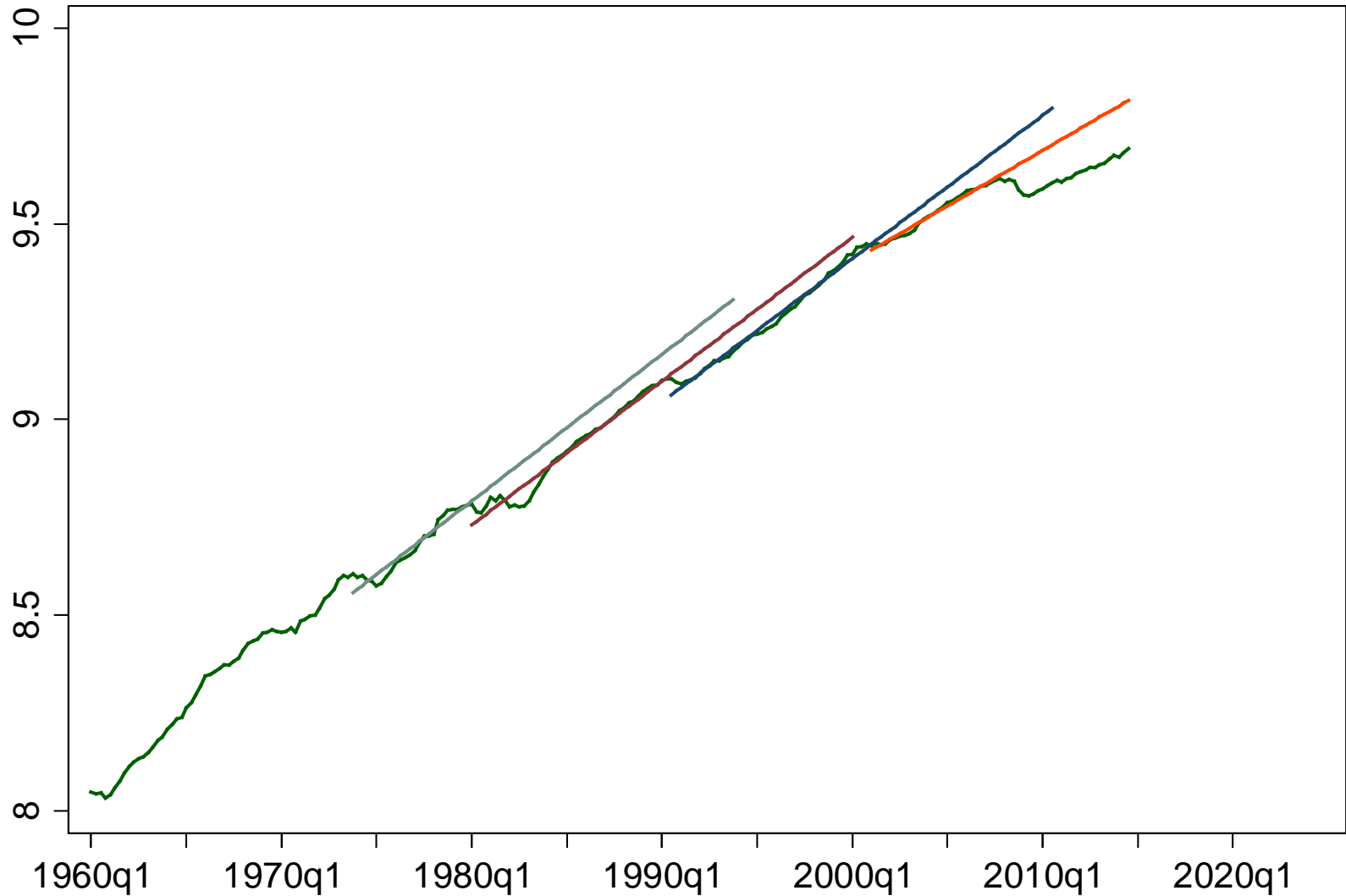
# The Slow Recovery

Real GDP (log) and NBER peak-to-peak trend



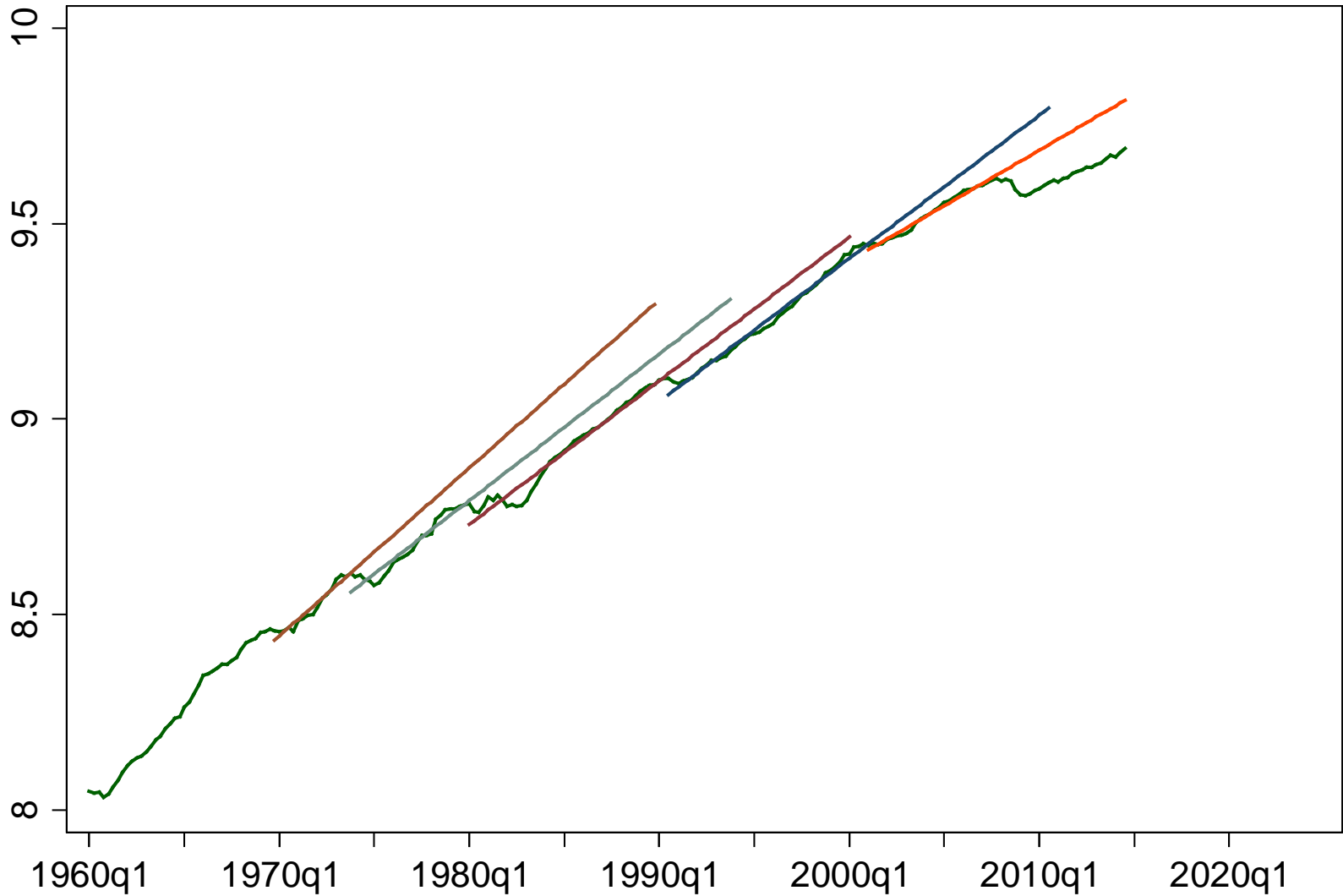
# The Slow Recovery

Real GDP (log) and NBER peak-to-peak trend



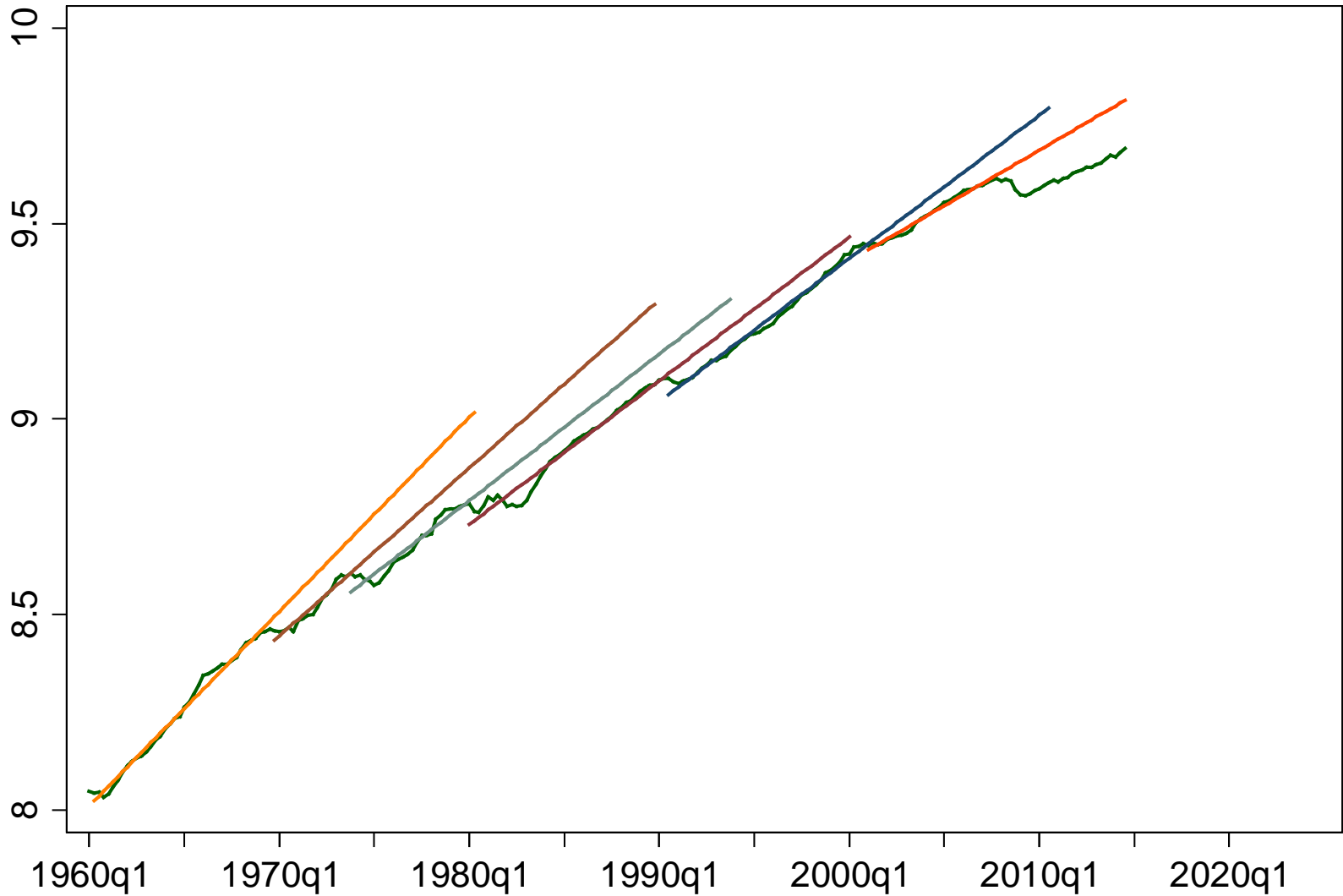
# The Slow Recovery

Real GDP (log) and NBER peak-to-peak trend



# The Slow Recovery

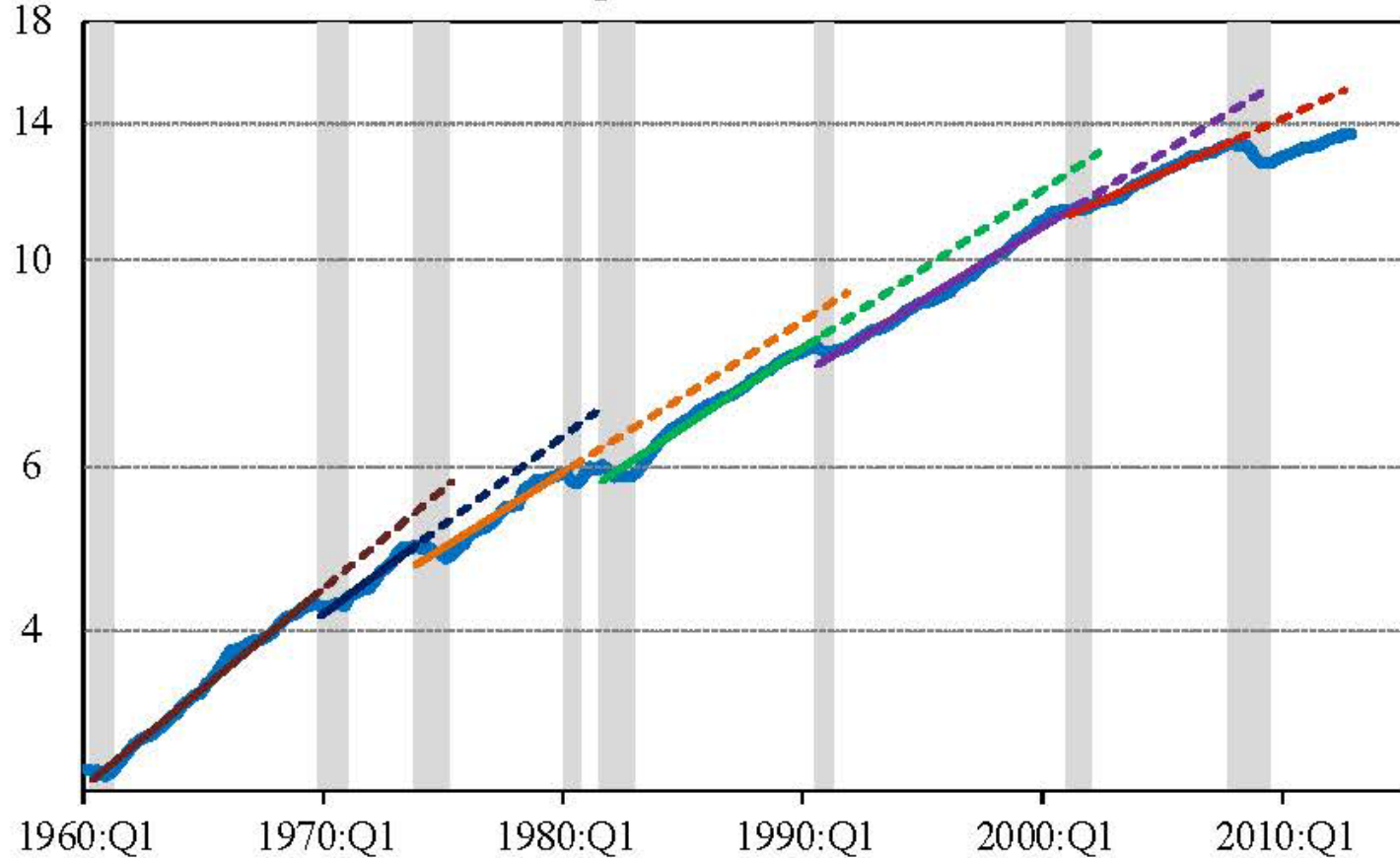
Real GDP (log) and NBER peak-to-peak trend



# The Slow Recovery

## Real Gross Domestic Product and Trends, 1960–2012

Trillions of chained 2005 dollars, log scale

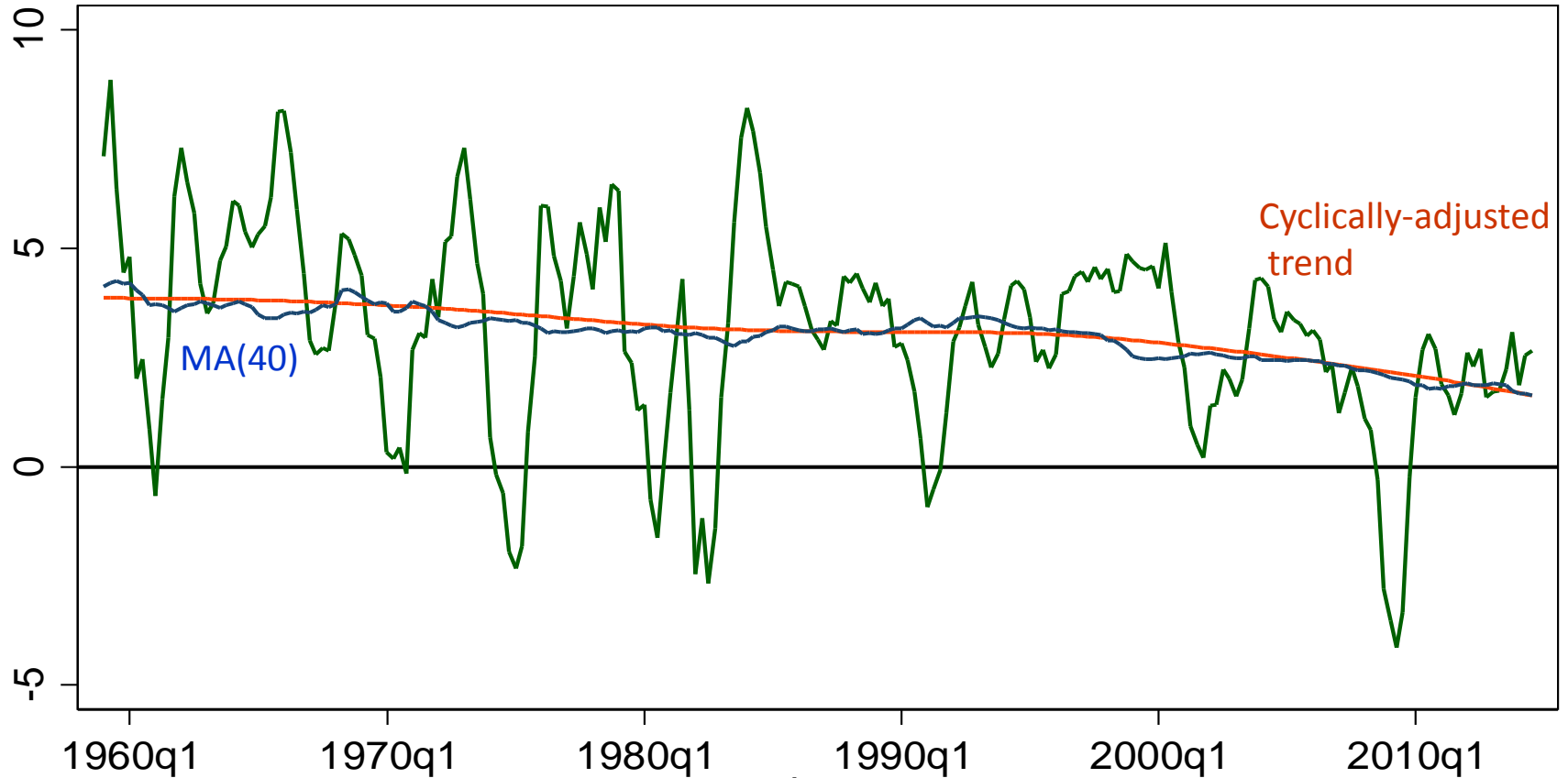


Note: Shading denotes recession. Trend lines represent the average growth rate between successive business-cycle peaks.

Source: Bureau of Economic Analysis, National Income and Product Accounts; National Bureau of Economic Research; CEA calculations.

Source: *Economic Report of the President* (2013)

# Real GDP: 4Q growth rates and trends



## Trend GDP growth

1965	3.8%
1975	3.5%
1985	3.1%
1995	3.0%
2005	2.5%
2010	2.1%

# Outline

1. Accounting framework: supply-side decomposition
2. Econometric approach to estimating trends; cyclical adjustment
3. Discussion of decomposition components (growth rates):
  - a) Decomposition
  - b) Additional discussion of components:
    - i. Productivity
    - ii. Weekly hours
    - iii. Labor force participation
4. Selected implications
  - a) [Fiscal: deficit, debt, Social Security, etc.]
  - b) [The slow recovery]
  - c) Equilibrium real rate,  $r-g$ , and monetary policy

# Selected References

## **Selected references on aspects of the GDP slowdown**

Aaronson, S. et. al., *BPEA* (2006) (on LFPR)

Stock and Watson, *BPEA* (2012)

CEA, *Economics Report of the President*, Ch. 2 (2013)

Aaronson, S. et. al., *BPEA* (2014) (on LFPR)

Aaronson, D. et. al., Chicago Fed *EP* (2014) (on LFPR)

CBO, *Economic Outlook – Update* (August 2014)

Gordon, *NBER WP 20423* (2014)

Hall, *NBER Macro Annual* (2014)

Hall (ms, 2014)

ASSA session on secular stagnation (2015) (Gordon, Summers,  
Eichengreen; Hall, Nordhaus, Mankiw)

# 1. Accounting Framework: Supply-Side Decomposition

**Supply side decomposition:**

$$GDP_t = \frac{GDP_t}{Hours_t} \times \frac{Hours_t}{Worker_t} \times \frac{Workers_t}{LaborForce_t} \times \frac{LF_t}{Population_t} \times Population$$

**Data note:**

- Hours, workers, labor force, LFPR are all economy-wide, measured from the household survey. (Hours data: Gordon (2014); Hall)
- Population: Census, adjusted and unadjusted

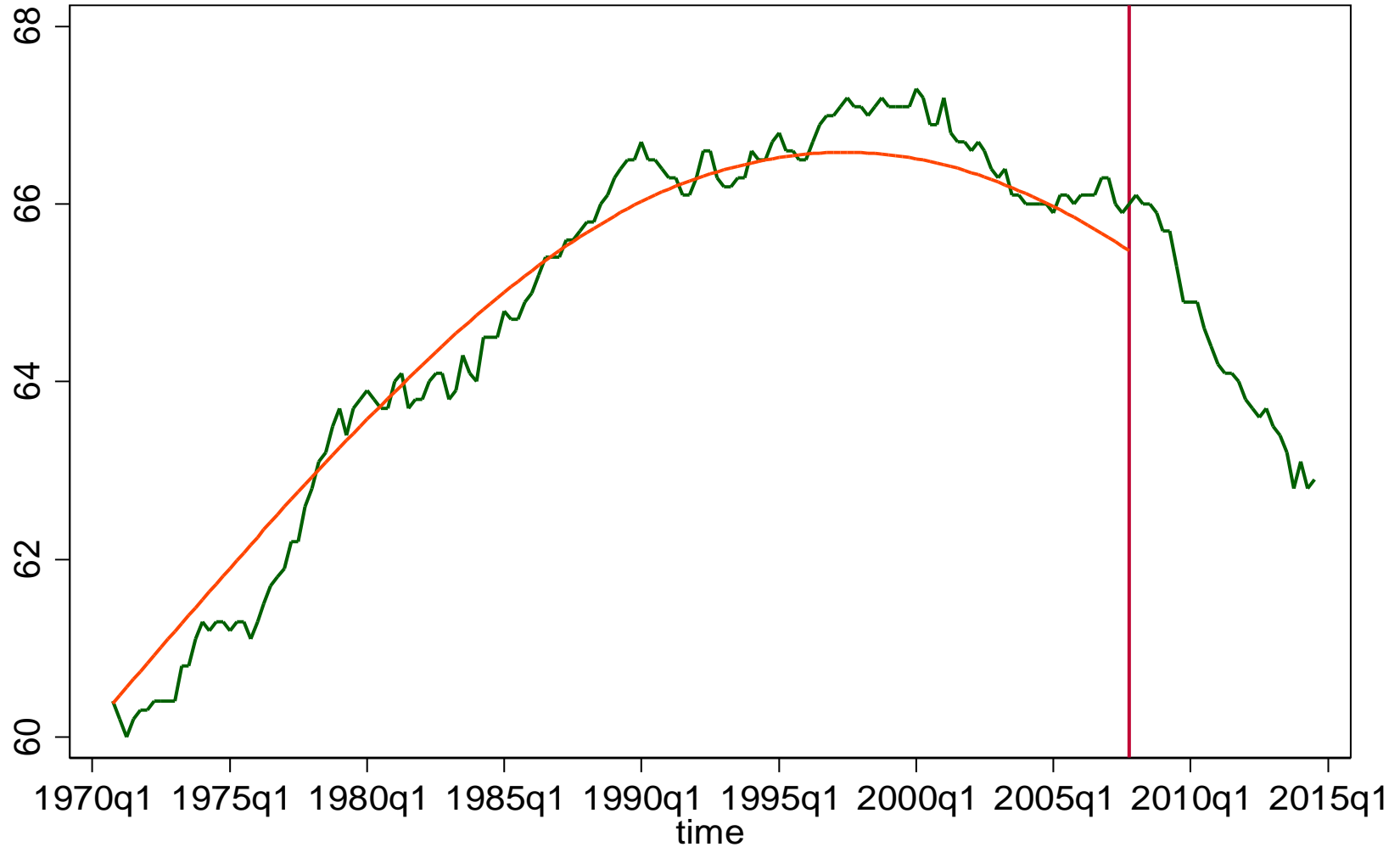
**In growth rates:**

$$\Delta \ln GDP_t = \Delta \ln Productivity_t + \Delta \ln WklyHrs_t + \Delta \ln EmpRate_t + \Delta \ln LFPR_t + \Delta \ln Pop_t$$

Note: *EmpRate* = the employment rate = 1 – unemployment rate, which is almost entirely cyclical – so ignore for this long-run analysis (makes negligible contribution)

## 2. Econometrics: The End-Point Problem of Trend Estimation

Total LFPR and 1970-2007 time series trend



## 2. Econometrics: Models for Cyclically-Adjusted Trend

**Econometric task:** Estimate low-frequency movements in  $\Delta y_t = \Delta \ln(LFPR_t)$

### Option 1: UC model

$$\Delta y_t = \mu_t + \beta(L)u_t^{gap} + v_t$$

$$\mu_t = \mu_{t-1} + \eta_t$$

$$(v_t, \eta_t) \text{ i.i.d. } N(0, \text{diag})$$

- Estimation by MLE/Kalman filter
- K Smoother provides estimates of  $\text{var}(\mu_t)$
- $\beta(L)$   $T^{1/2}$ -consistently estimated
- Optimal filter implied by time series model
- End points handled (in effect) by model-based projection of  $(\mu_t, v_t)$
- Estimated trends aggregate over series in the decomposition if the model parameters are the same for each series

**References:** Harvey (1989); Gordon (2014)

### Option 2: Partially linear regression

$$\Delta y_t = \mu_t + \beta(L)u_t^{gap} + v_t,$$

$$\mu_t = \mu(t/T),$$

$$\mu''(\cdot) \text{ is bdd and cts.}$$

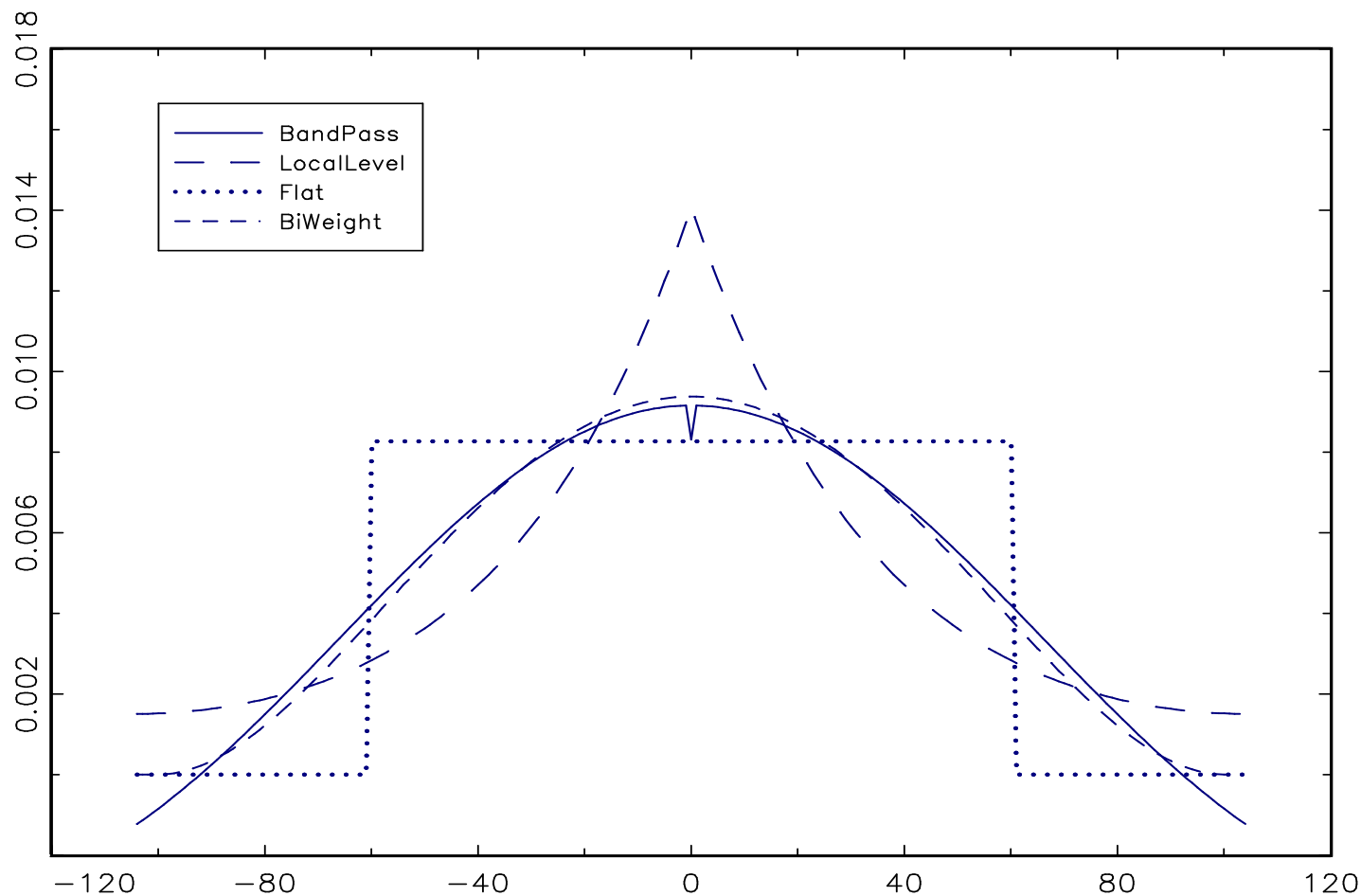
- Estimation by kernel methods (or extensions – local linear trend)
- Asymptotics provides  $\text{SE}(\mu)$
- $\beta(L)$   $T^{1/2}$ -consistently estimated
- Optimal filter implied by  $\mu''$
- End points handled by truncation of filter and reweighting (so asymmetric filter)
- Estimated trends aggregate over series in the decomposition if the kernel is the same for each series

**References:** Robinson (1988), Stock (1989); Wu and Zhao (2007), Cai (2007), Zhang and Wu (2012); CEA 2014

## 2. Econometrics: Models for Cyclically-Adjusted Trend, ctd.

### Comparison of implied filters

Filter weights for MA(60), Bandpass ( $\omega_0 = 200$ ), Biweight ( $m = 100$ ), and UC model (local level) – no UGAP term



## 2. Econometrics: Partially Linear Regression Model – odds & ends

$$\Delta y_t = \mu_t + \beta(L)u_t^{gap} + v_t$$

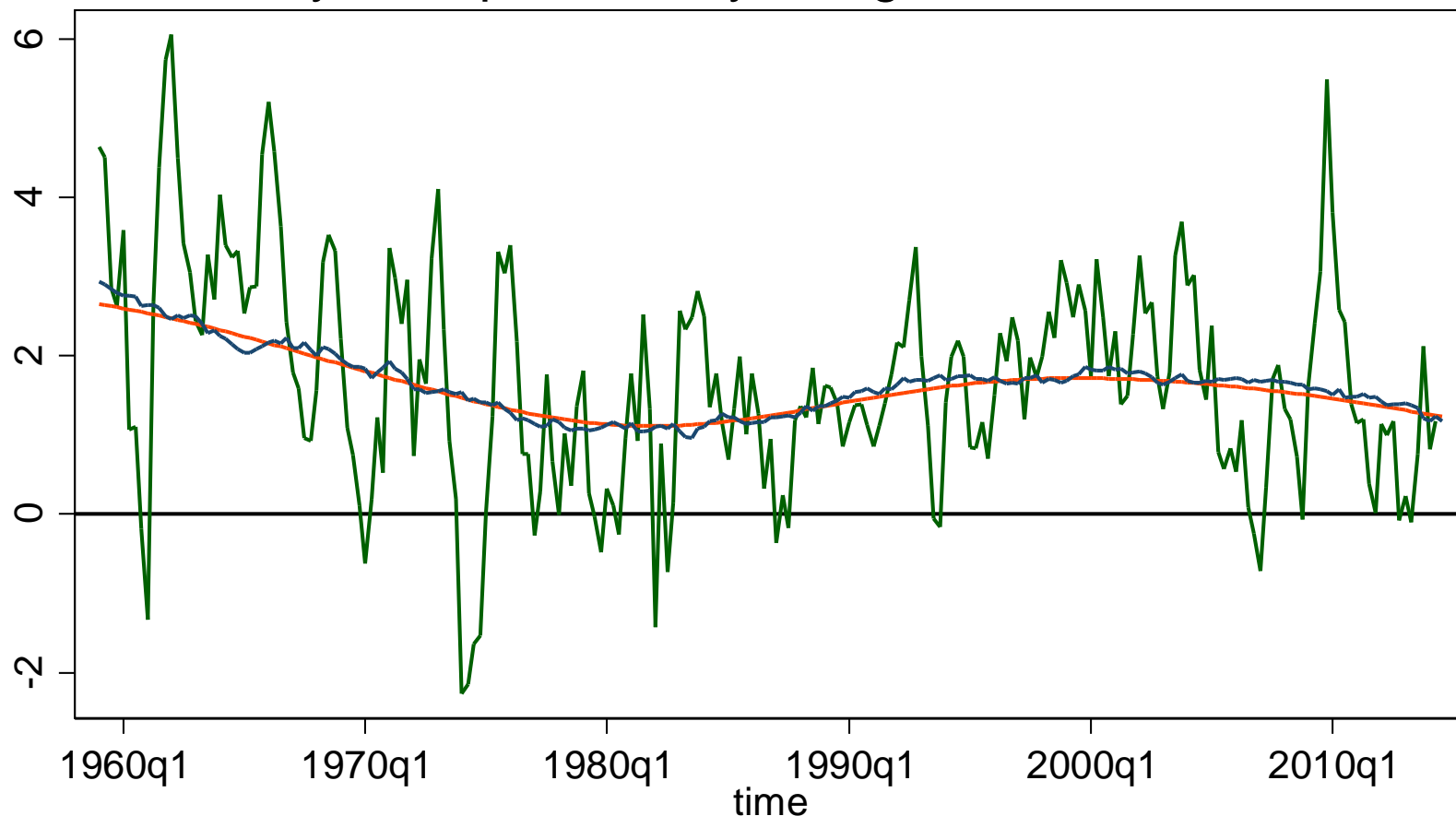
### Estimation

- Options for trend:
  - Kernel smoother (the choice here)
  - Local polynomial (local linear trend)
  - Global polynomial (many drawbacks, especially end-points)
- 2-step kernel estimation of  $\beta(L)$ :
  - i. Deviate LFPR, u-gap from low-frequency trend (biweight kernel, BW = 40)
  - ii. Regress deviated LFPR on deviated u-gap ( $t+2, t+1, \dots, t-8$ )
    - Smoothed residual (biweight kernel, BW = 72) is cyclically-adjusted estimate of  $\mu_t$
    - Trend in  $y_t$  is cumulated trend in  $\Delta y_t$
- Estimate on 1959q1-2007q4 – so cyclical coeffs estimated through 2007q4
- Have done many robust checks, alternative estimators (local linear trend), etc.

### 3. Supply-side growth rate decomposition

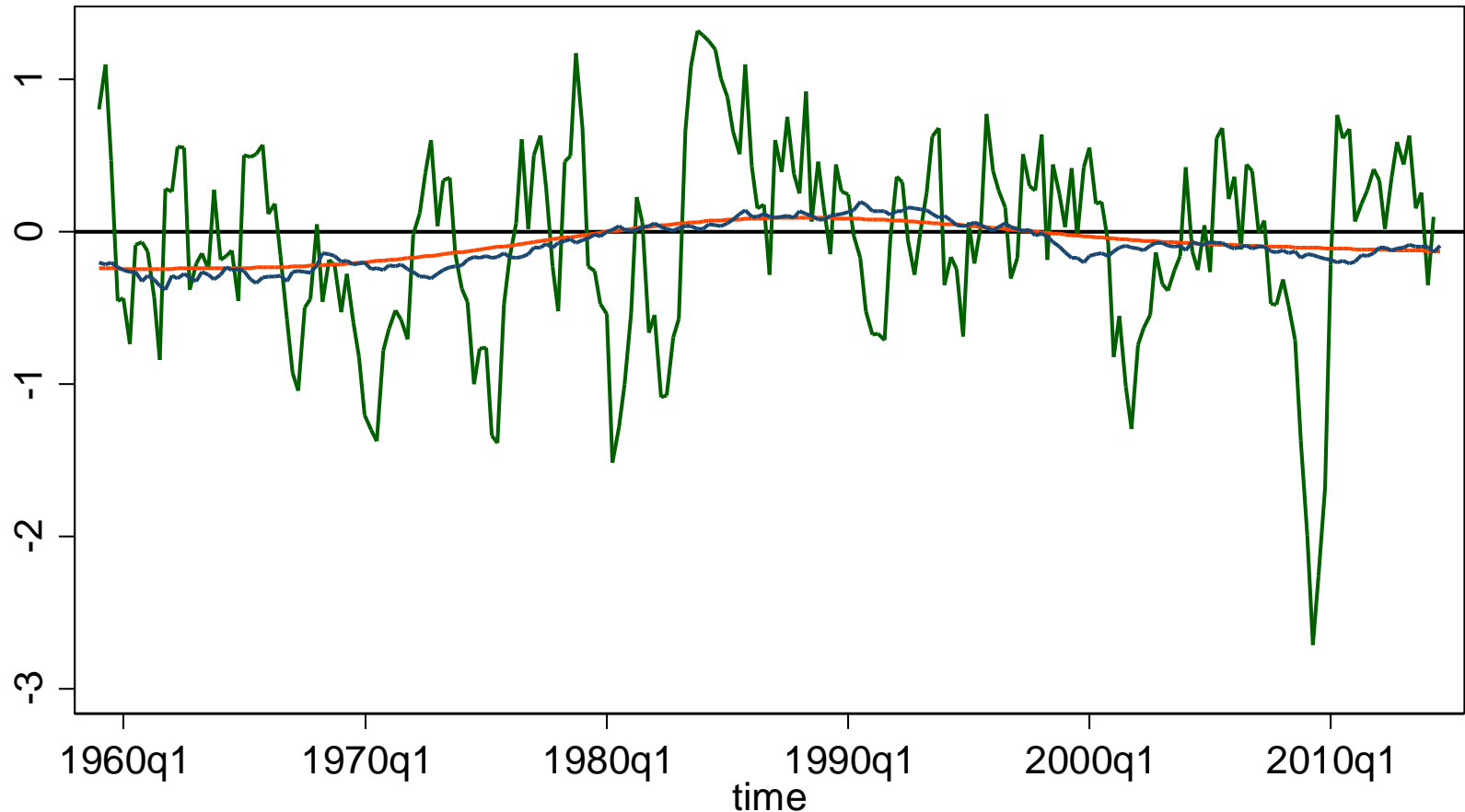
$$\Delta \ln GDP_t = \Delta \ln Productivity_t + \Delta \ln WklyHrs_t + \Delta \ln EmpRate_t + \Delta \ln LFPR_t + \Delta \ln Pop_t$$

Economy-wide productivity: 4Q growth rates and trends



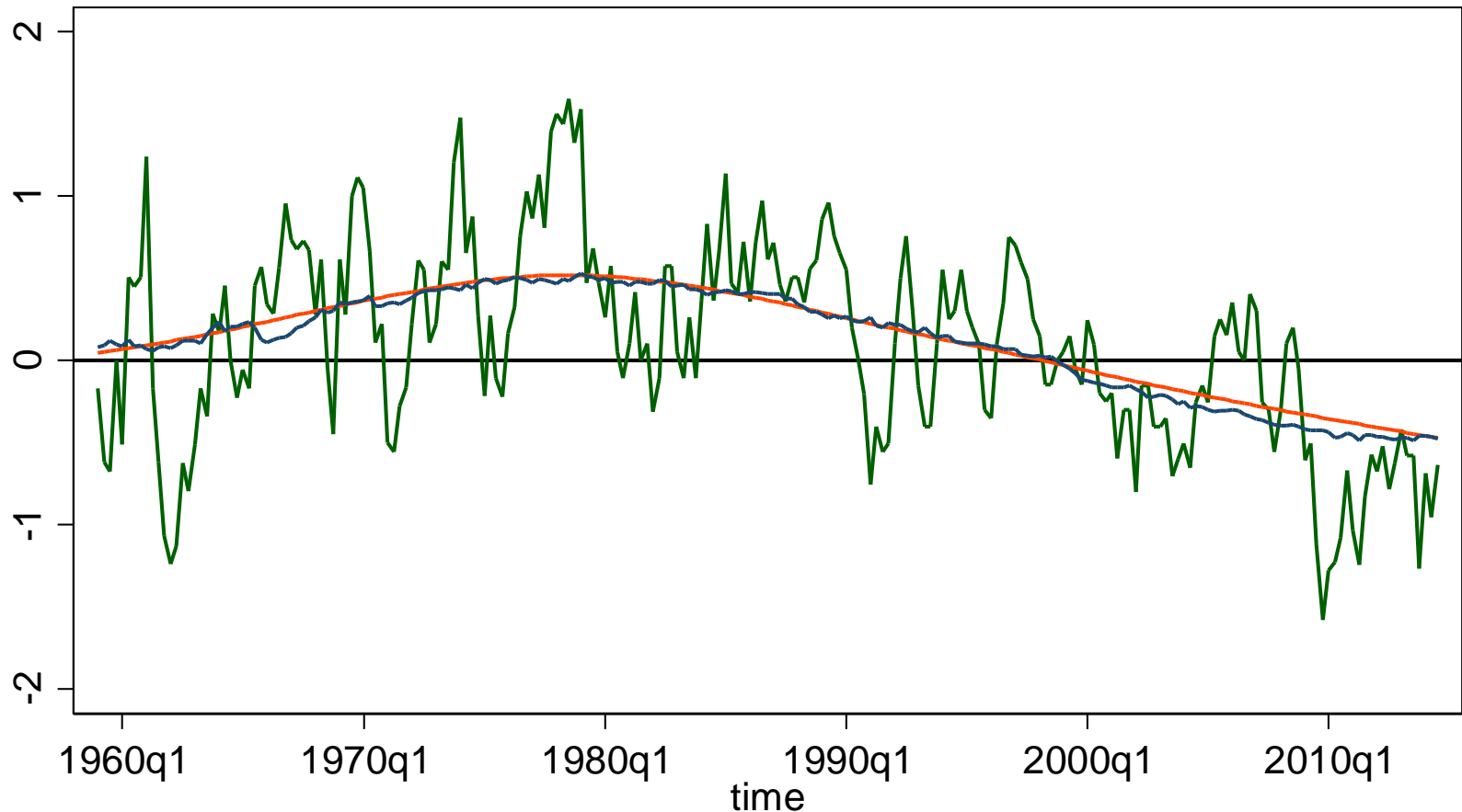
$$\Delta \ln GDP_t = \Delta \ln Productivity_t + \Delta \ln WklyHrs_t + \Delta \ln EmpRate_t + \Delta \ln LFPR_t + \Delta \ln Pop_t$$

### Hours per employee (HH): 4Q growth rates and trends



$$\Delta \ln GDP_t = \Delta \ln Productivity_t + \Delta \ln WklyHrs_t + \Delta \ln EmpRate_t + \Delta \ln LFPR_t + \Delta \ln Pop_t$$

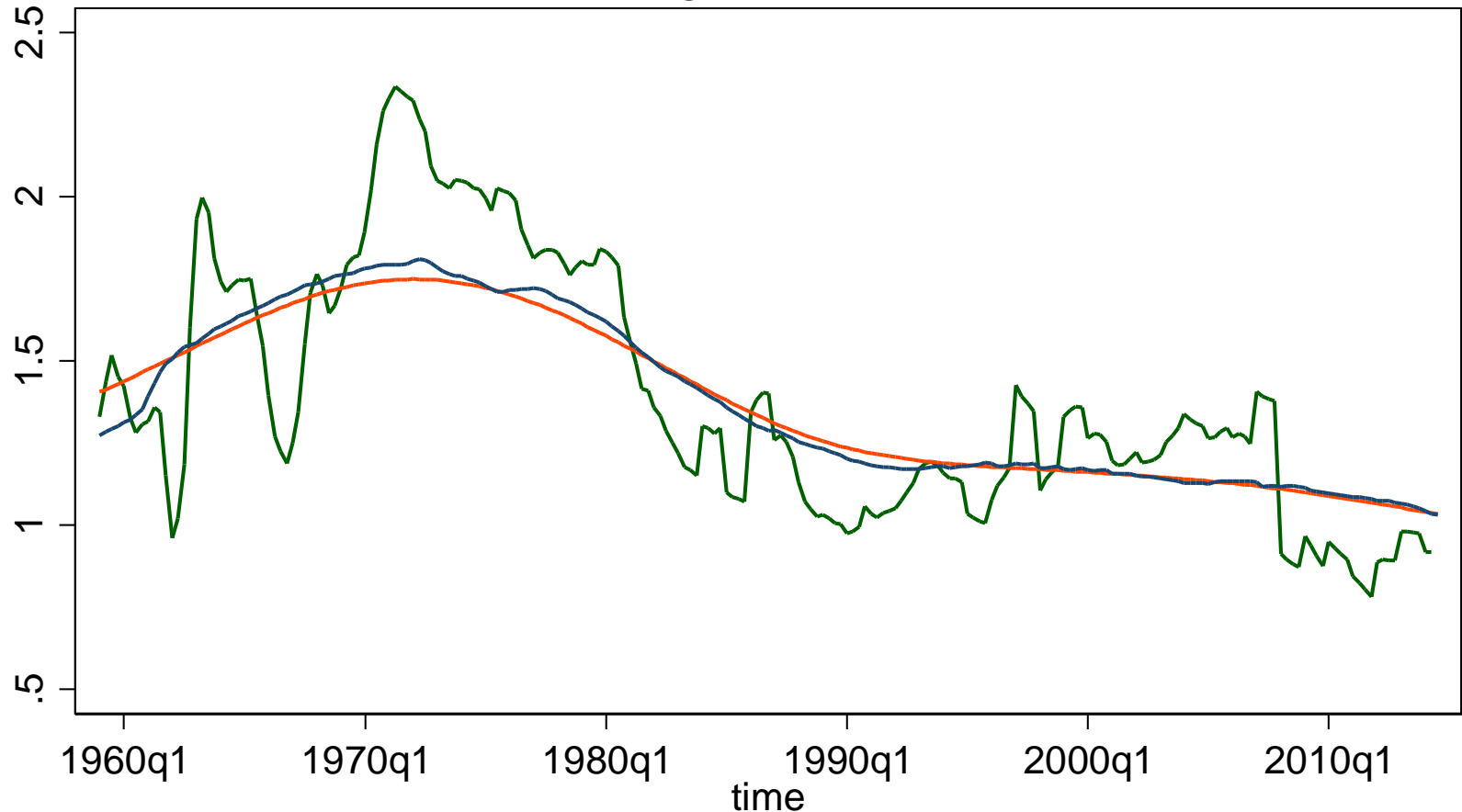
## LFPR: 4Q growth rates and trends



— d4lfpr  
— lfpr: MA(40) trend  
— lfpr: cycl. adj. trend

$$\Delta \ln GDP_t = \Delta \ln Productivity_t + \Delta \ln WklyHrs_t + \Delta \ln EmpRate_t + \Delta \ln LFPR_t + \Delta \ln Pop_t$$

## Population: 4Q growth rates and trends



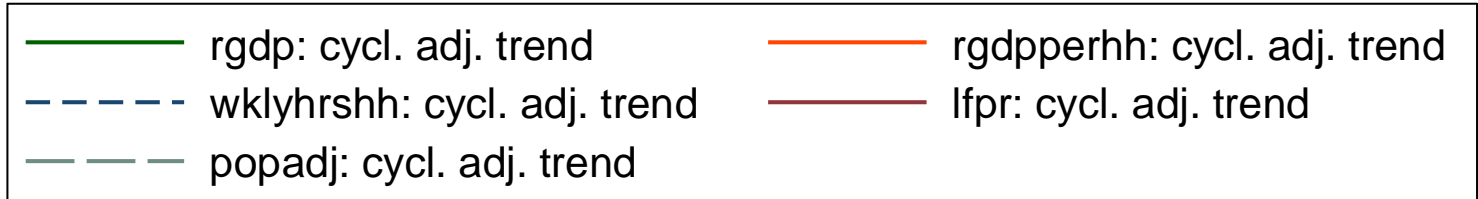
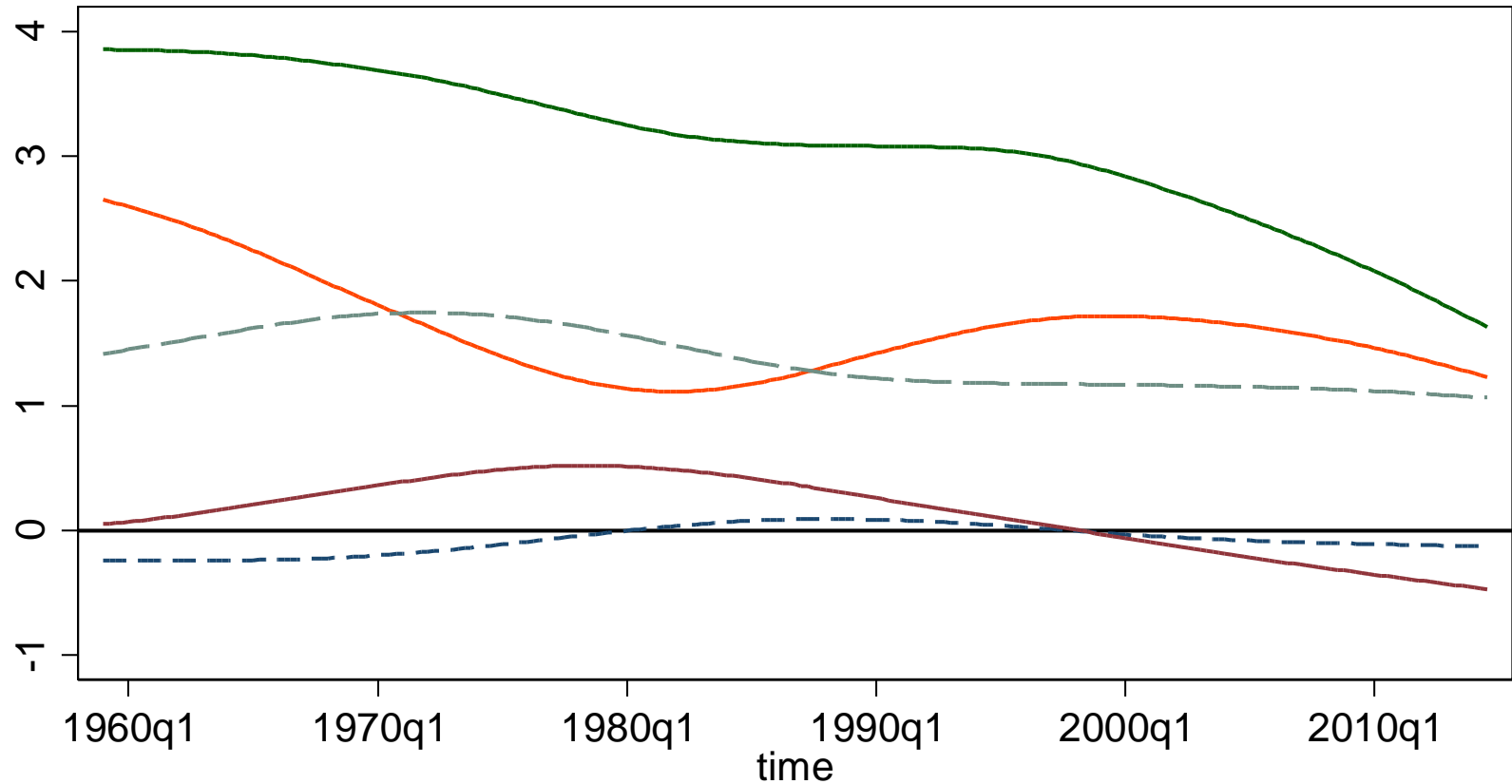
d4lpopgord

popgord: MA(40) trend

popgord: cycl. adj. trend

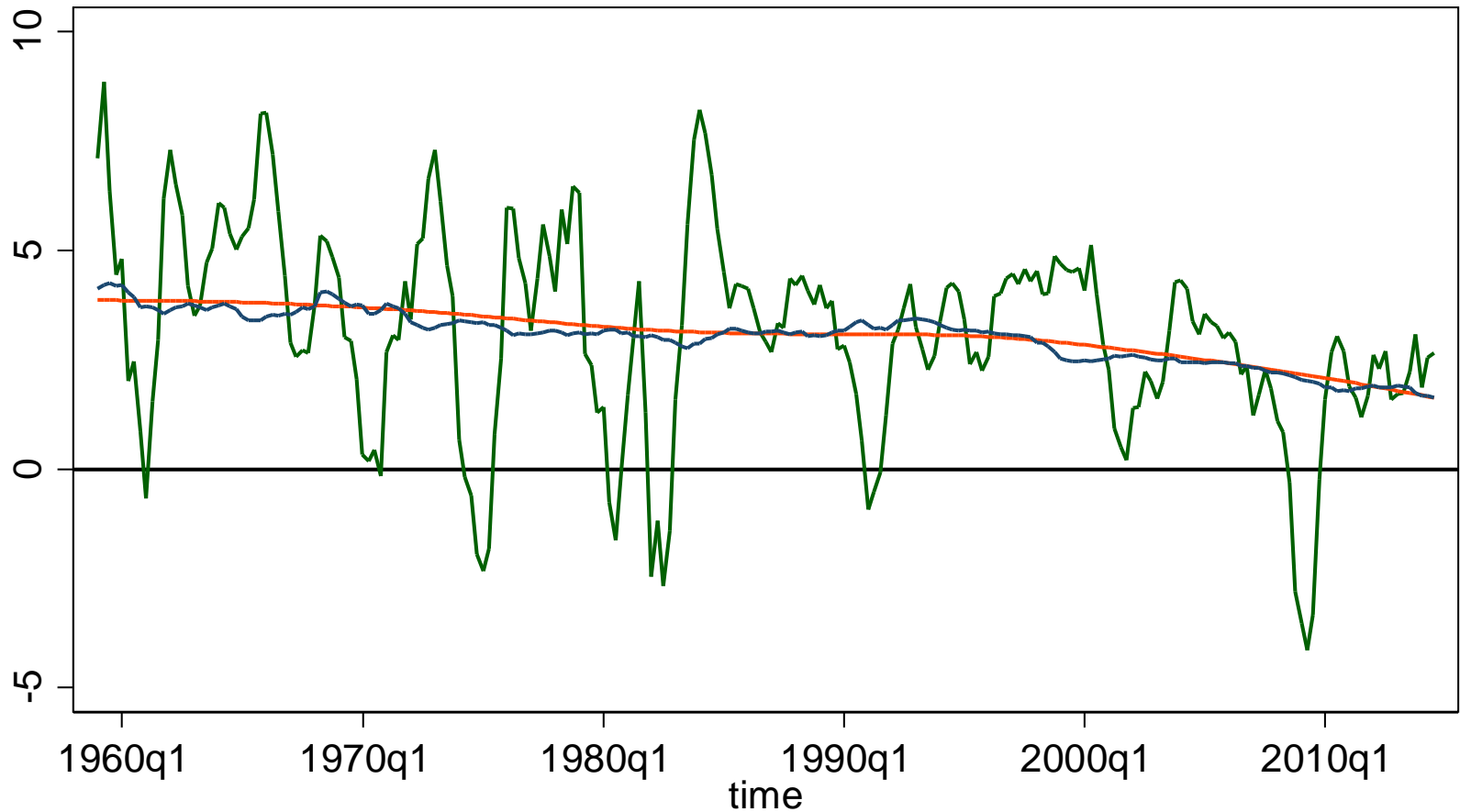
$$\Delta \ln GDP_t = \Delta \ln Productivity_t + \Delta \ln WklyHrs_t + \Delta \ln EmpRate_t + \Delta \ln LFPR_t + \Delta \ln Pop_t$$

### Supply-side decomposition of trend GDP growth



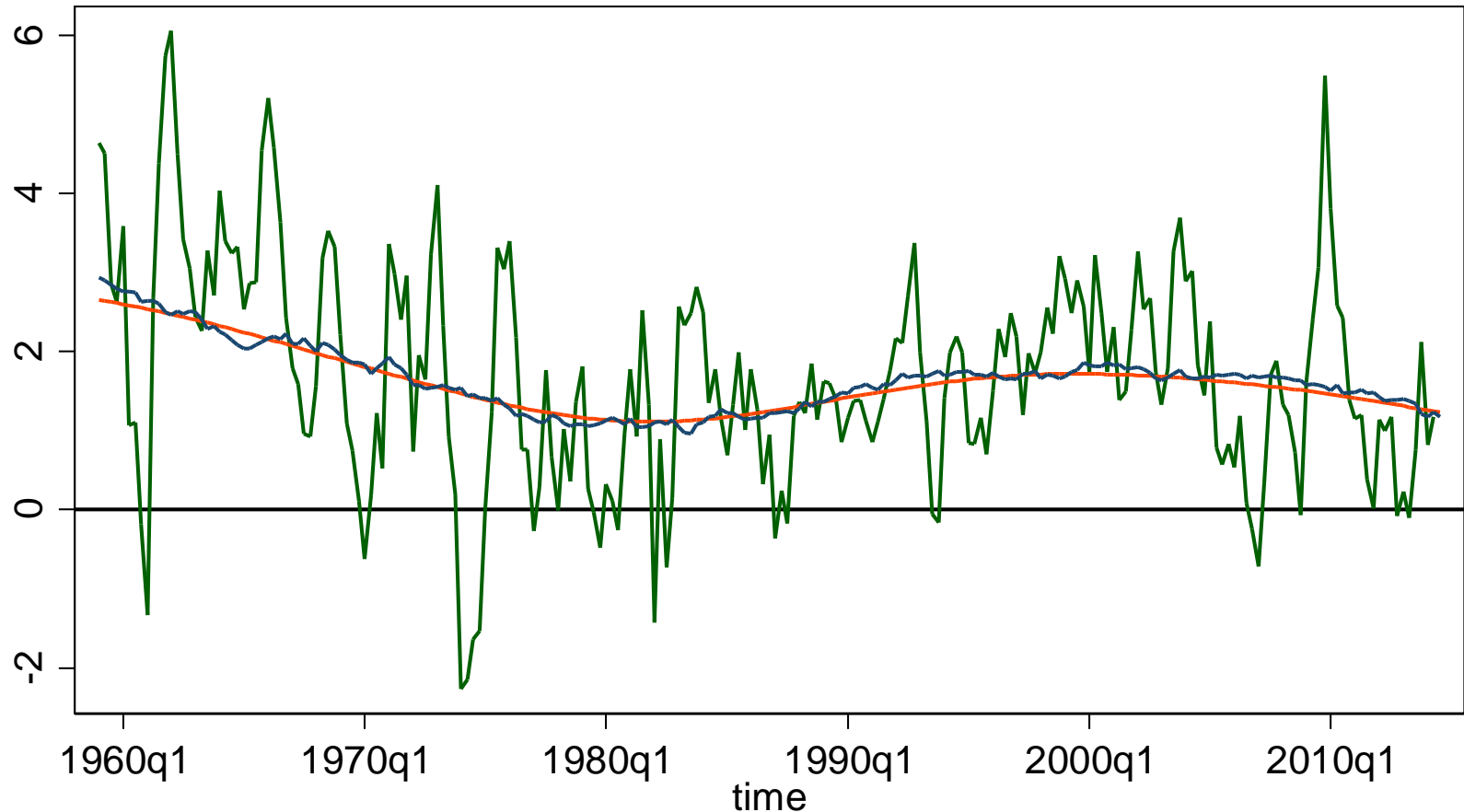
$$\Delta \ln GDP_t = \Delta \ln Productivity_t + \Delta \ln WklyHrs_t + \Delta \ln EmpRate_t + \Delta \ln LFPR_t + \Delta \ln Pop_t$$

## Real GDP: 4Q growth rates and trends



## 3b(i) Productivity

Economy-wide productivity: 4Q growth rates and trends



# Productivity

The past ~10 years have seen very slow productivity growth:  
Are we reverting to a slow-growth period (Gordon)?



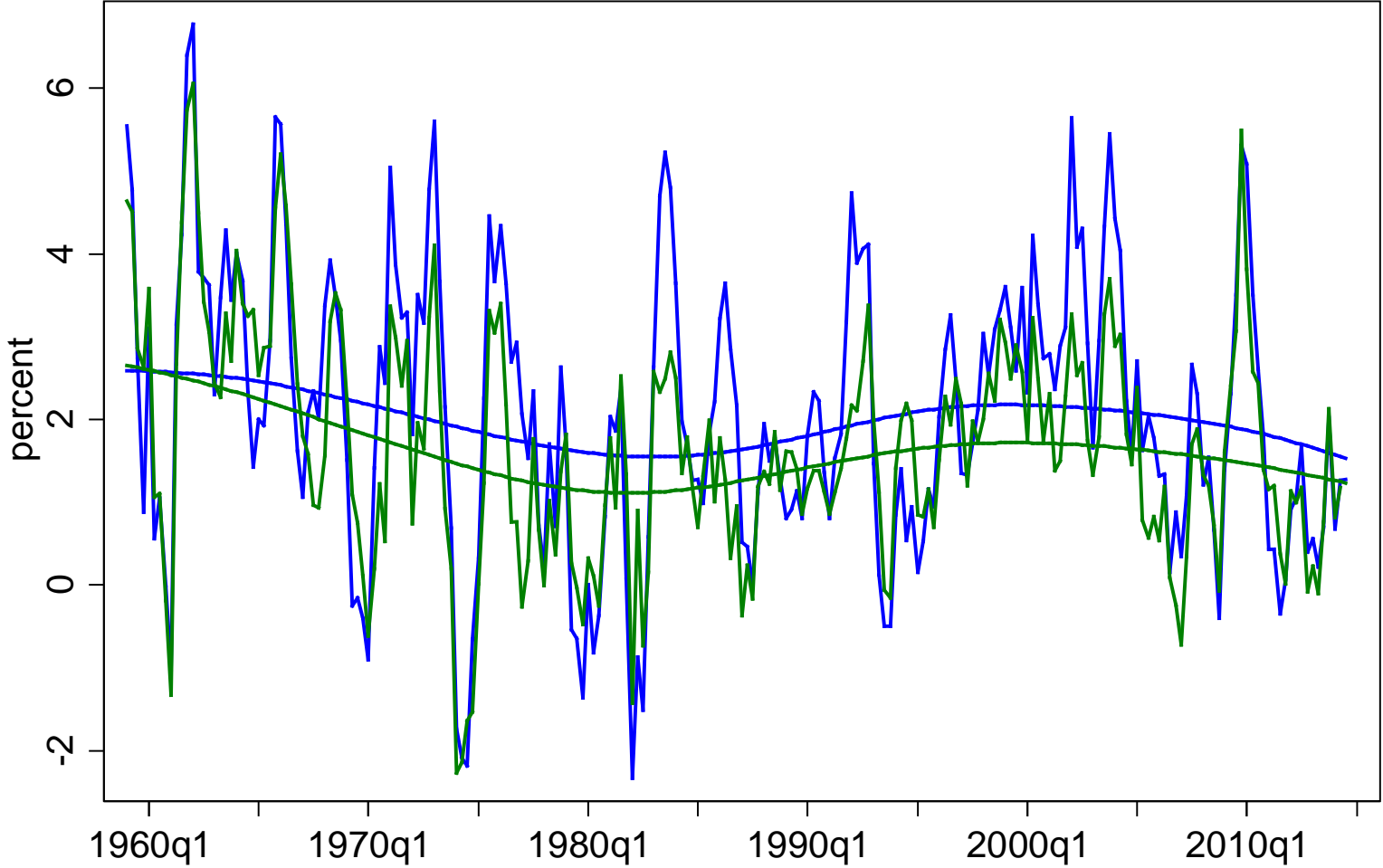
## Four observations

1. Data remark: Economy-wide v. NFB productivity growth
2. Is the slow productivity growth a normal cyclical movement, or unusual?
3. Regime shifts in productivity growth?
4. A stray piece of evidence from agriculture

# Productivity

1. Data remark: Economy-wide v. NFB productivity growth

Labor productivity: 4-quarter growth:  
Non-farm business (blue) and economy-wide (green)



# Productivity

## 2. Is the slow productivity growth a normal cyclical movement, or unusual?

### NFB Labor Productivity, 4-quarter growth, and cyclical component

- Cyclical component estimated **1960q1-2007q4**
- 95% confidence interval for predicted cyclical component is shown in orange
- No time-varying parameters

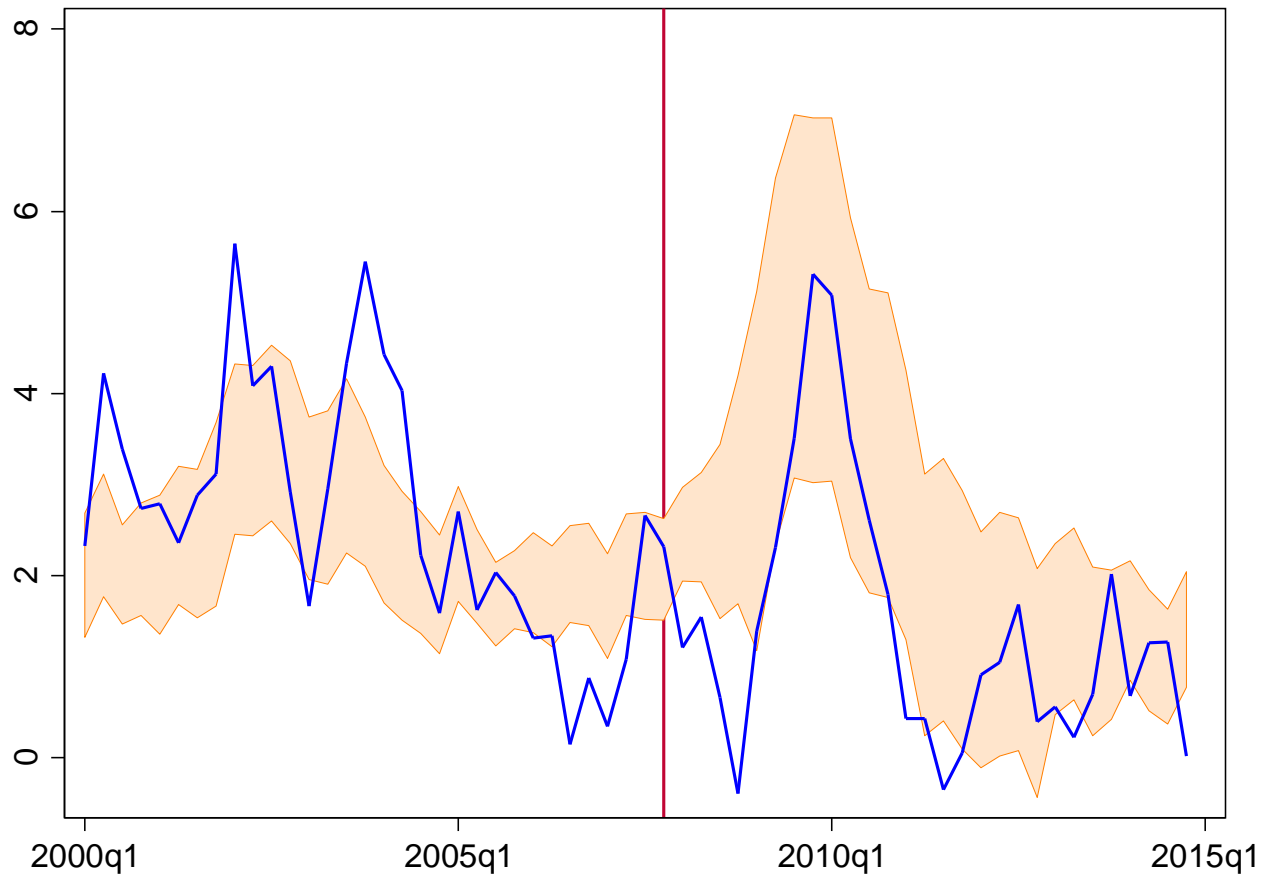


# Productivity

## 2. Is the slow productivity growth a normal cyclical movement, or unusual?

### NFB Labor Productivity, 4-quarter growth, and cyclical component

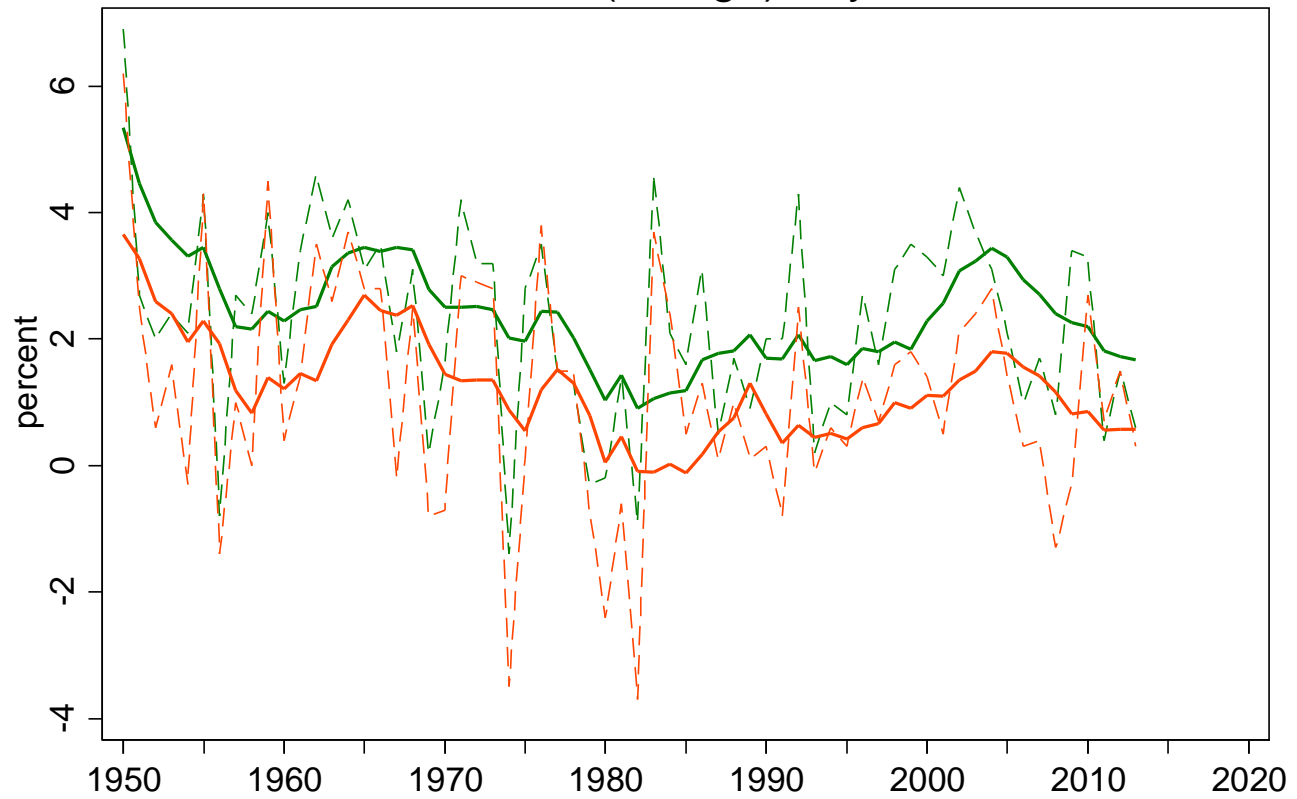
- Cyclical component estimated **1984q1-2007q4**
- 95% confidence interval for predicted cyclical component is shown in orange
- No time-varying parameters



# Productivity

## 3. Regime shifts in productivity growth?

Growth of NFB labor productivity (green) and TFP (orange), 7-yr MA



HAR break tests (2-regime), breaks in 1974 and 1998:

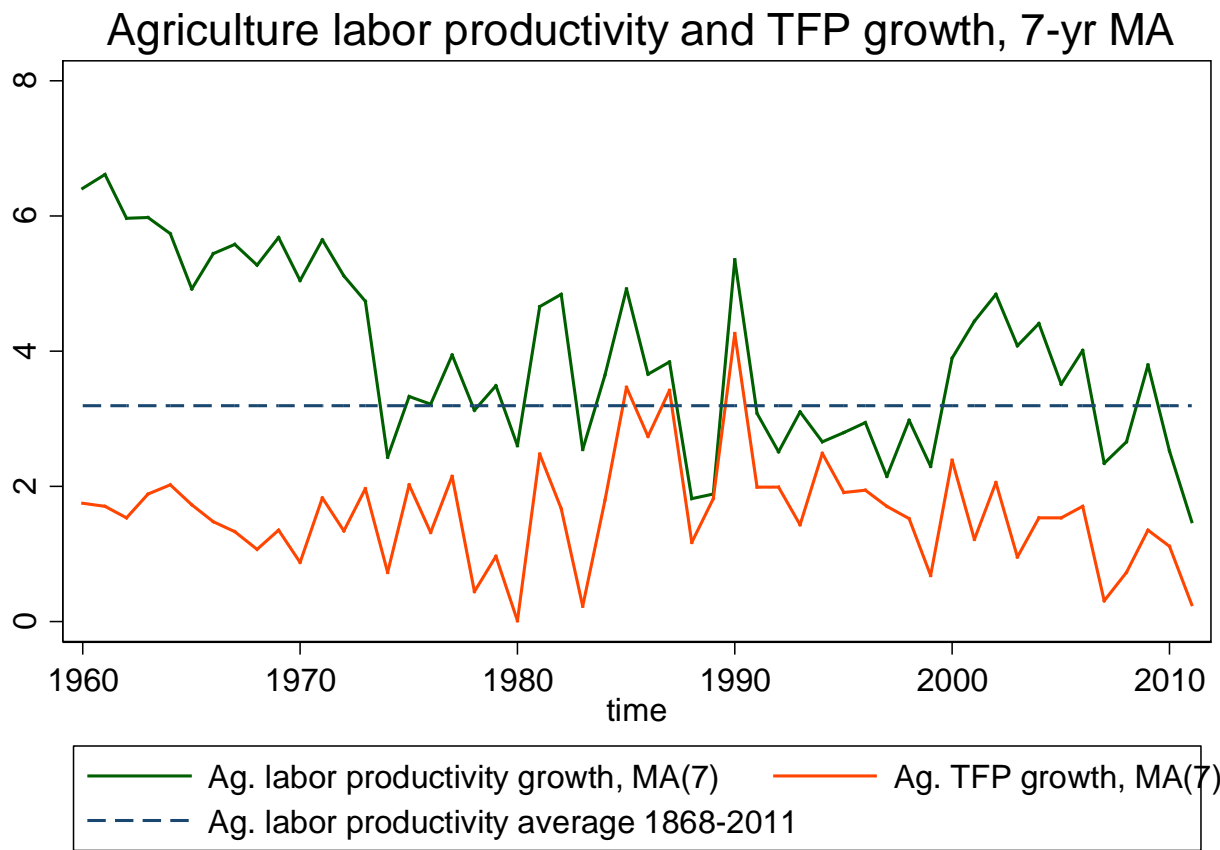
	<u>F-stat</u>	<u>p (given break)</u>	<u>p (break estimated)</u>
Labor productivity:	4.21	.020	>0.9
MFP	6.34	.003	0.8
Joint (SUR, same dates)	3.01	.017	>0.9

# Productivity

## 4. A stray piece of evidence from agriculture

### Agricultural Productivity

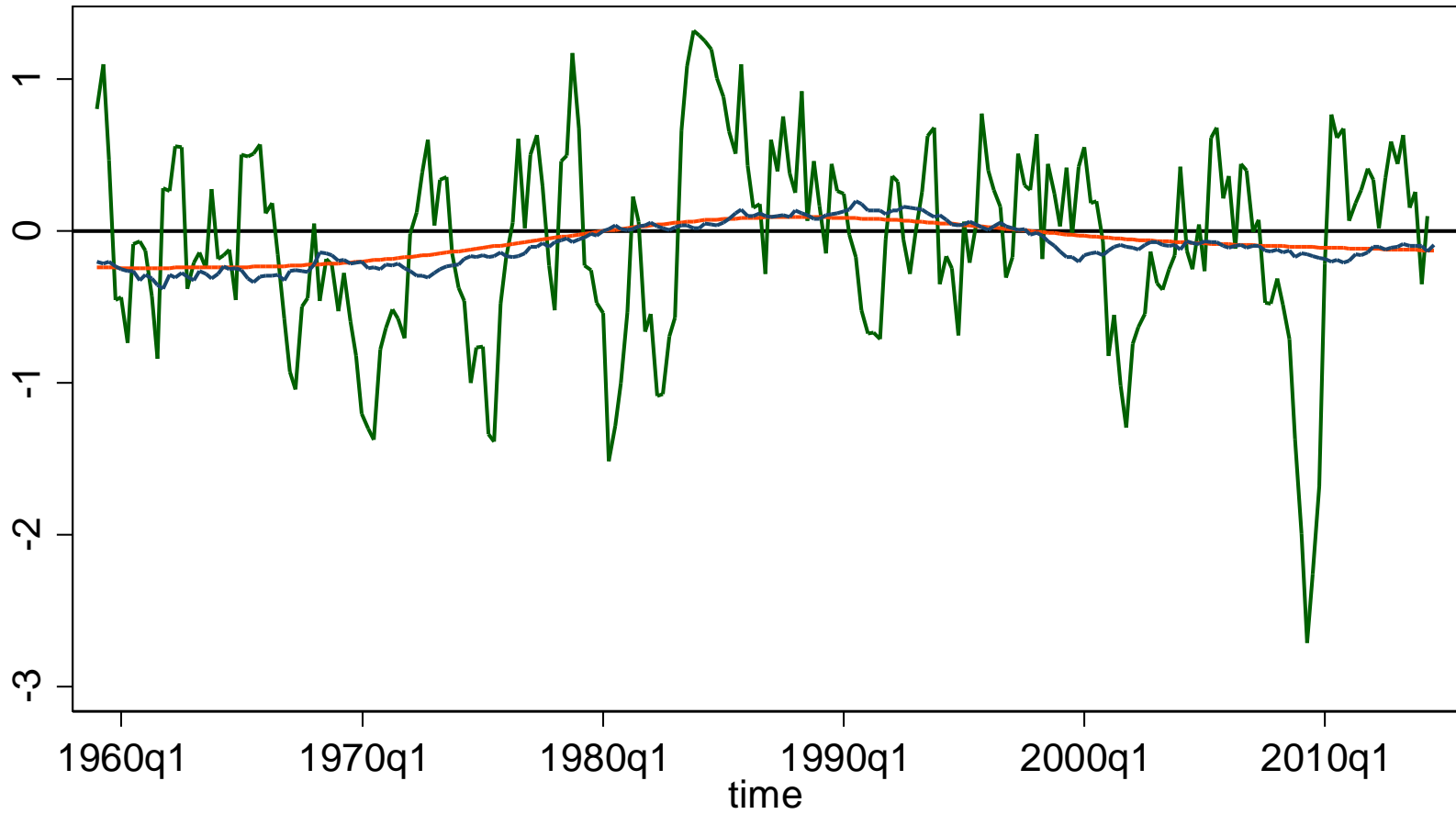
- Labor productivity growth (7r MA)
- TFP growth (7r MA)
- Labor productivity growth, 1868-2011 (3.2%)



- Outputs and inputs are relatively well-measured
- Little evidence of a labor productivity or TFP slowdown
- In fact, ag. labor productivity growth 1975-present fluctuates around its post-1868 average [Iowa corn, Parker and Klein (1966), 1870 Census of Mfgs, BLS, USDA; CEA ERP (2014)]

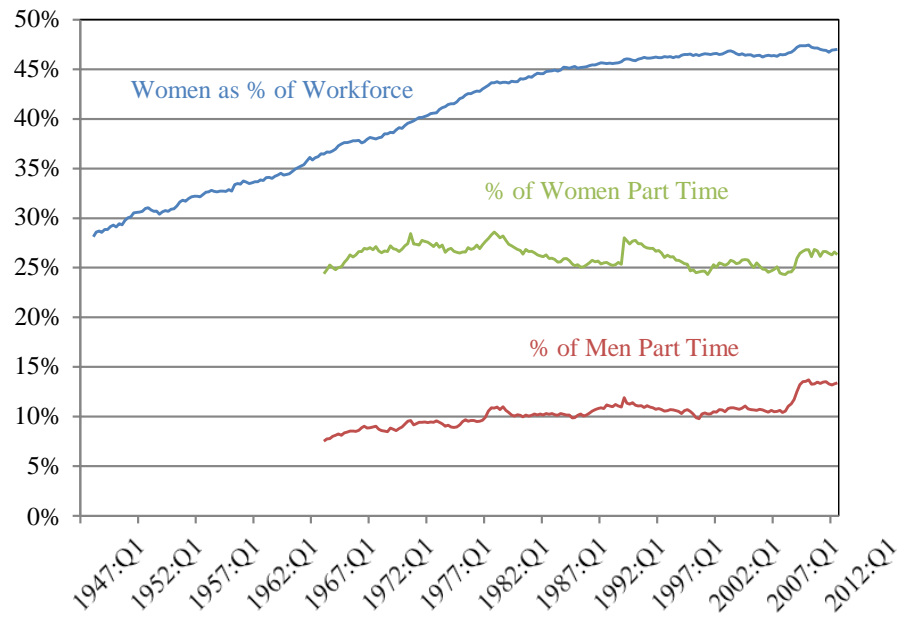
# Employee-hours

## Hours per employee (HH): 4Q growth rates and trends

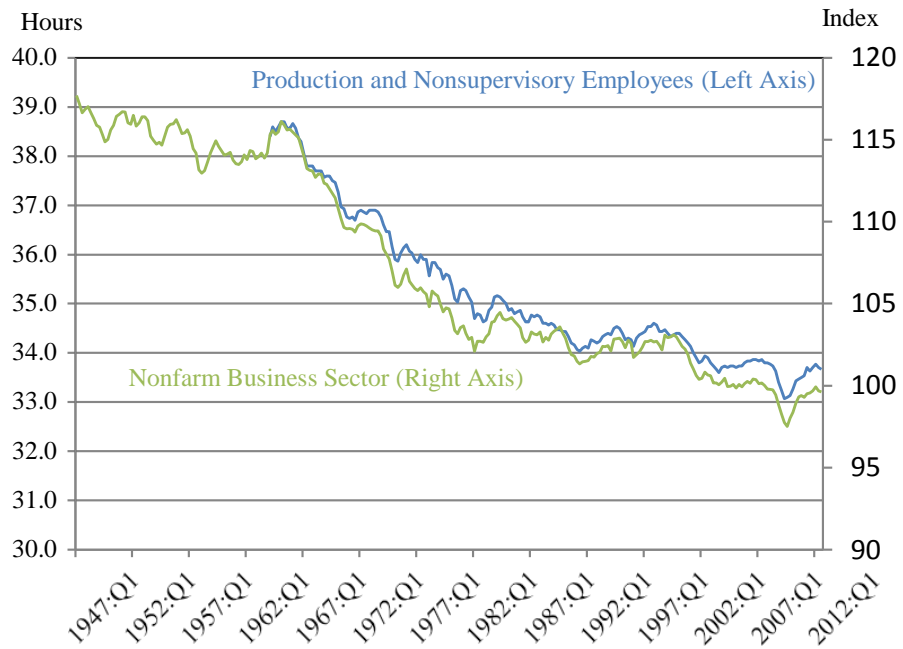


# Employee-hours

Weekly Hours of Men and Women



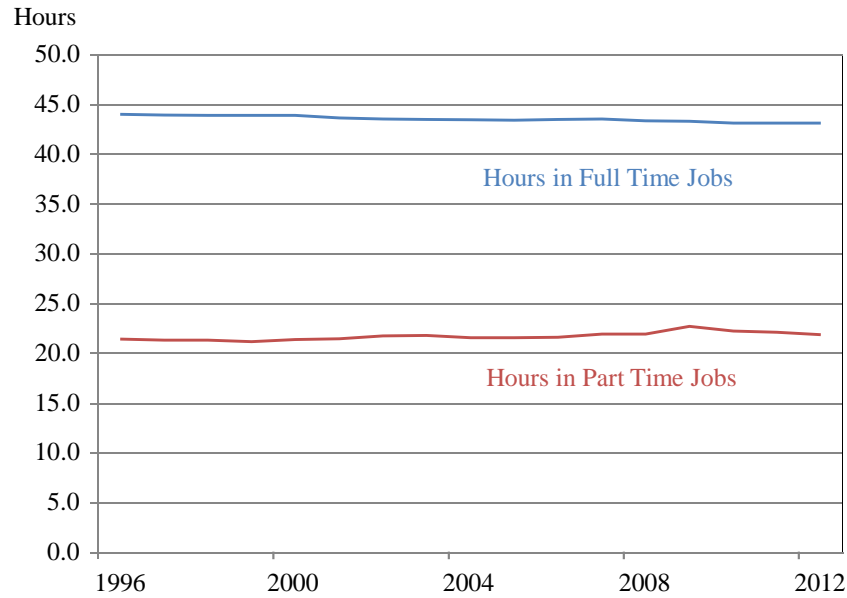
Average Weekly Hours



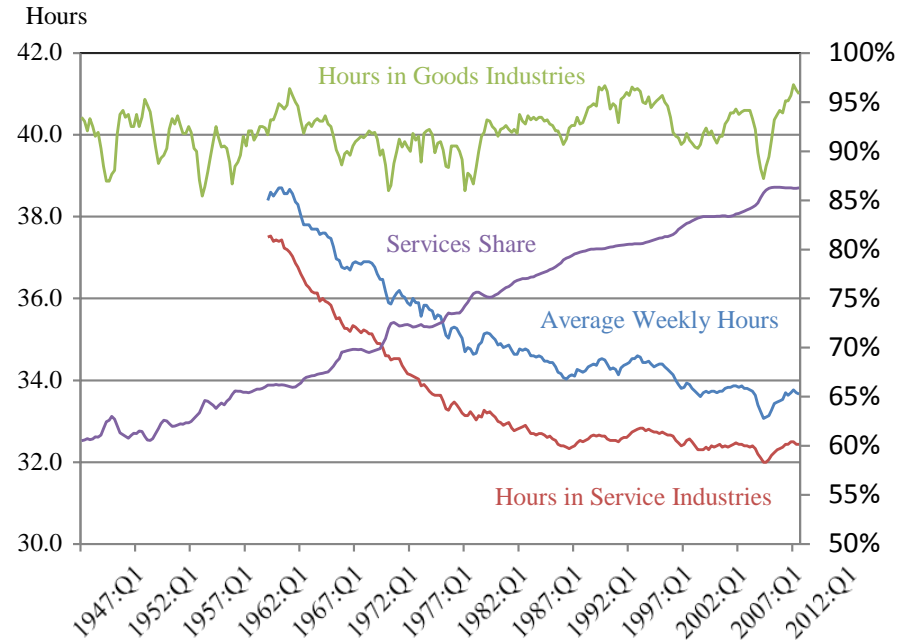
- Overall weekly hours fell during the 1970s, have fallen less since then
- Shift-share decomposition suggests that the decline in hours is largely compositional
- Women work part-time more than men – both shares are fairly stable – and entered the workforce strongly in the 1970s, with a plateau around 2000

# Employee-hours

Weekly Hours for Full-Time and Part-Time Workers



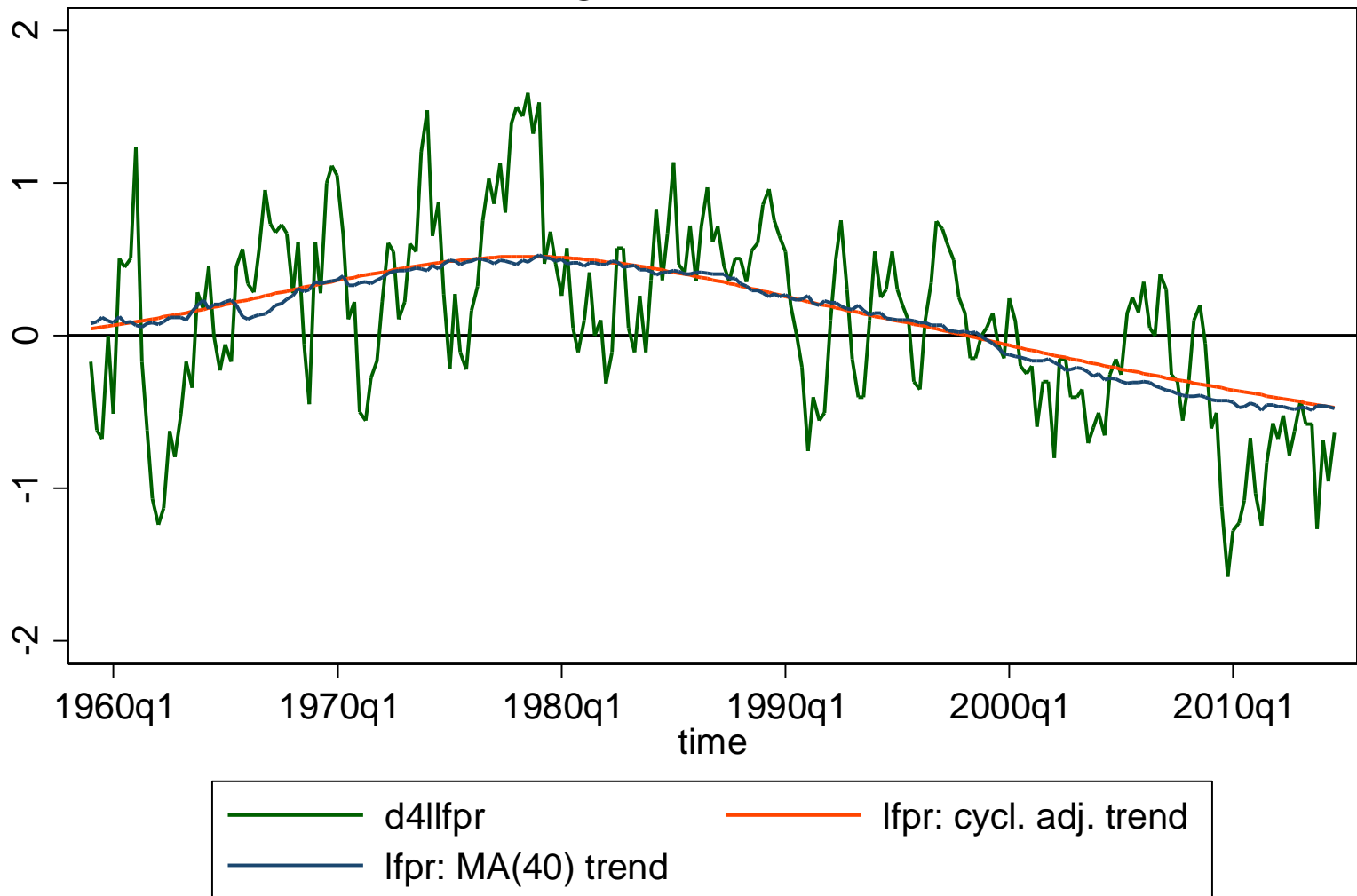
Weekly Hours, Services and Goods-Producing Industries



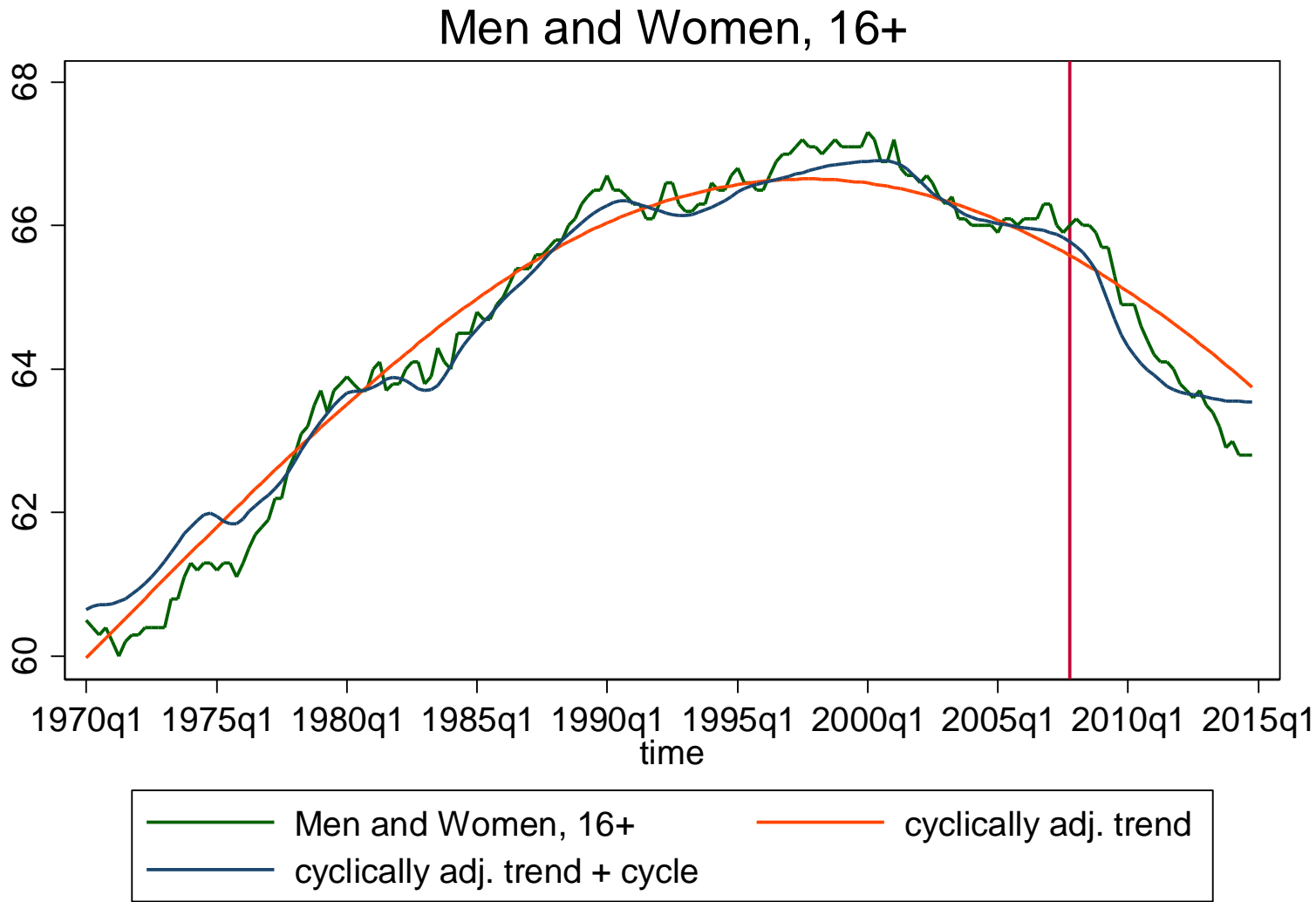
- Full-time and part-time hours have remained remarkably steady
- There has also been a shift from goods-producing industries (with hours around 40) to services (with lower hours, around 32.5 since the mid-80s).

# Labor Force Participation Rate (LFPR)

## LFPR: 4Q growth rates and trends

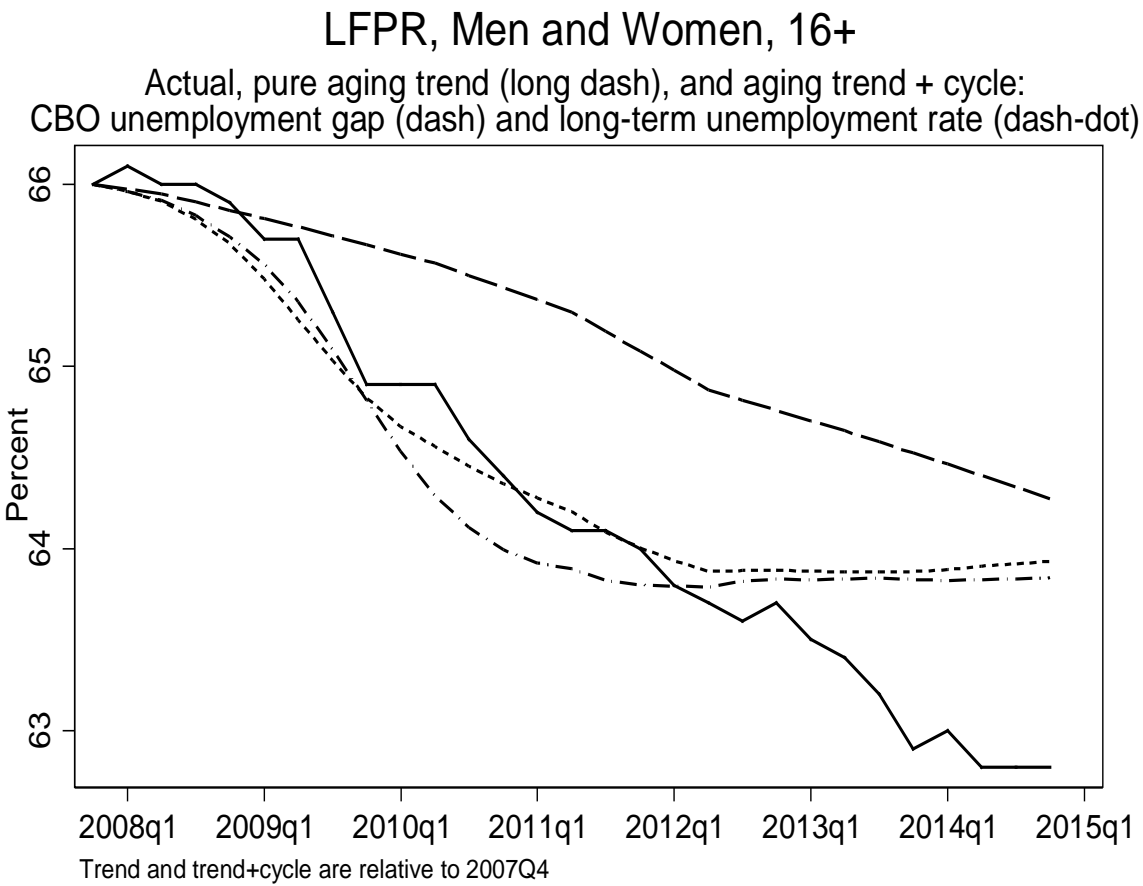


# Labor Force Participation Rate (LFPR)

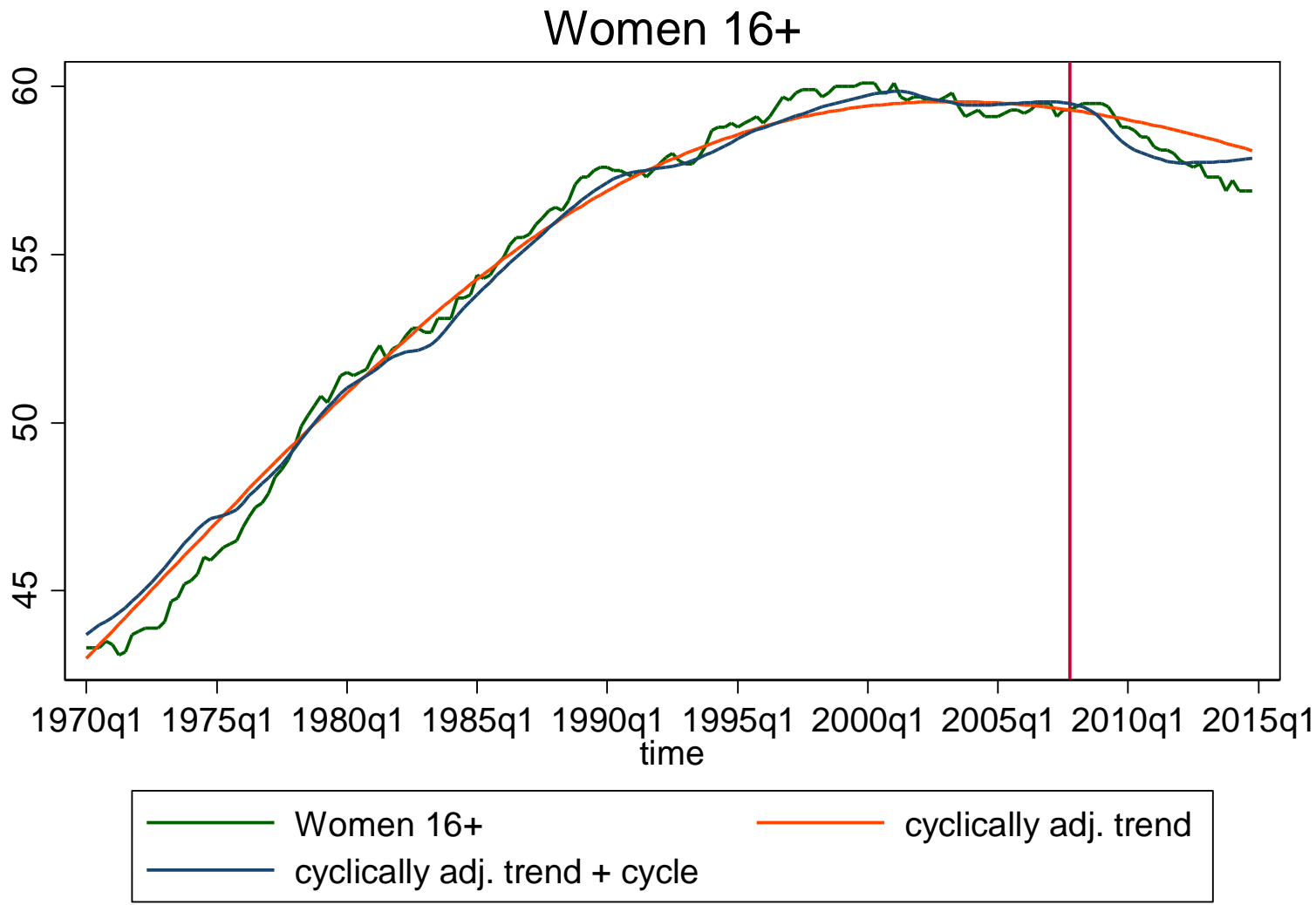


# LFPR since 2007q4 (total)

- Currently, the dominant trend is the retirement of the Baby Boom
- The pure aging effect is calculated by holding the 2007 age profile constant and letting the population age (i.e. retire at historically normal rates)
- The pure aging trend and the time series trends are virtually identical

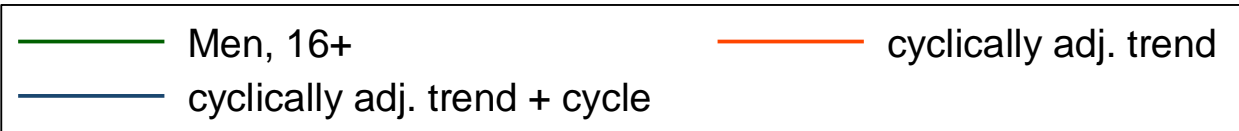
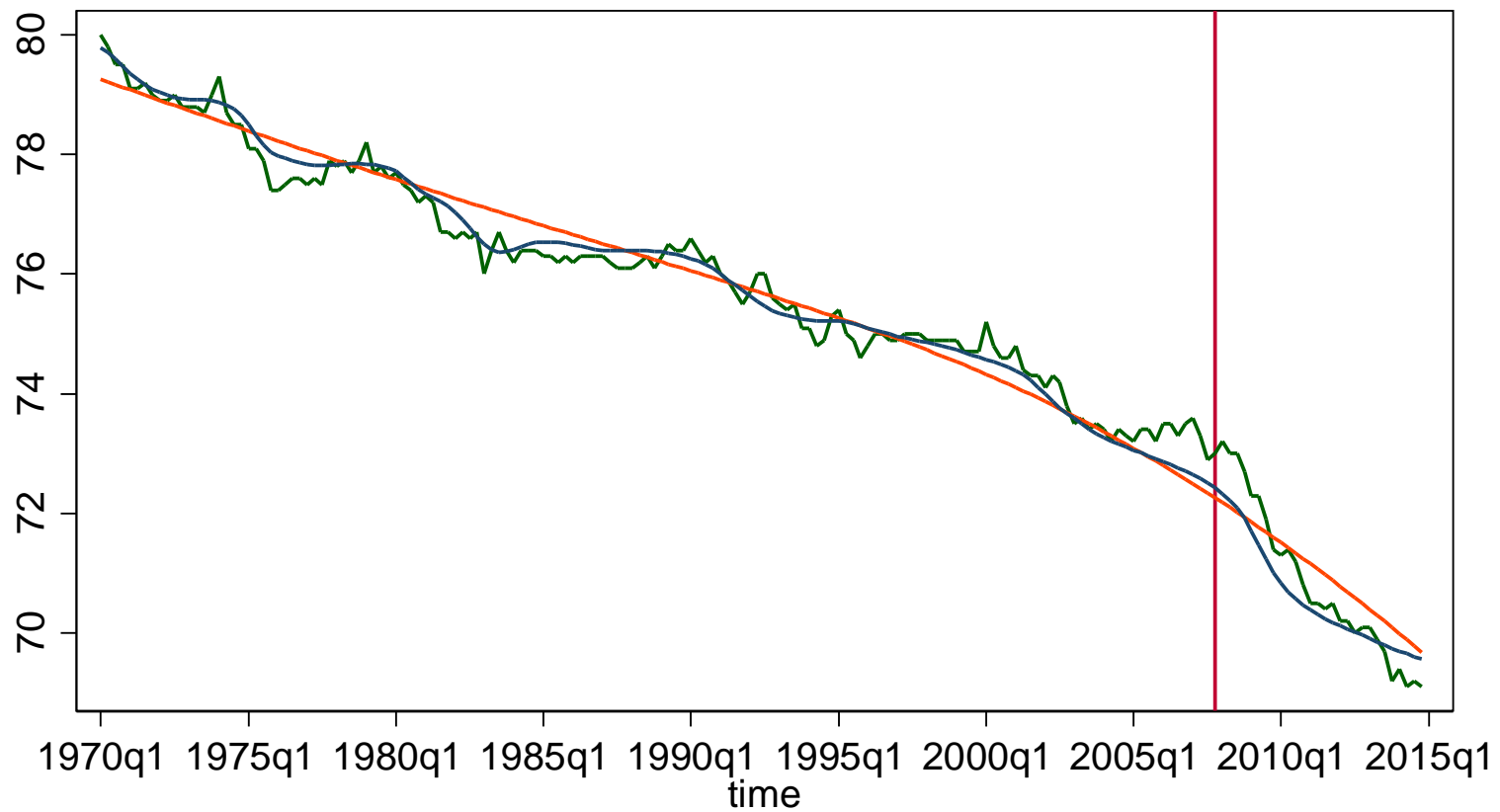


# LFPR, Women 16+



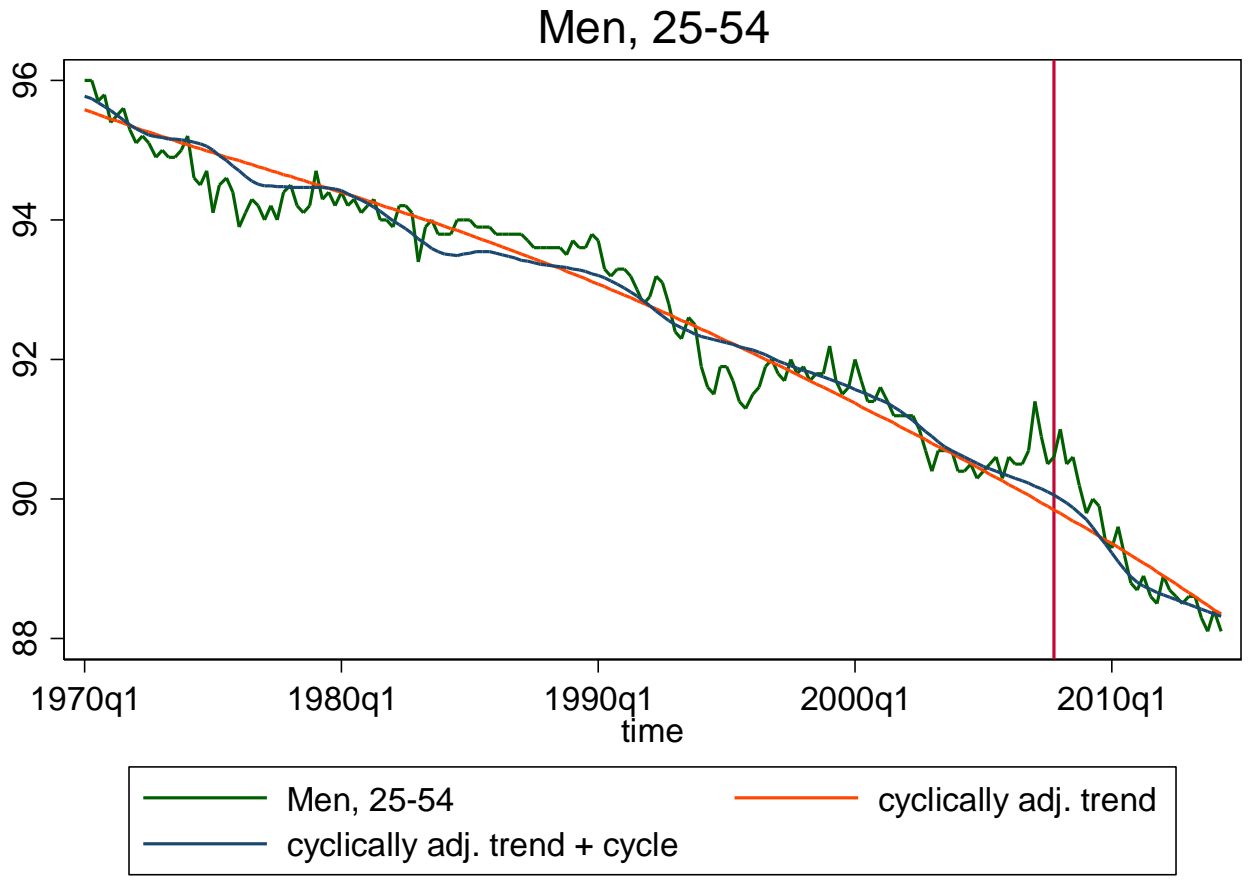
# LFPR, men 16+

## Men, 16+



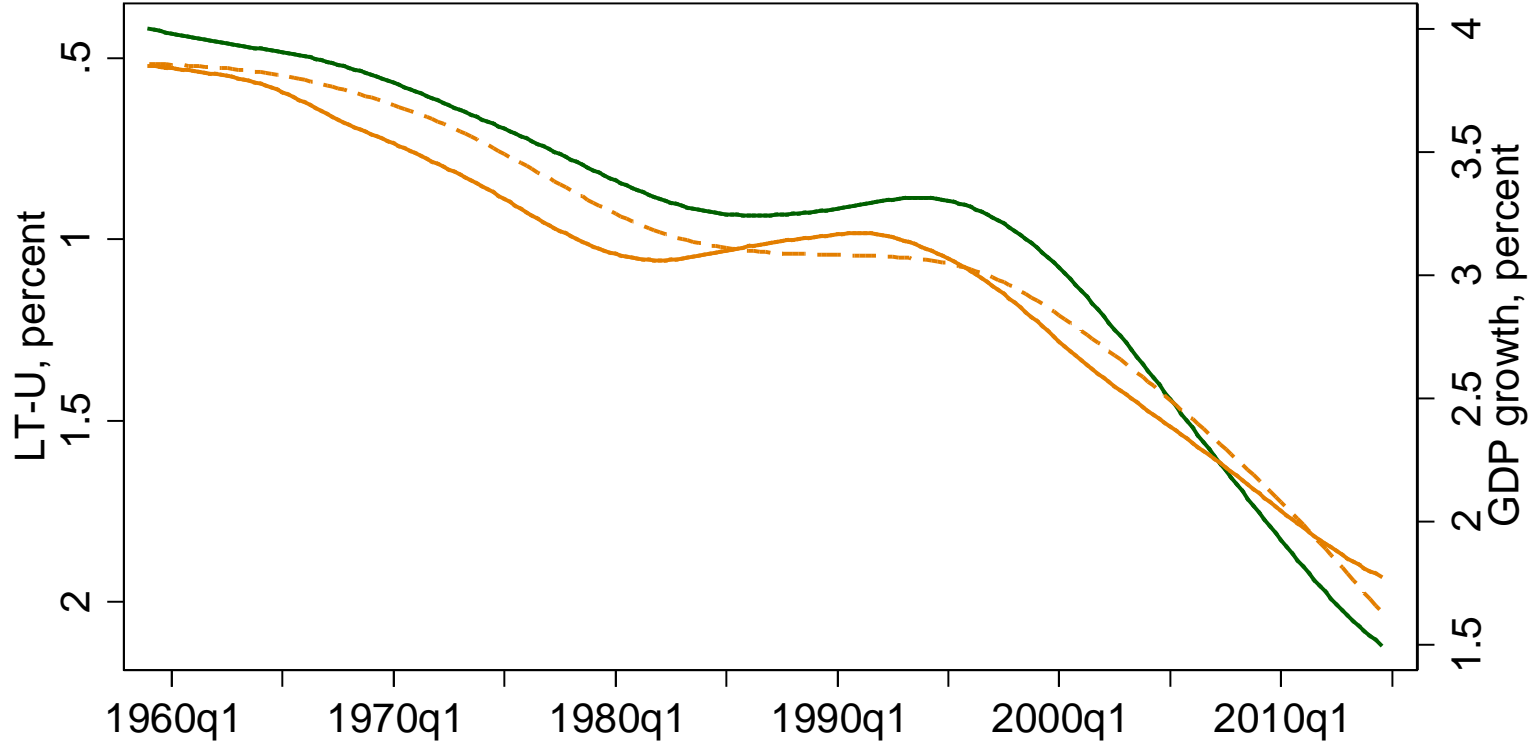
# LFPR, men 25-54

- For men, the downward decline in the LFPR has been ongoing for decades – that isn't an aging effect
- Cyclical LFPR movements for men 25-54 are small
- A key question is whether this preexisting non-aging trend decline will continue, on top of the aging effect?



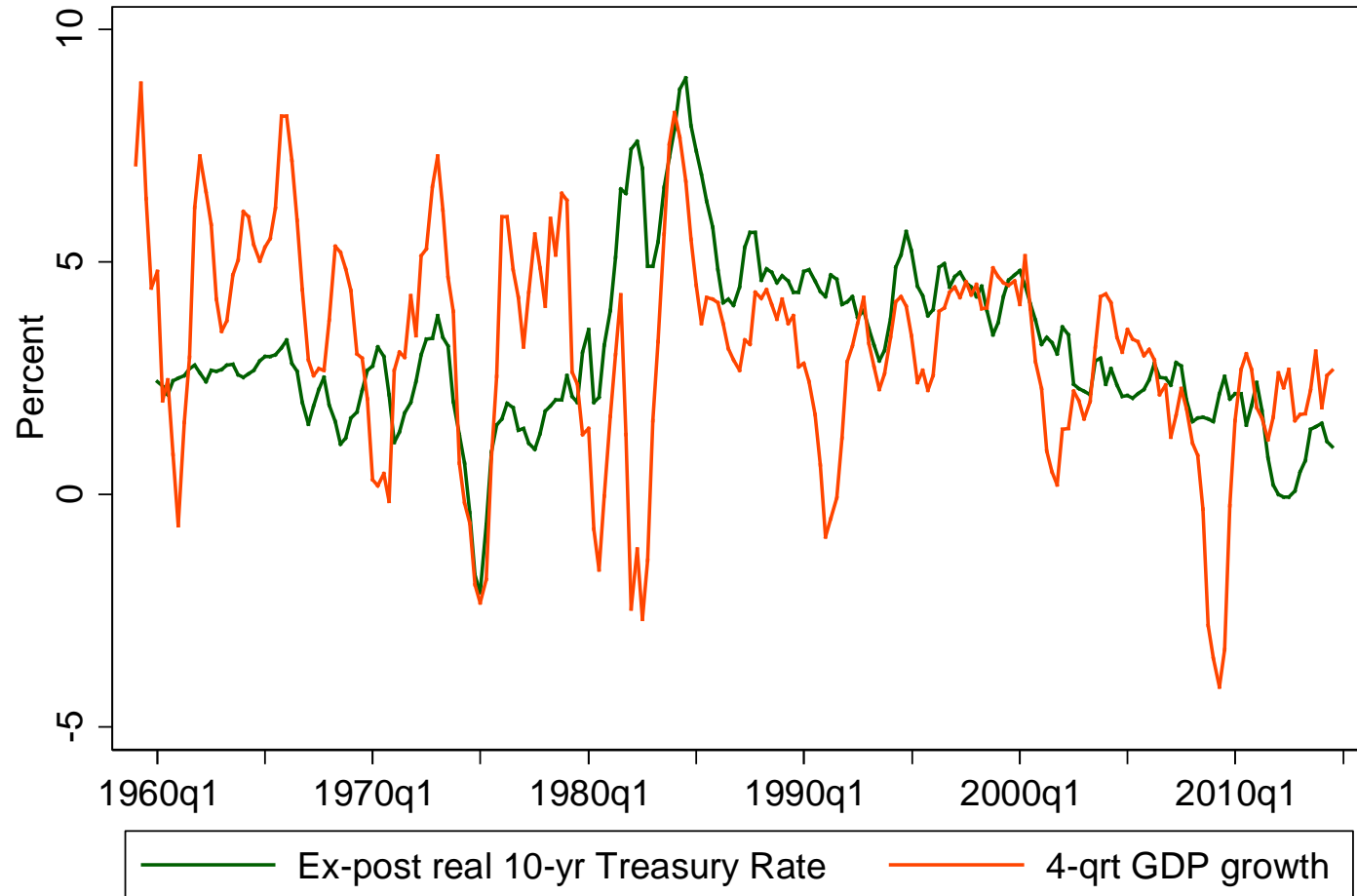
# Long-term unemployment (>26 weeks)

## Trends in GDP growth and long-term unemployment rate (inverted)



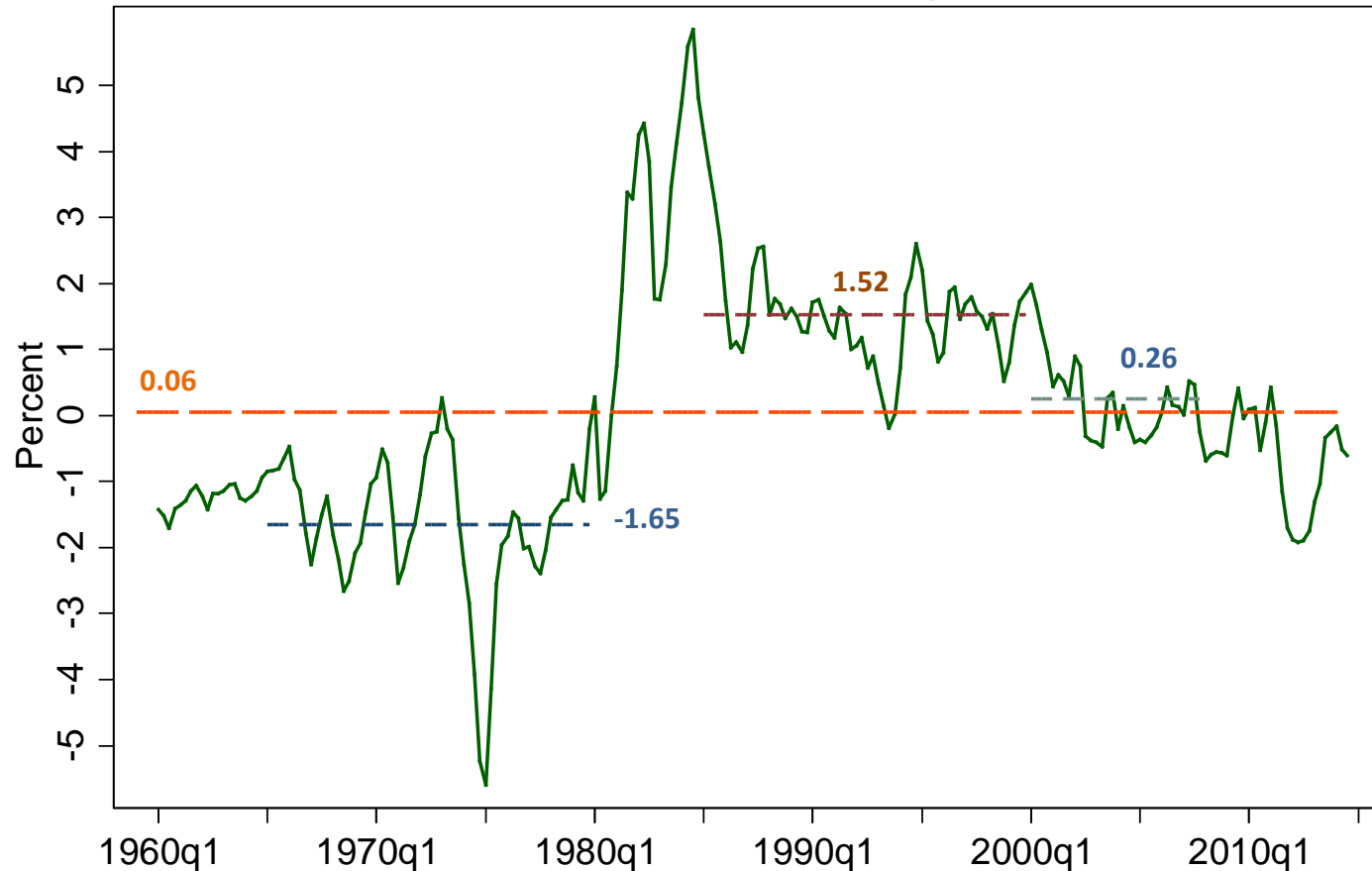
- LT-U trend, not cyclically adjusted
- GDP trend, not cyclically adjusted
- - - GDP trend, cyclically adjusted

## 10 year Treasury rate and 4-quarter GDP growth



- Since 1985, the 10-year Treasury rate has followed the decline in real GDP growth
- Both series are noisy and cyclical...

## r-g: Ex-post real 10-yr Treasury Rate minus CA trend GDP growth



- During the late 60's and 70's, inflation forecasts were too low
- During the late 80's and 90's, inflation forecasts were too high
- During 2000-2007, inflation forecasts were right on average and r-g averaged  $\sim 0$
- This points to r-g close to zero; the post-1960 average is 0.06
- A decline in g of 0.9pp since 1995 corresponds to a comparable decline in r