

*Mary Daly (FRBSF, IZA, and USC), Bart Hobijn (FRBSF, VU Amsterdam, and TI)*

# DOWNWARD NOMINAL WAGE RIGIDITIES BEND THE PHILLIPS CURVE

Disclaimer: The views expressed in this presentation are those of the authors and do not necessarily reflect those of the Federal Reserve Bank of San Francisco or the Federal Reserve System as a whole.

# What we do in this paper...

- Record-high fraction of U.S. workers with wage frozen in aftermath of Great Recession.
- Even as unemployment rate has declined, wage growth has continued to slow.
- *Introduce model* of monetary policy and downward wage rigidities.
- Show that *transitional dynamics* of model of downward nominal wage rigidities are qualitatively consistent with facts.

# Our main contribution is...

- *Introduce model* of DNWR and monetary policy

Benigno and Ricci (2011)

- Replicate existence of long-run Phillips Curve from other models in the literature.

“Inflation greases the wheels of the labor market”

Tobin (1972), Akerlof, Dickens, and Perry (1997), Fagan and Messina (2008), Benigno and Ricci (2011)

- Focus on *transitional dynamics*

- Solve for non-linear path in response to a negative demand shock.

Abbritti and Fahr (2013)

- Track the evolution of the distribution of real wages along the equilibrium path.

Solve non-linear transitional dynamics using extended path method by Fair and Taylor (1983)

Part I: Three facts about the U.S. labor market

# **INDIVIDUAL-LEVEL WAGE CHANGES AND THE U.S. WAGE PHILLIPS CURVE**

Fact 1

# NON-NORMAL DISTRIBUTION OF LOG WAGE CHANGES

Akerlof, Dickens, and Perry (1996), Kahn (1997), Card and Hyslop (1997), Altonji and Devereux (2000), Lebow, Saks, and Wilson (2003), Gottschalk (2005), Dickens et al. (2007), Elsby (2009), Daly, Hobijn, and Lucking (2012).

# Wage cuts are rare

## Distribution of 12-month change in log wages in 2006

All workers (hourly and salary, job-stayers and job-switchers)

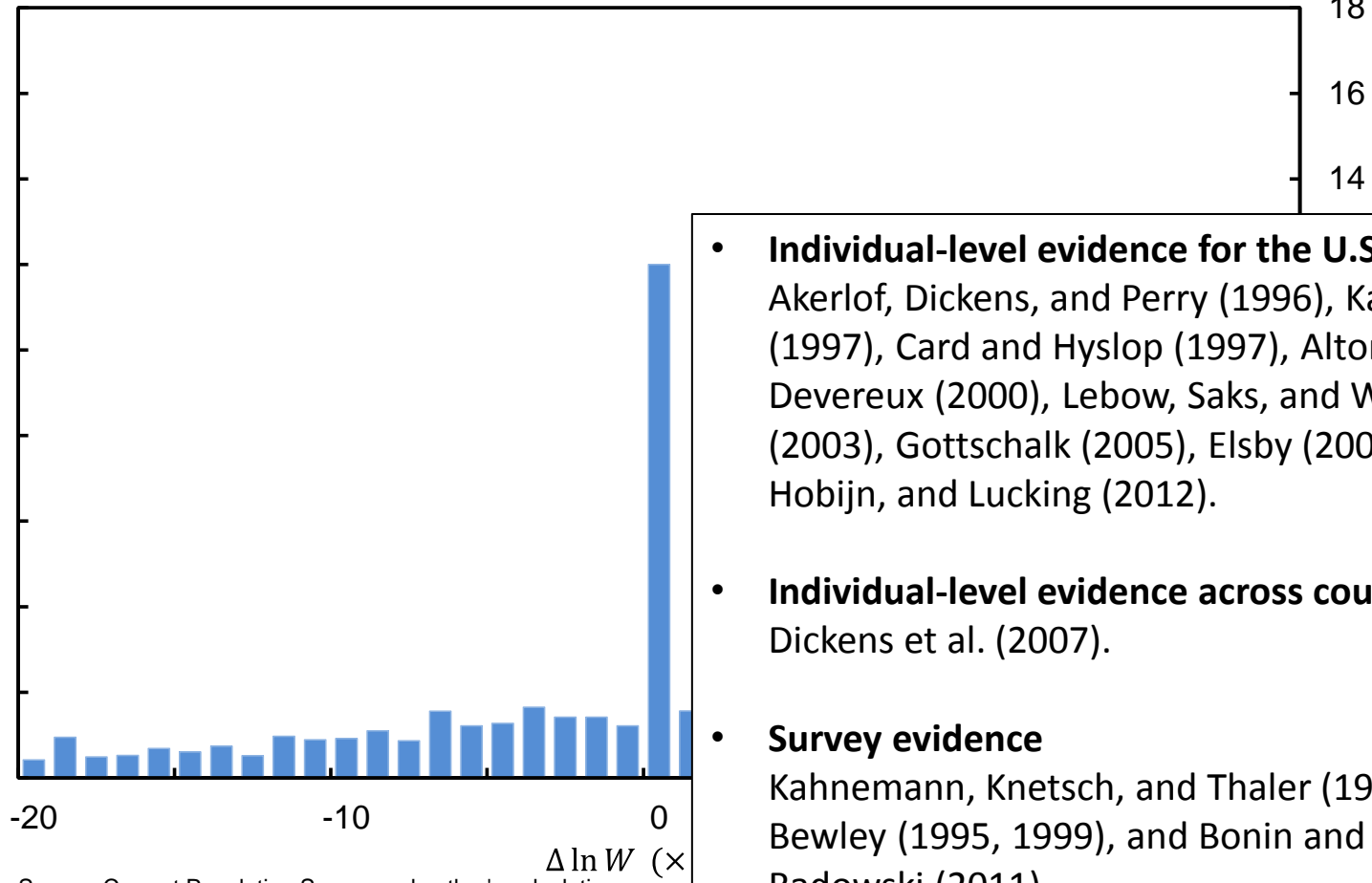


# Rarity of wage cuts well-known

## Distribution of 12-month change in log wages in 2006

All workers (hourly and salary, job-stayers and job-switchers)

Percent

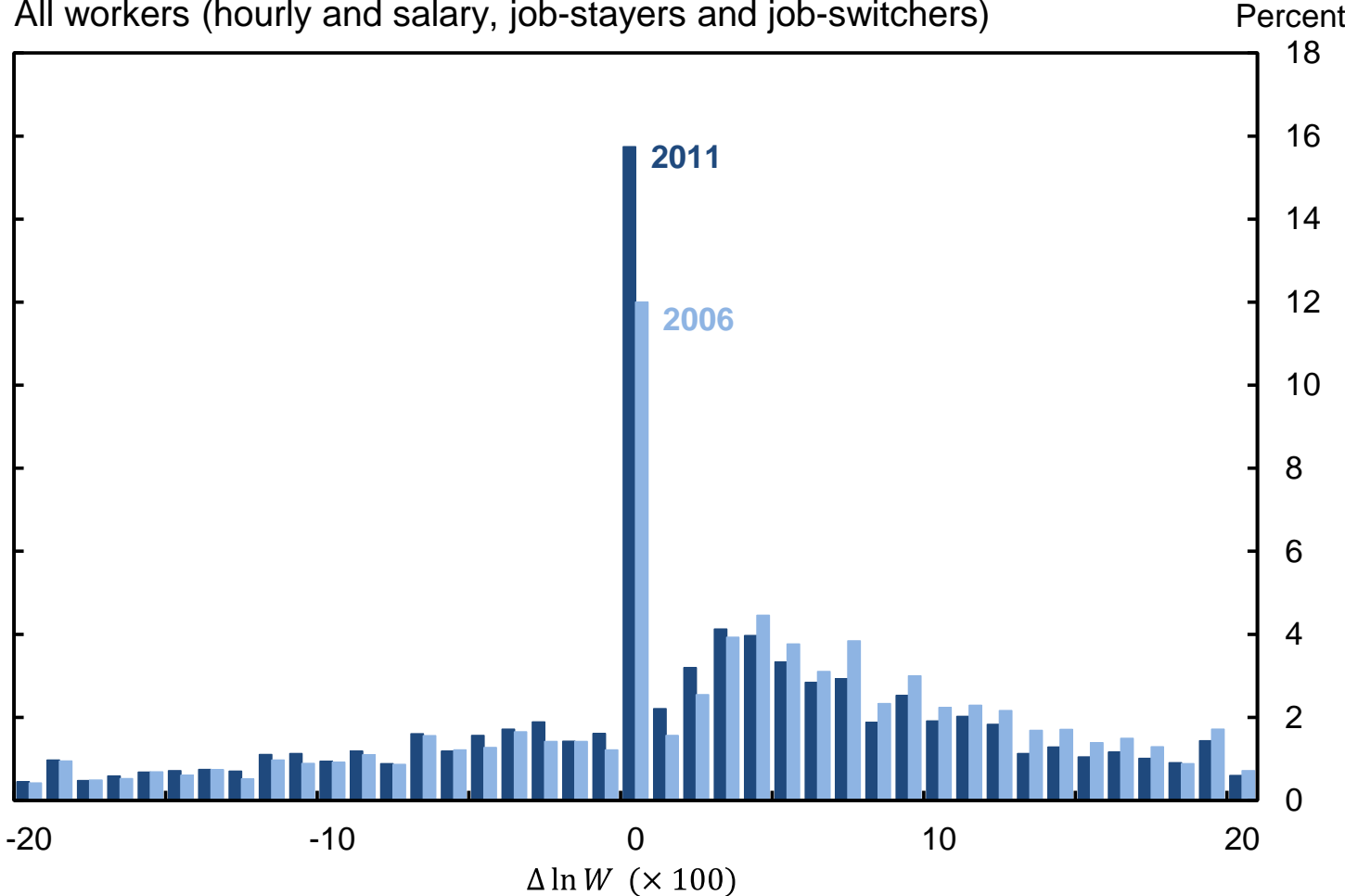


- **Individual-level evidence for the U.S.**  
Akerlof, Dickens, and Perry (1996), Kahn (1997), Card and Hyslop (1997), Altonji and Devereux (2000), Lebow, Saks, and Wilson (2003), Gottschalk (2005), Elsby (2009), Daly, Hobijn, and Lucking (2012).
- **Individual-level evidence across countries**  
Dickens et al. (2007).
- **Survey evidence**  
Kahnemann, Knetsch, and Thaler (1986), Bewley (1995, 1999), and Bonin and Radowski (2011)

# Shift in distribution of wage changes

## Distribution of 12-month change in log wages

All workers (hourly and salary, job-stayers and job-switchers)



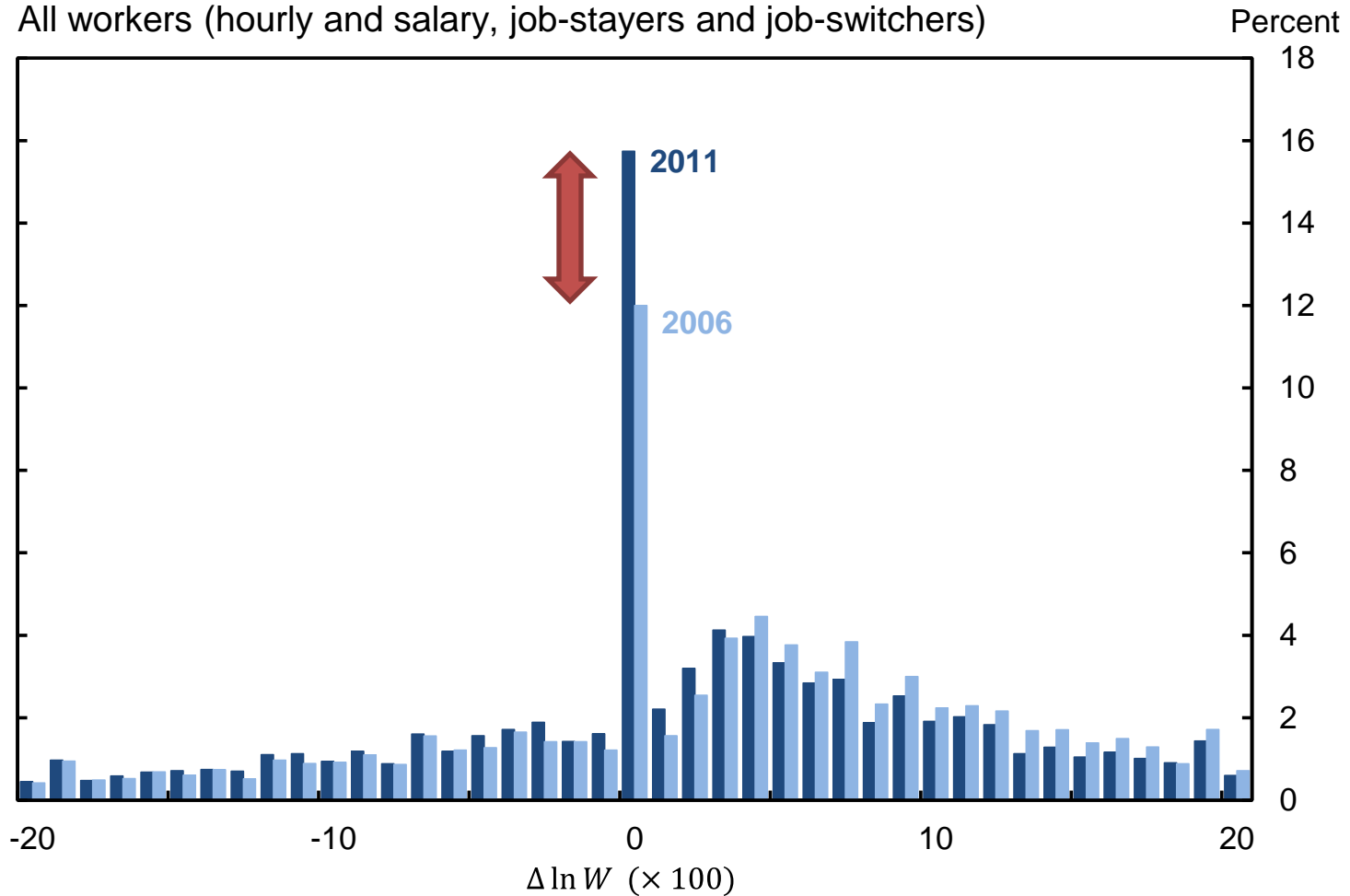
Source: Current Population Survey and author's calculations.



# Increase of spike at zero

## Distribution of 12-month change in log wages

All workers (hourly and salary, job-stayers and job-switchers)

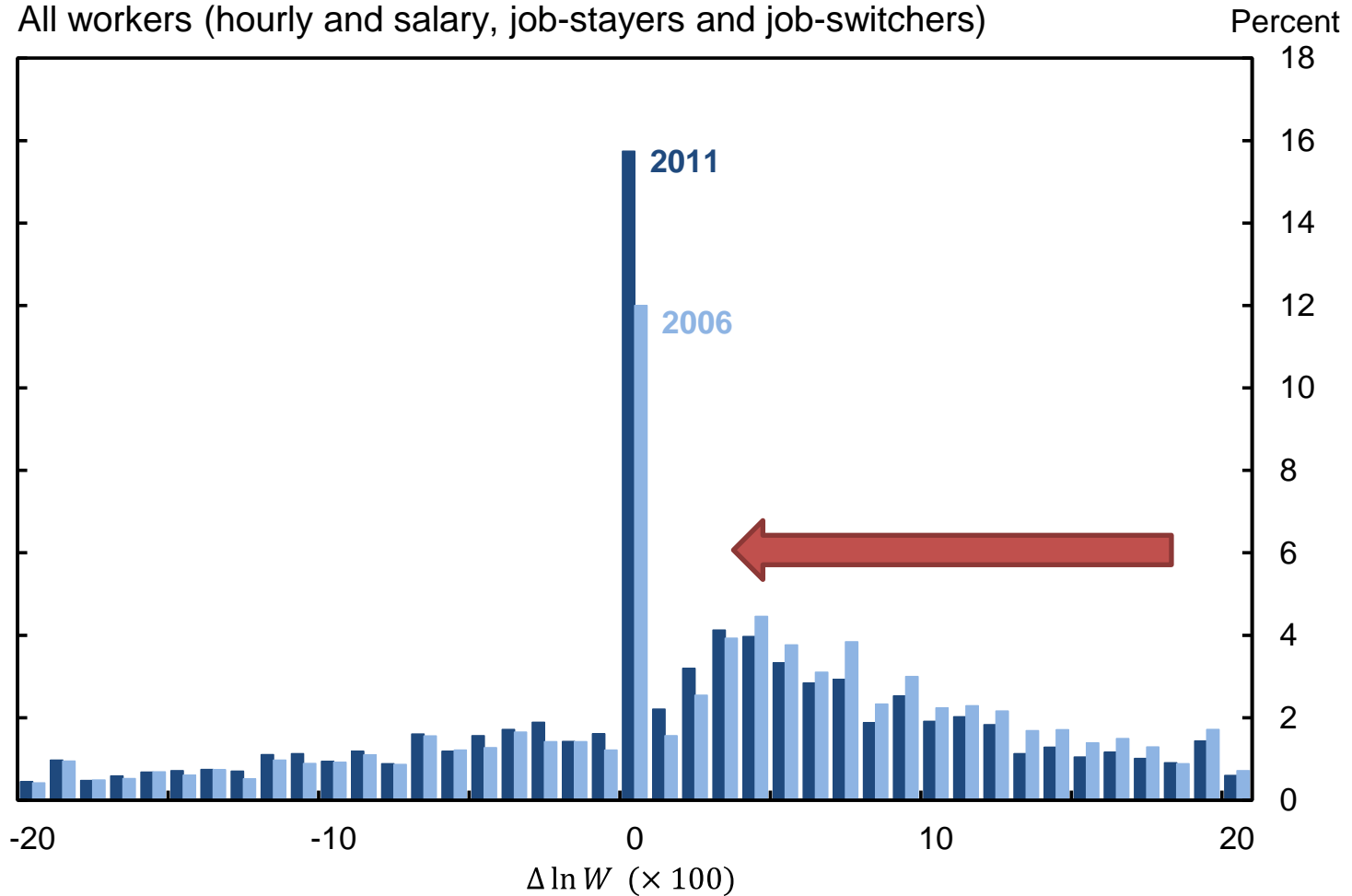


Source: Current Population Survey and author's calculations.

# Compression of wage increases

## Distribution of 12-month change in log wages

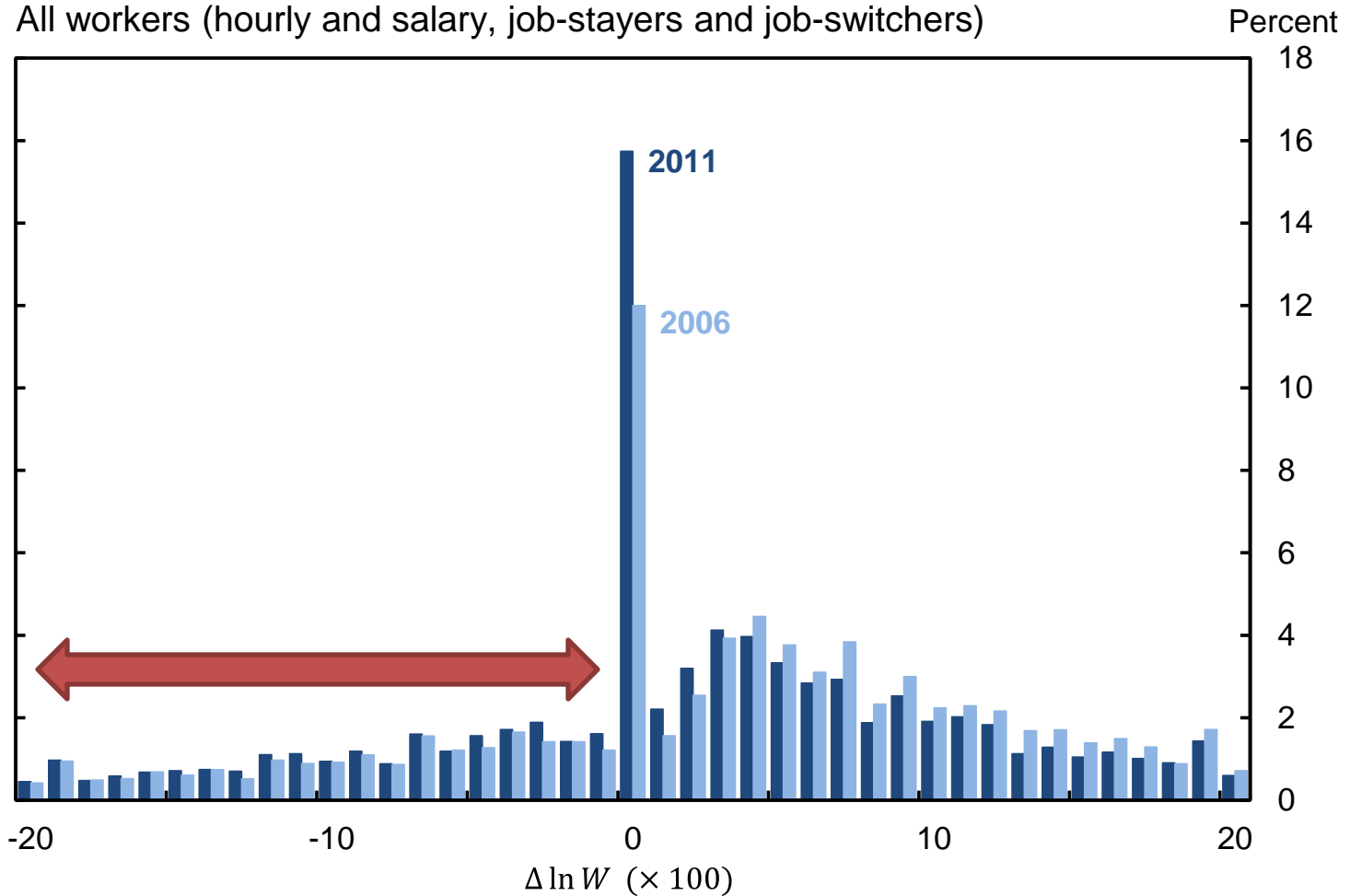
All workers (hourly and salary, job-stayers and job-switchers)



# Not many more wage cuts

## Distribution of 12-month change in log wages

All workers (hourly and salary, job-stayers and job-switchers)



Fact 2

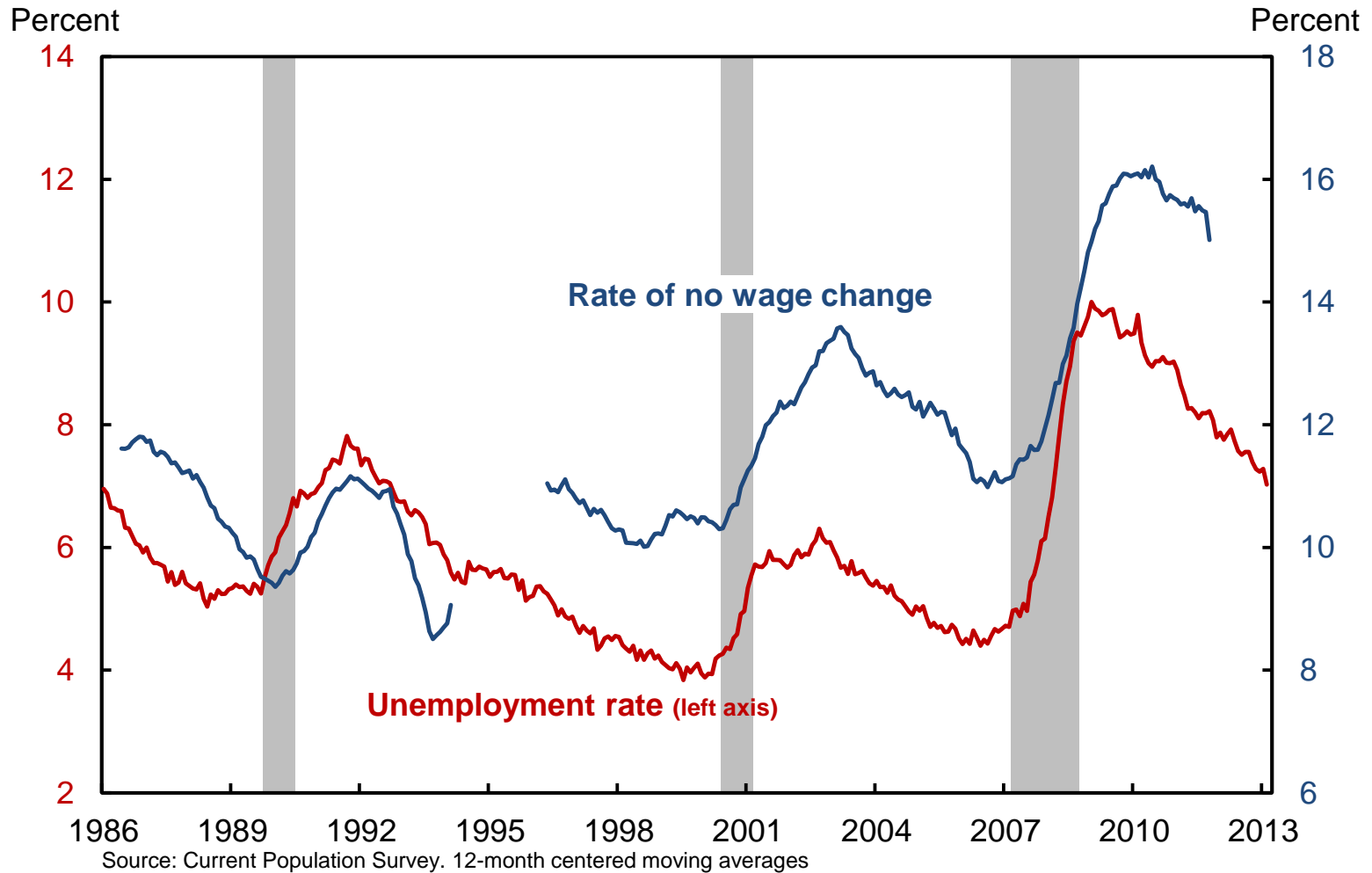
# **SPIKE AT ZERO COUNTERCYCLICAL**

Card and Hyslop (1997)

# Spike increases in recessions

## Unemployment rate and rate of no wage change

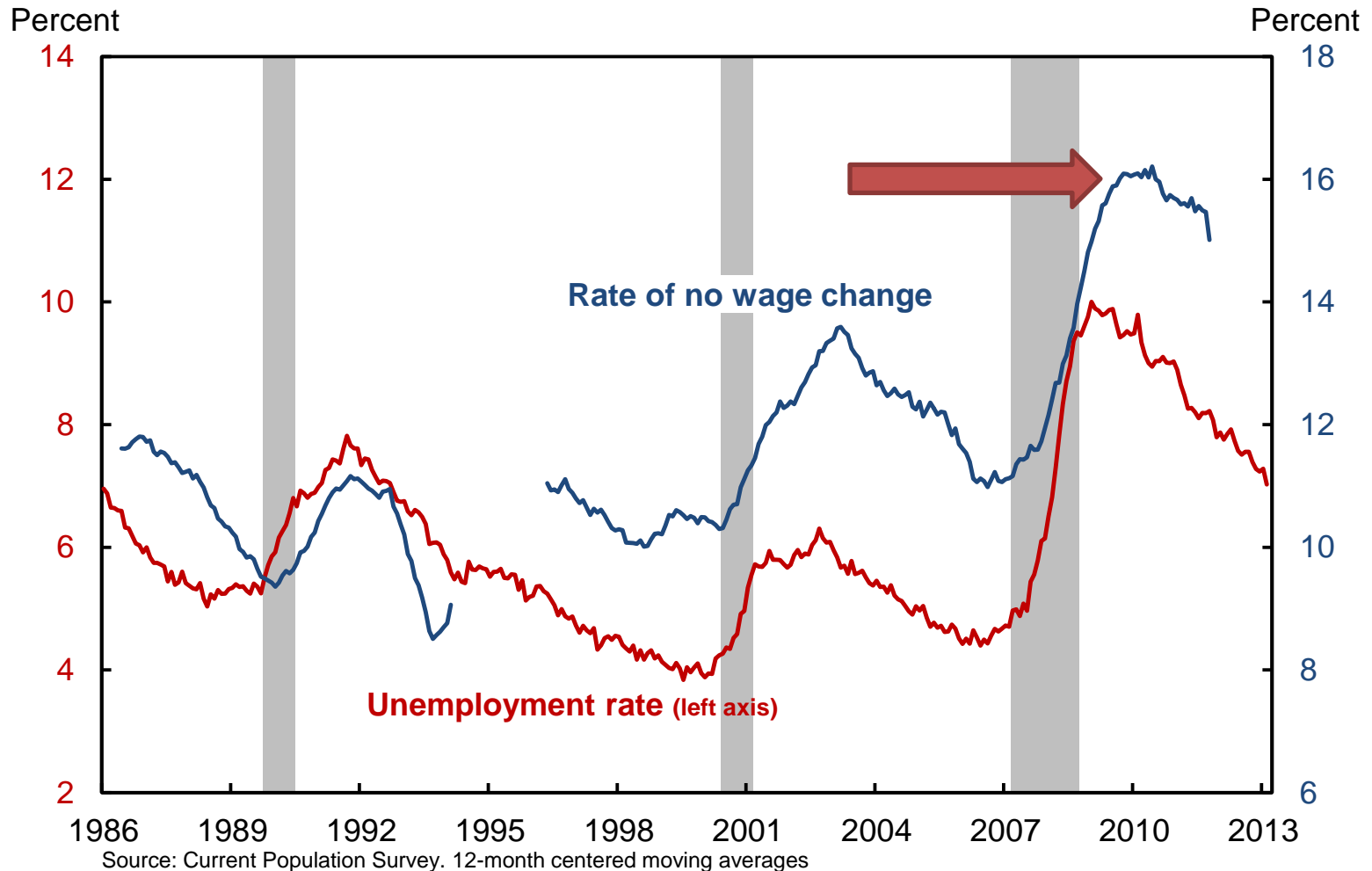
Zero 12-month wage change; All types of workers (hourly, salary, and job switchers, and job stayers)



# Record-high spike after Great Recession

## Unemployment rate and rate of no wage change

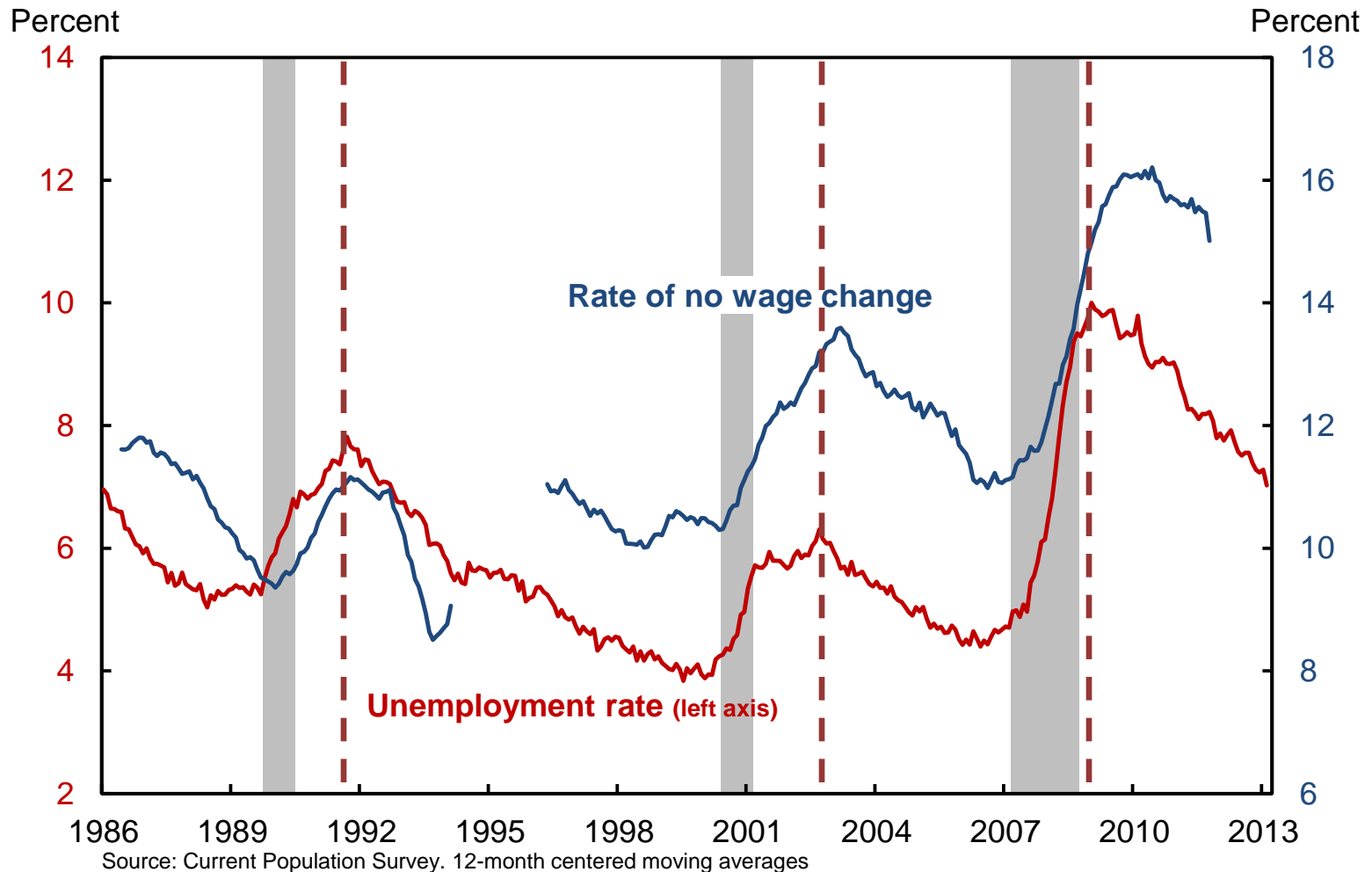
Zero 12-month wage change; All types of workers (hourly, salary, and job switchers, and job stayers)



# Spike trails peak in unemployment rate

## Unemployment rate and rate of no wage change

Zero 12-month wage change; All types of workers (hourly, salary, and job switchers, and job stayers)



Fact 3

# U.S. WAGE PHILLIPS CURVE IS BENT

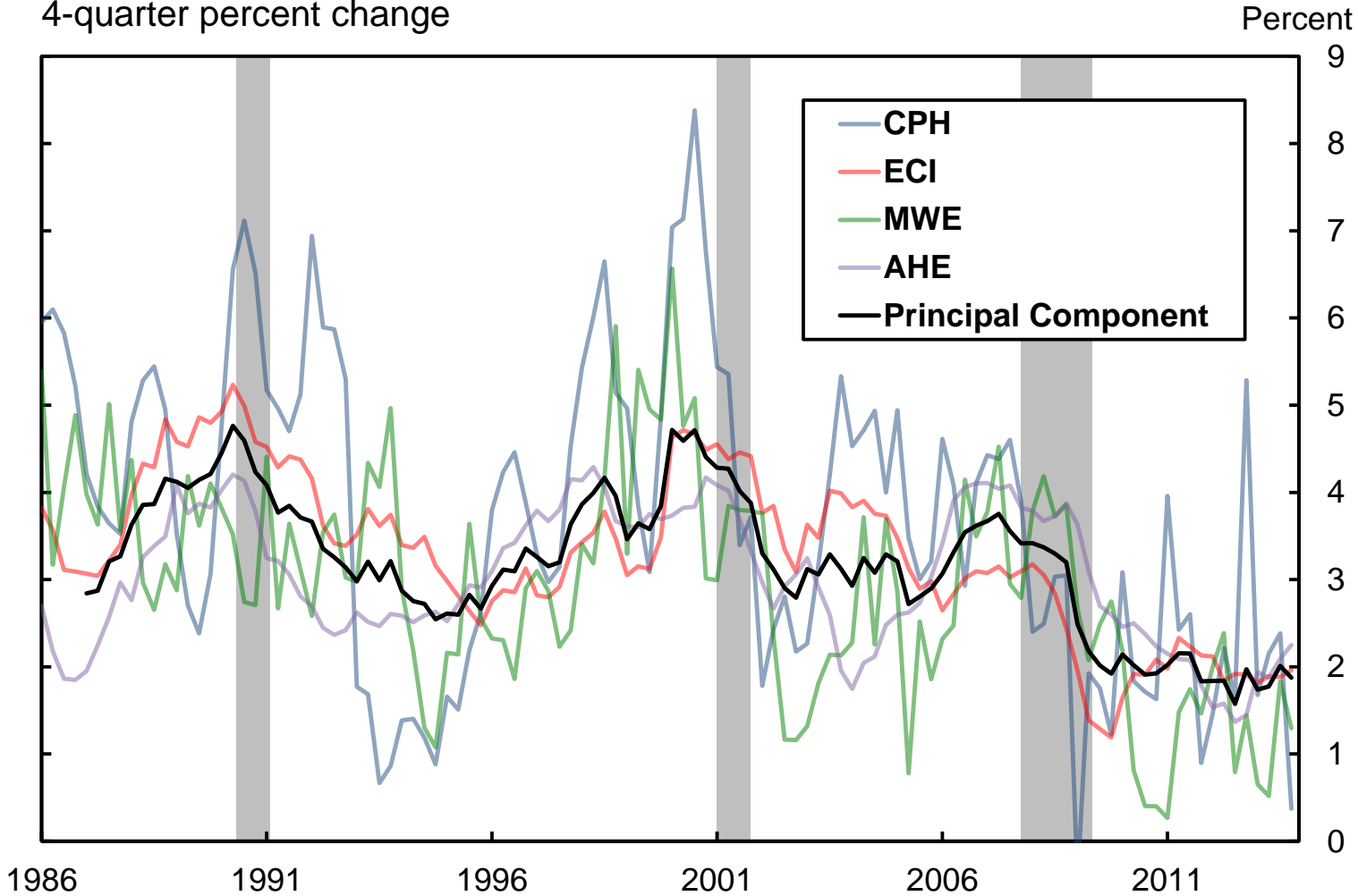
Phillips (1958), Samuelson and Solow (1960), Galí (2011)



# Composite measure of wage growth

## Four Measures of Nominal Compensation Growth

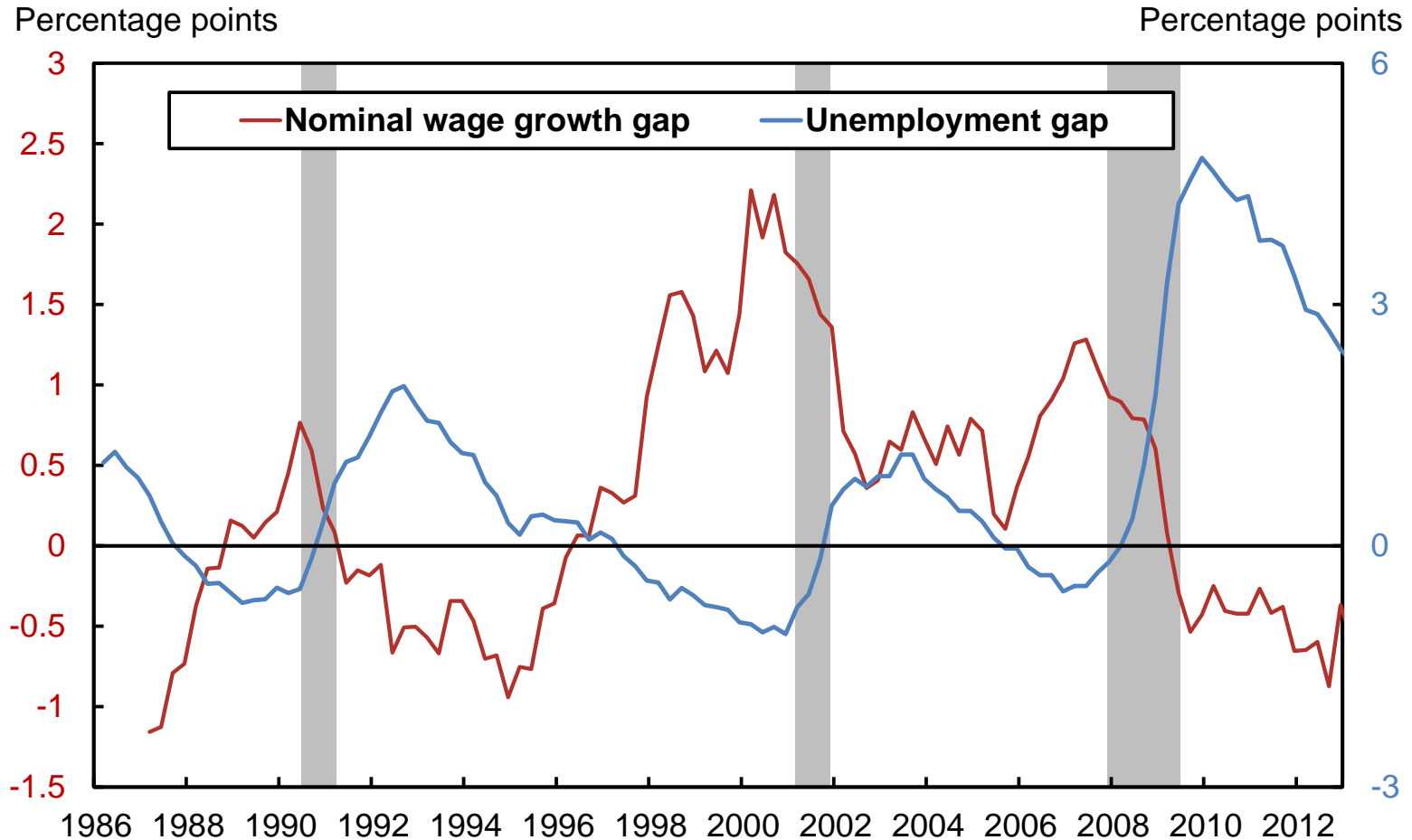
4-quarter percent change



# High unemployment low wage growth

## Nominal wage growth and unemployment gaps

4-quarter moving average



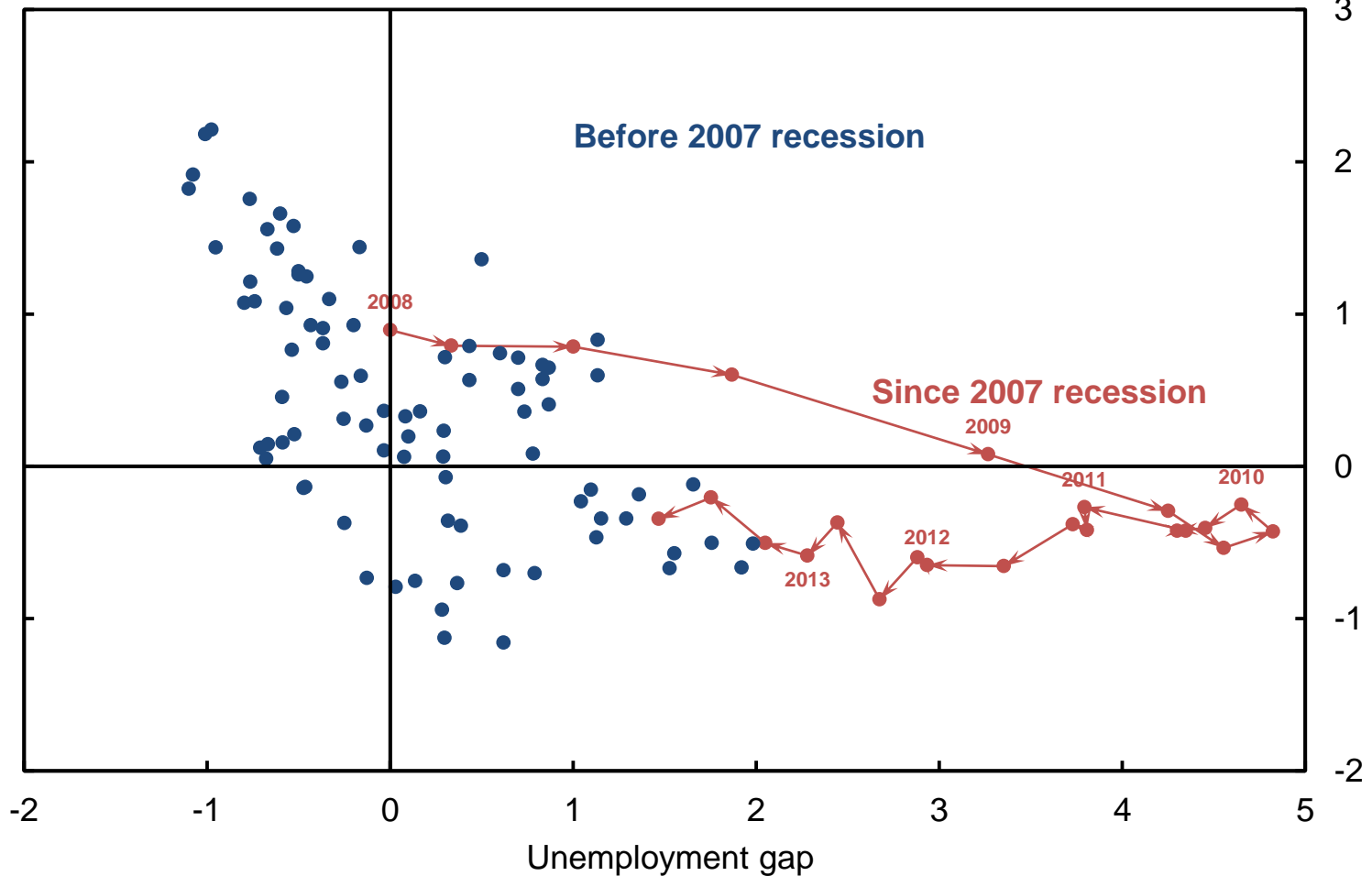
Source: Bureau of Labor Statistics and authors' calculations

# U.S. wage Phillips curve bent

## U.S. Wage Phillips Curve: 1986-2012

Nominal wage growth is 4Q change

Nominal wage growth gap



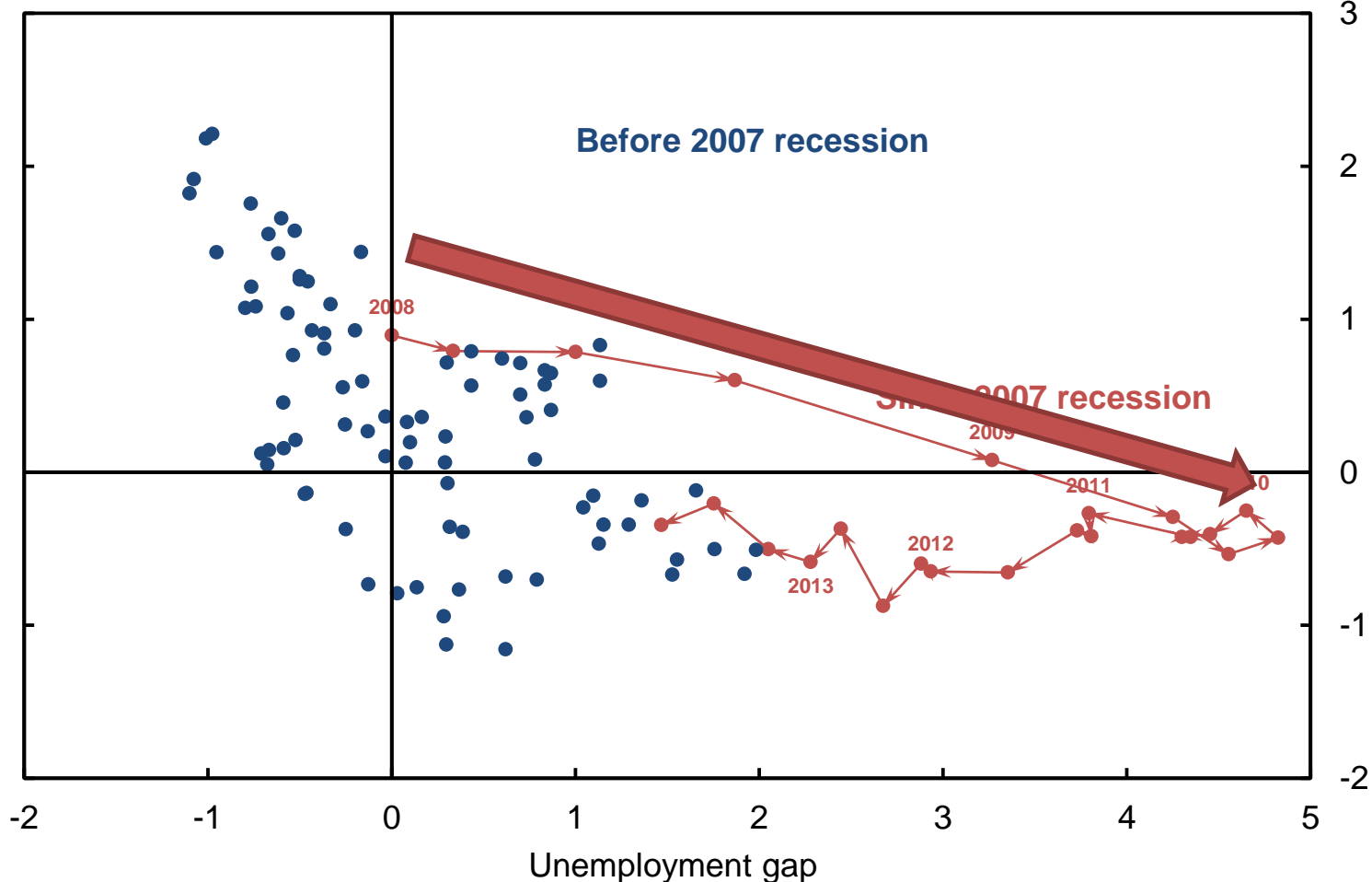
Source: Bureau of Labor Statistics and authors' calculations

# Wage growth leveled off when unemployment rose

## U.S. Wage Phillips Curve: 1986-2012

Nominal wage growth is 4Q change

Nominal wage growth gap



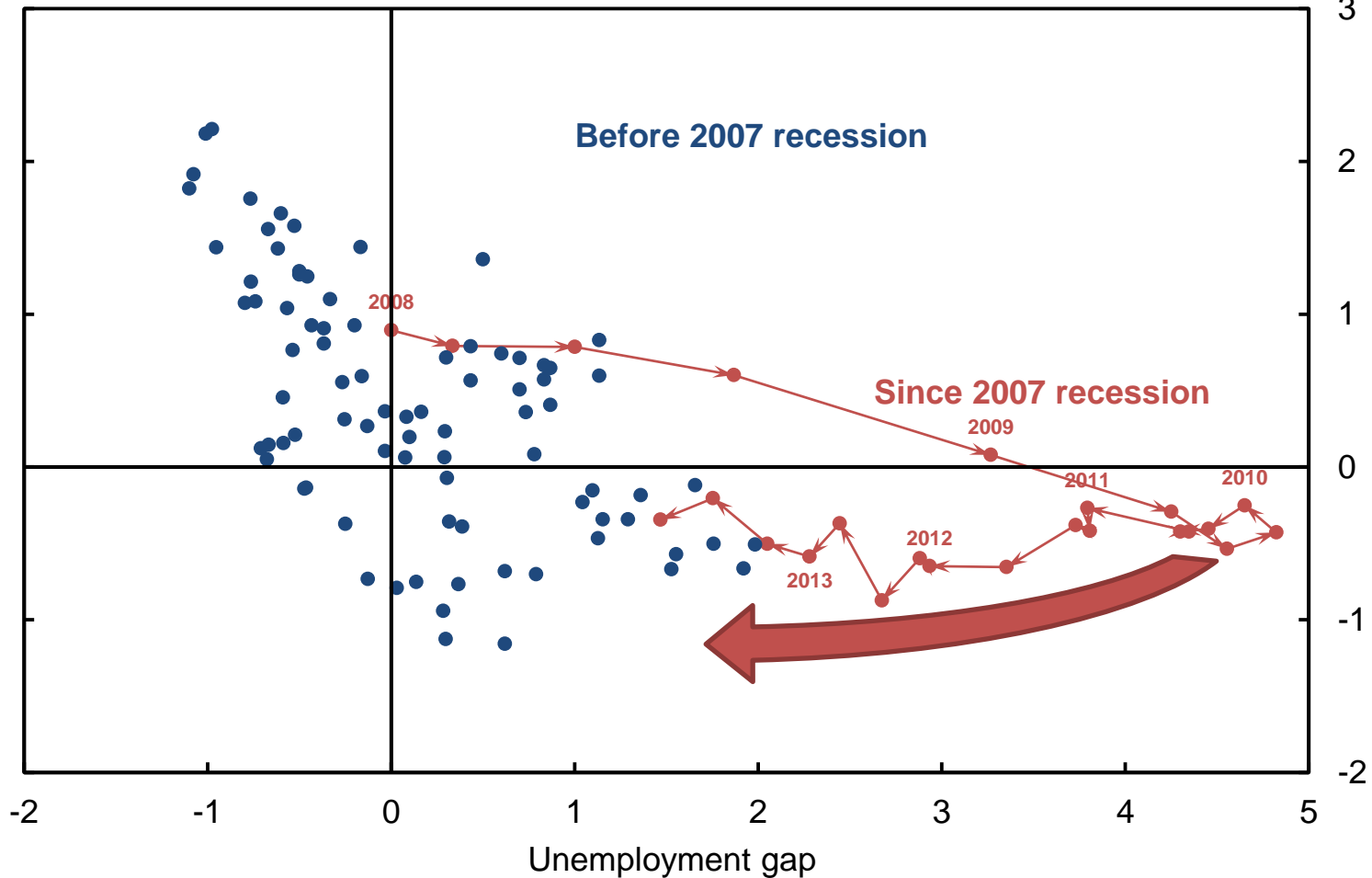
Source: Bureau of Labor Statistics and authors' calculations

# Wage growth decelerated and unemployment declined

## U.S. Wage Phillips Curve: 1986-2012

Nominal wage growth is 4Q change

Nominal wage growth gap



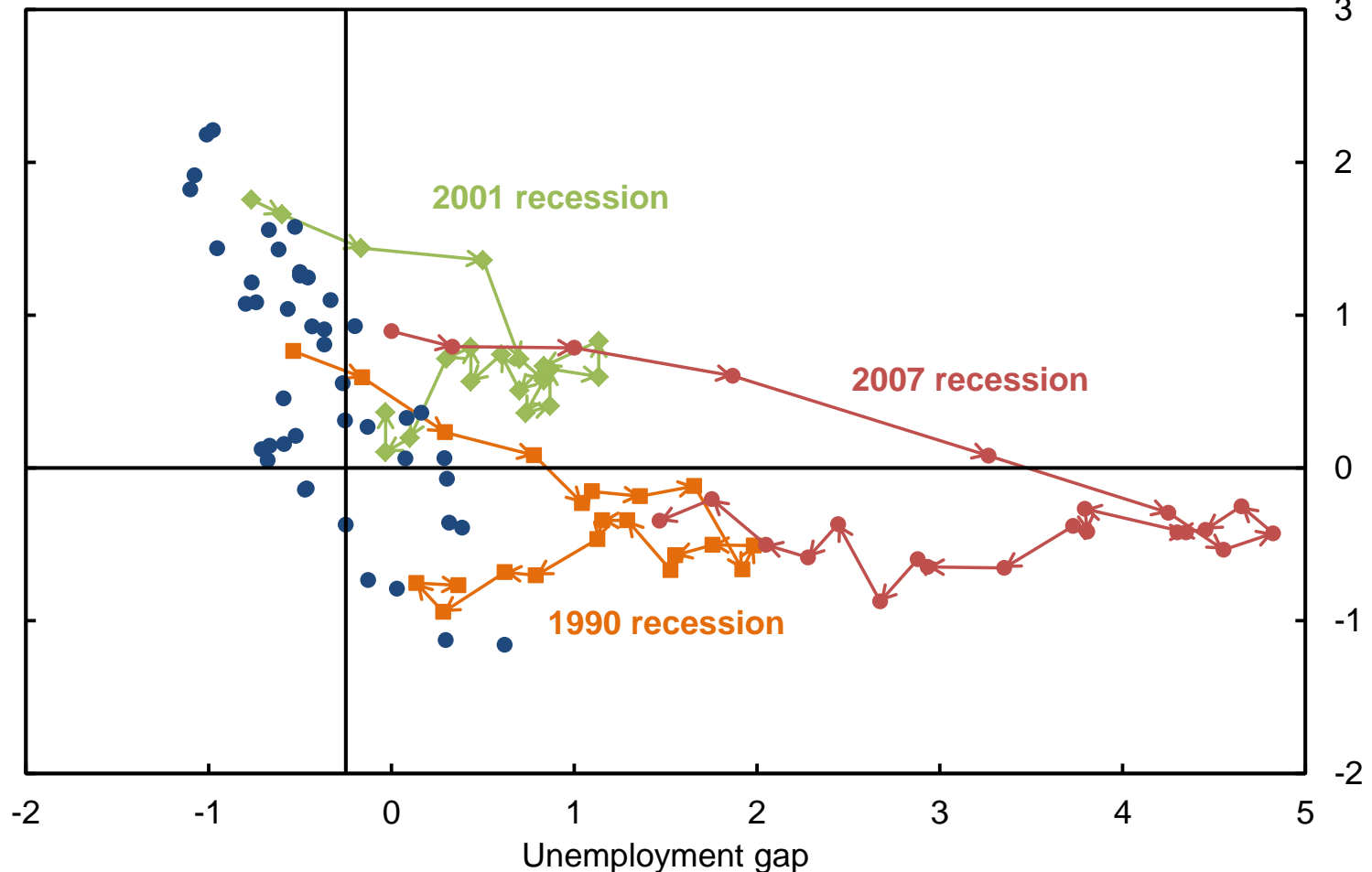
Source: Bureau of Labor Statistics and authors' calculations

# Similar pattern across recessions

## U.S. Wage Phillips Curve: 1986-2012

Nominal wage growth is 4Q change

Nominal wage growth gap



Source: Bureau of Labor Statistics and authors' calculations

Part II: Sketch of model

# **MODEL OF MONETARY POLICY AND DOWNWARD NOMINAL WAGE RIGIDITIES**

# Standard aggregate demand side

Aggregate demand curve determined by standard IS-curve and monetary policy rule

- **IS-curve**  
Consumption Euler equation
- **Monetary policy rule**  
Standard Taylor Rule

Taylor (1993), Rudebusch (2009)



# No distortions in the goods market

- Production function is linear in labor.
- Perfectly competitive market of goods producers.
- Price equals unit labor cost,  
*Nominal wage corrected for productivity growth*

# Wages are distorted

- Wages set by workers

Erceg, Henderson, and Levin (2000)

- DNWR: Fixed probability,  $\lambda$ , of a worker not being allowed to adjust wage downwards.

Calvo (1983), Fagan and Messina (2008)

- Idiosyncratic shocks to labor supply,  $Z_{it}$ .

Benigno and Ricci (2011)

- Productivity shocks give similar representation of equilibrium dynamics of aggregates. Fagan and Messina (2008)

# Implications of DNWR for wage setting

- **DNWR constraint:**

Workers who, in absence of constraint, would have lowered their wages keep them fixed.

– *Work less than under flexible wages.*

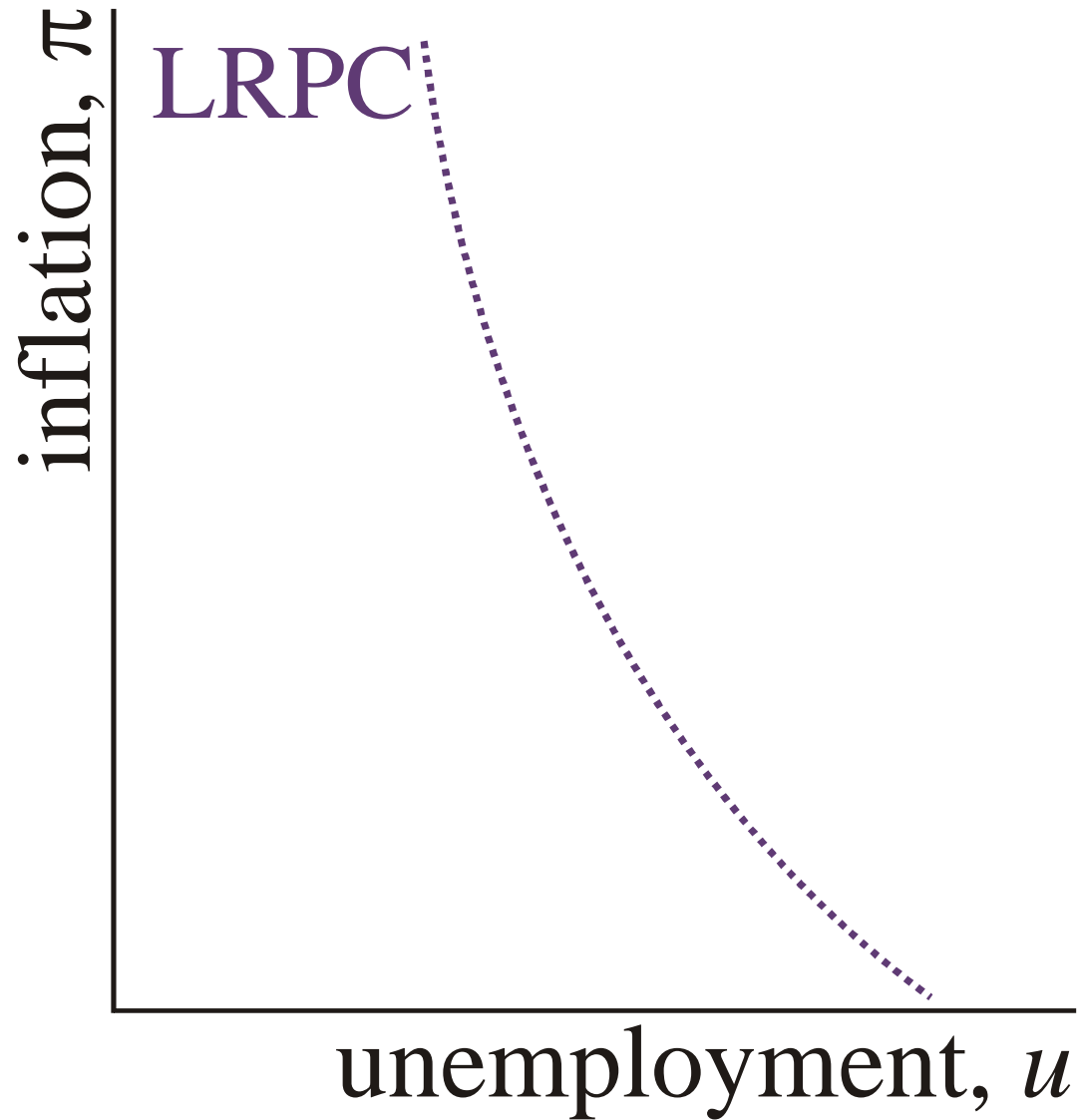
- **Subdued wage increases:**

Workers who change their wages set them lower than under flexible wages.

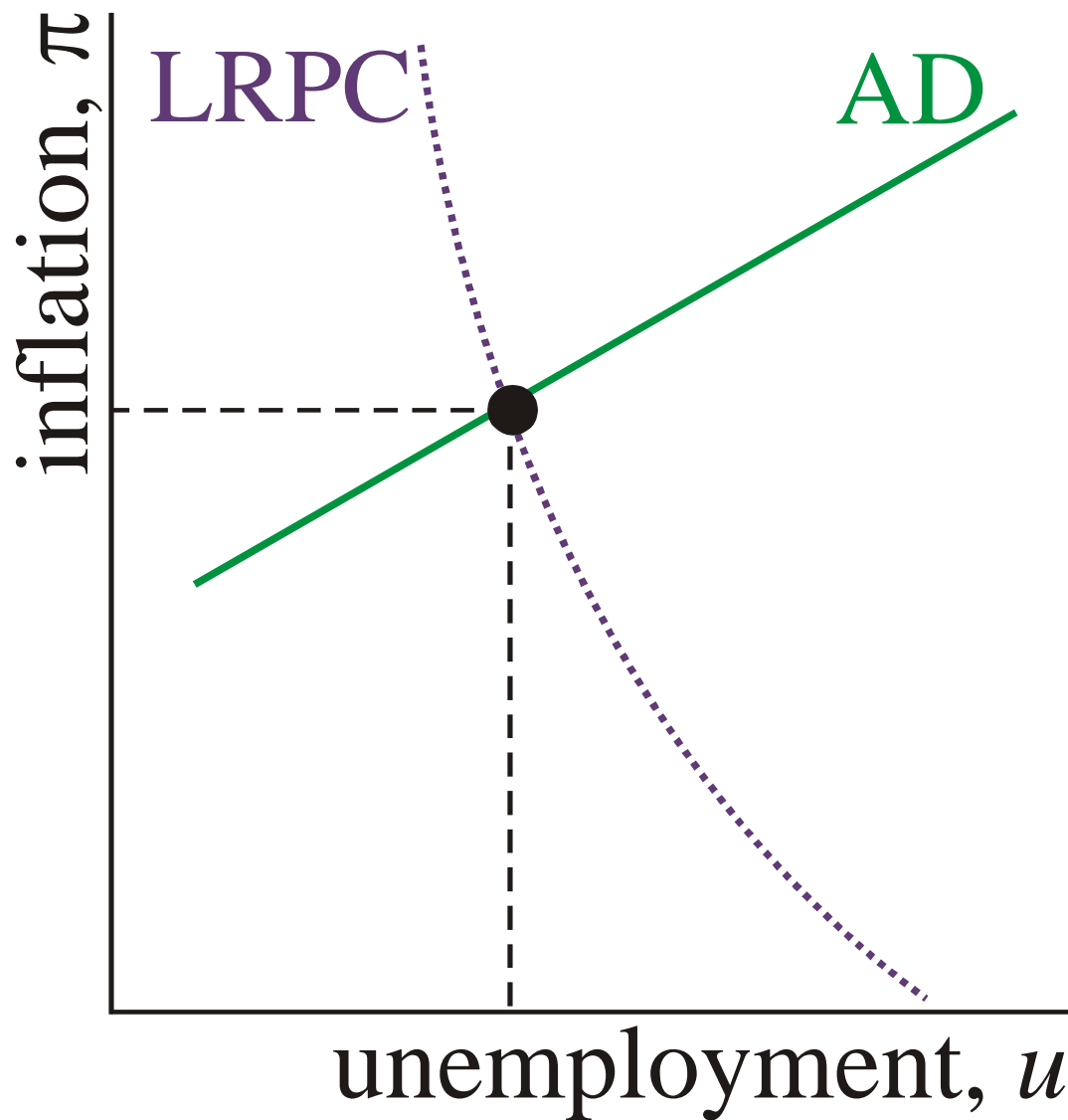
– *Work more than under flexible wages.*

Elsby (2009), Ball and Mankiw (1994)

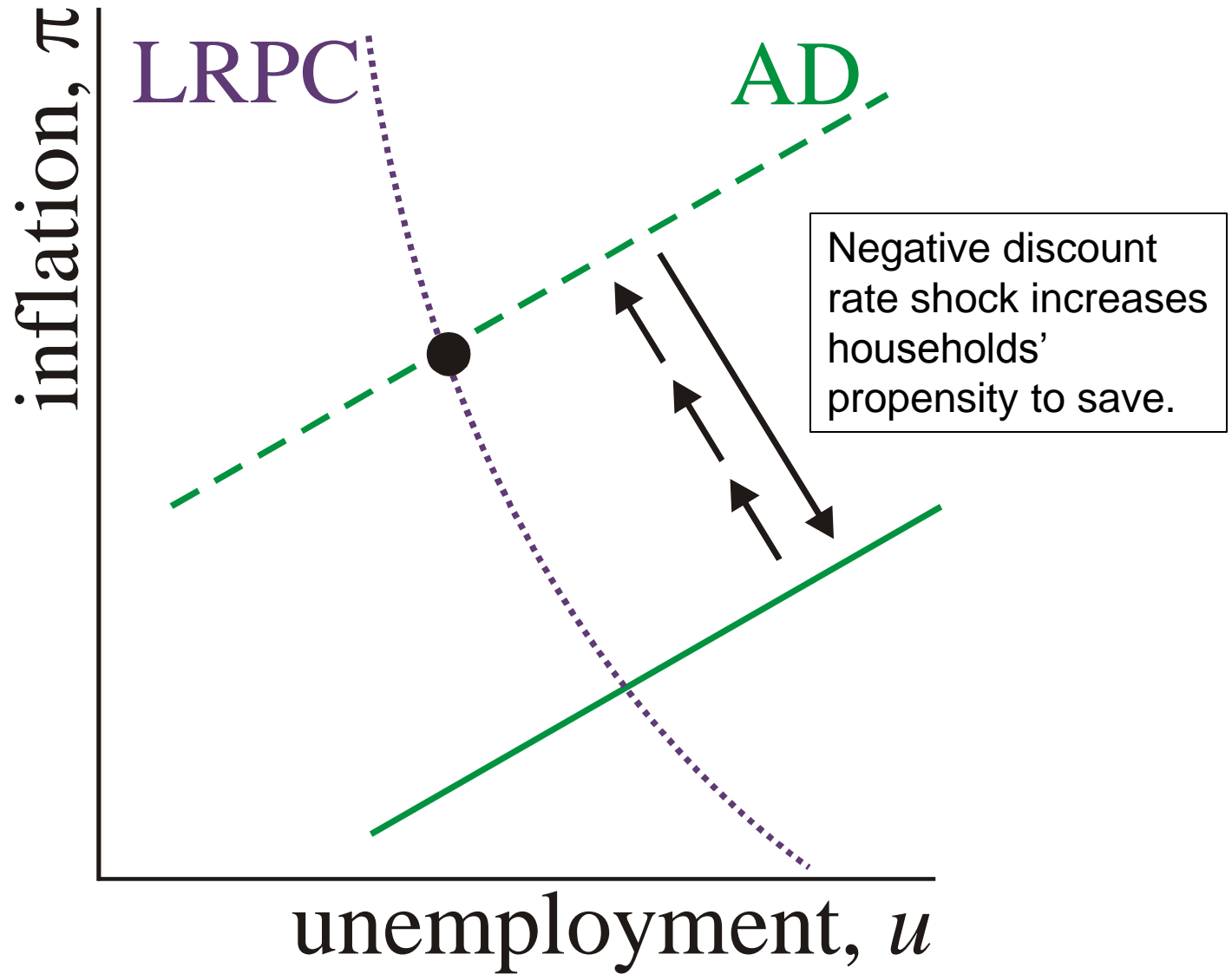
# Long-run Phillips curve due to DNWR



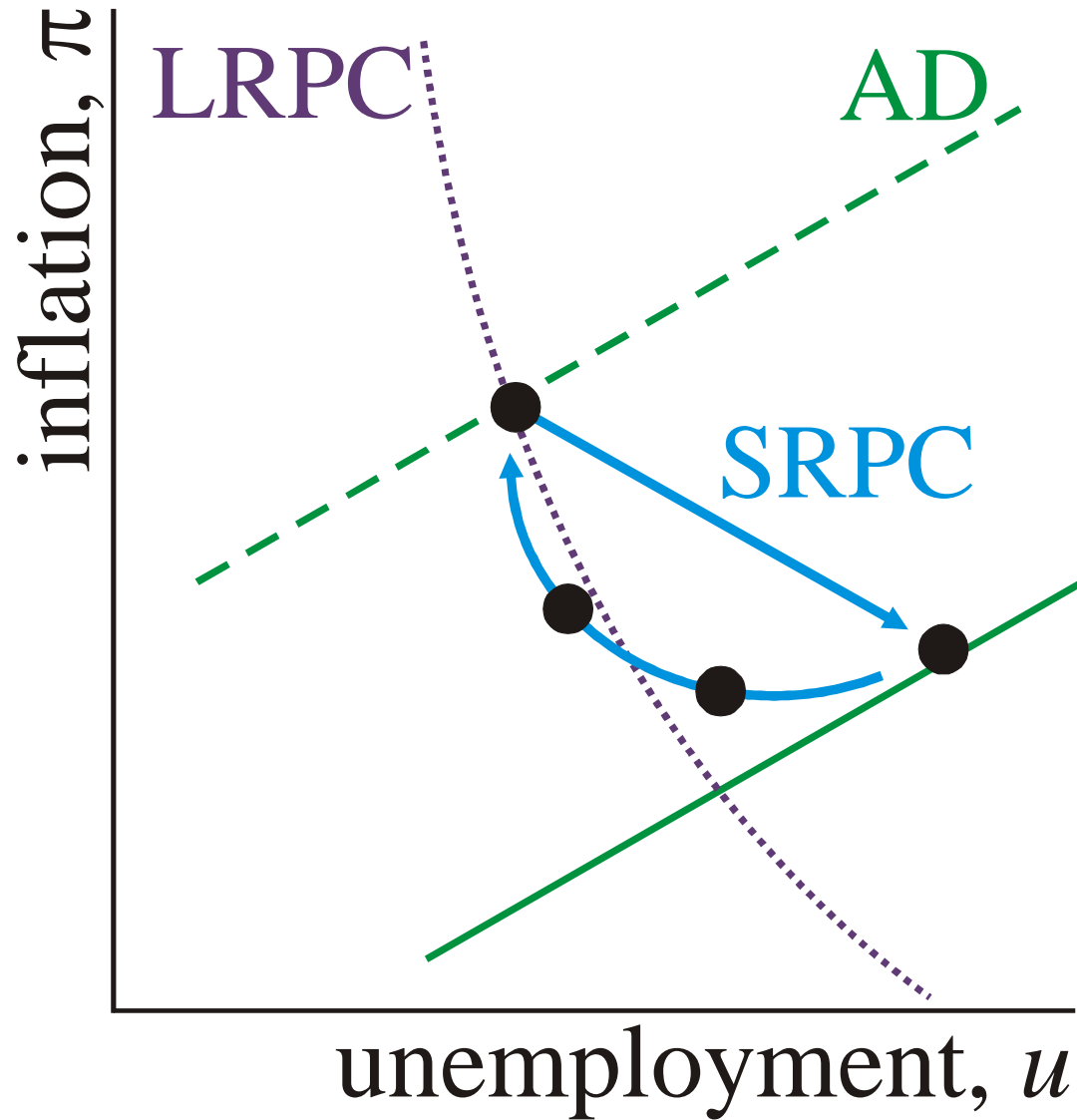
# Aggregate demand side: IS and MPR



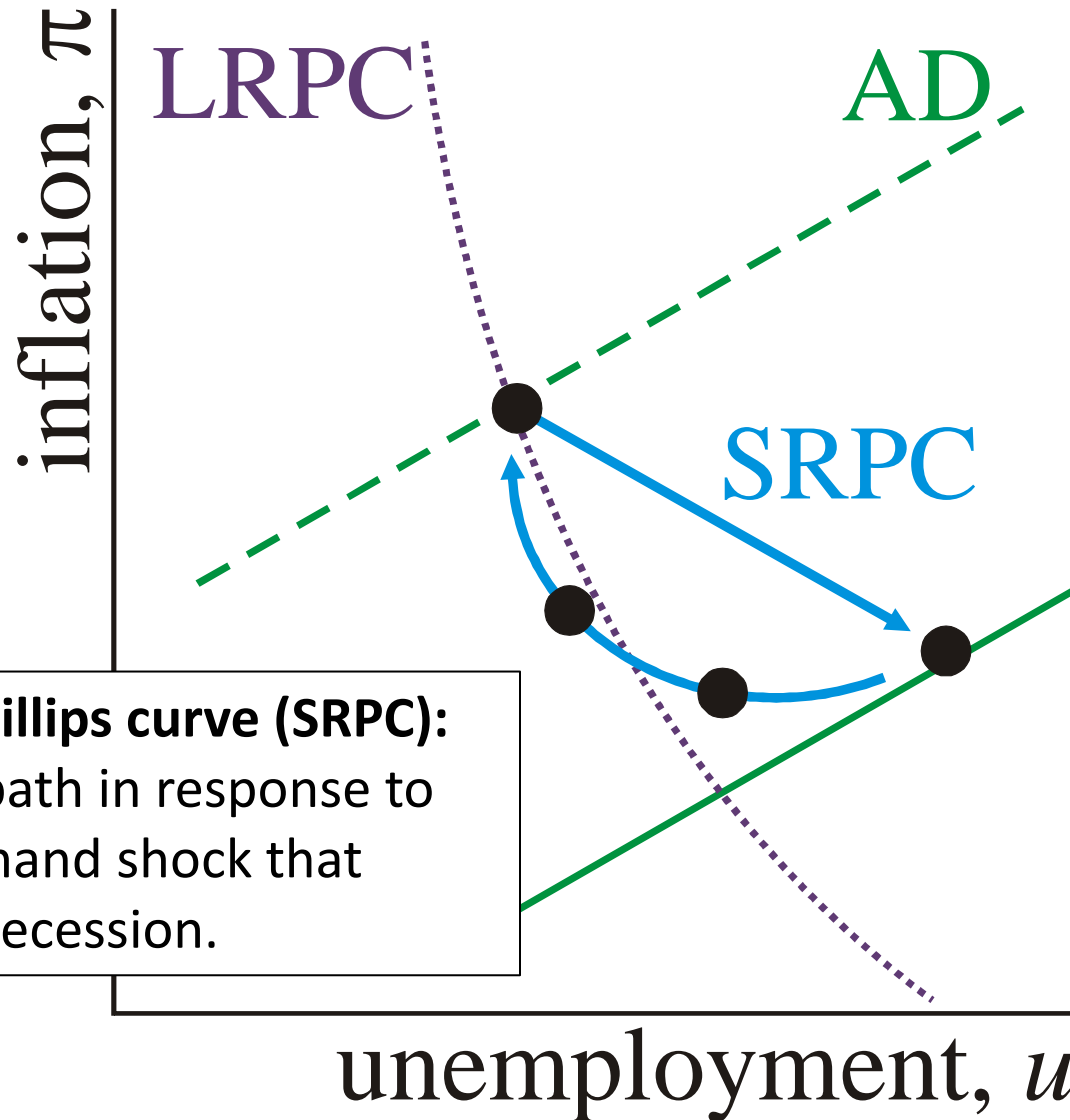
# Recession: Drop in aggregate demand



# Results in short-run trade-off



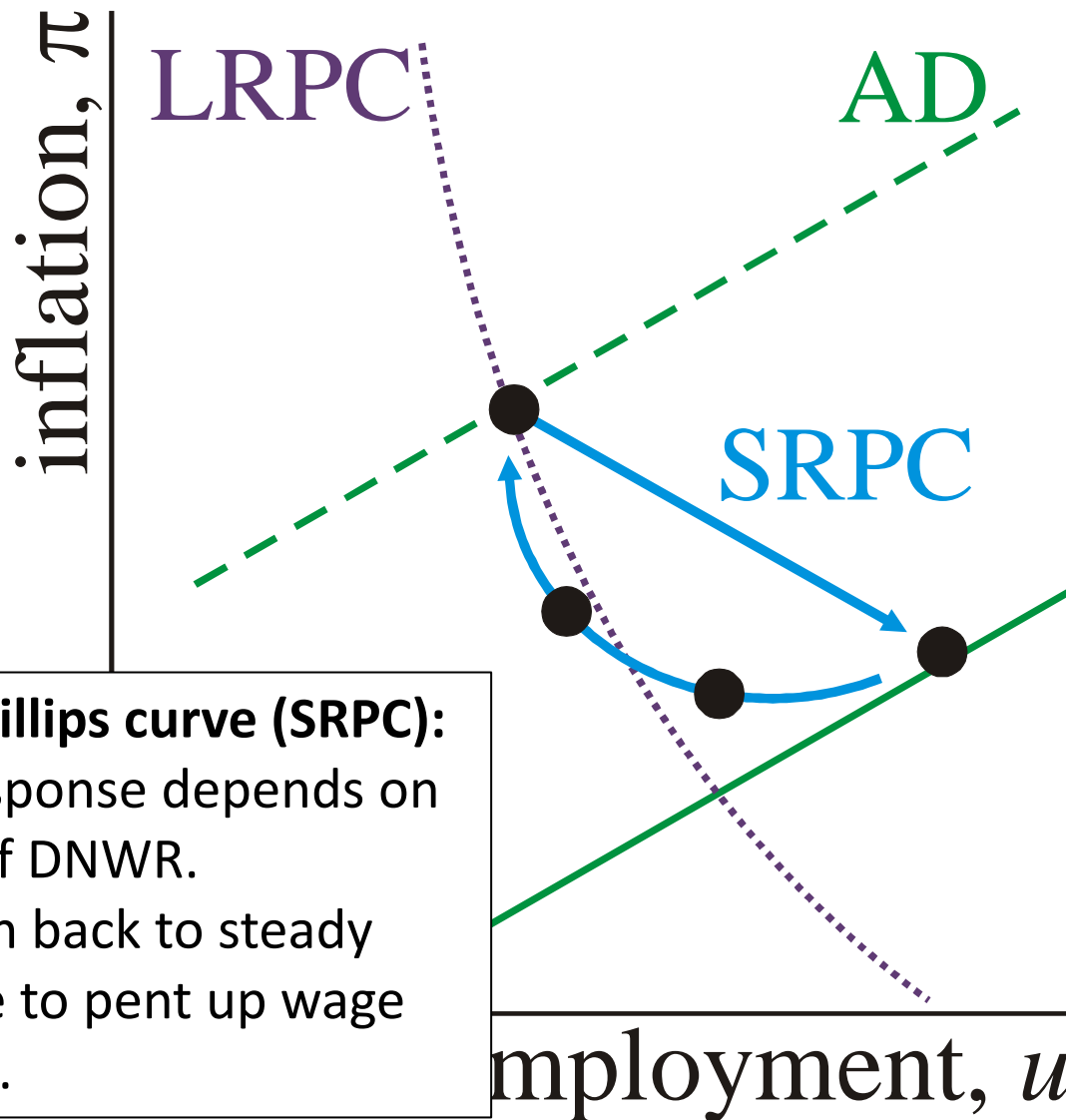
# Traced out by transitional dynamics



**Short-run Phillips curve (SRPC):**  
Equilibrium path in response to negative demand shock that generates a recession.



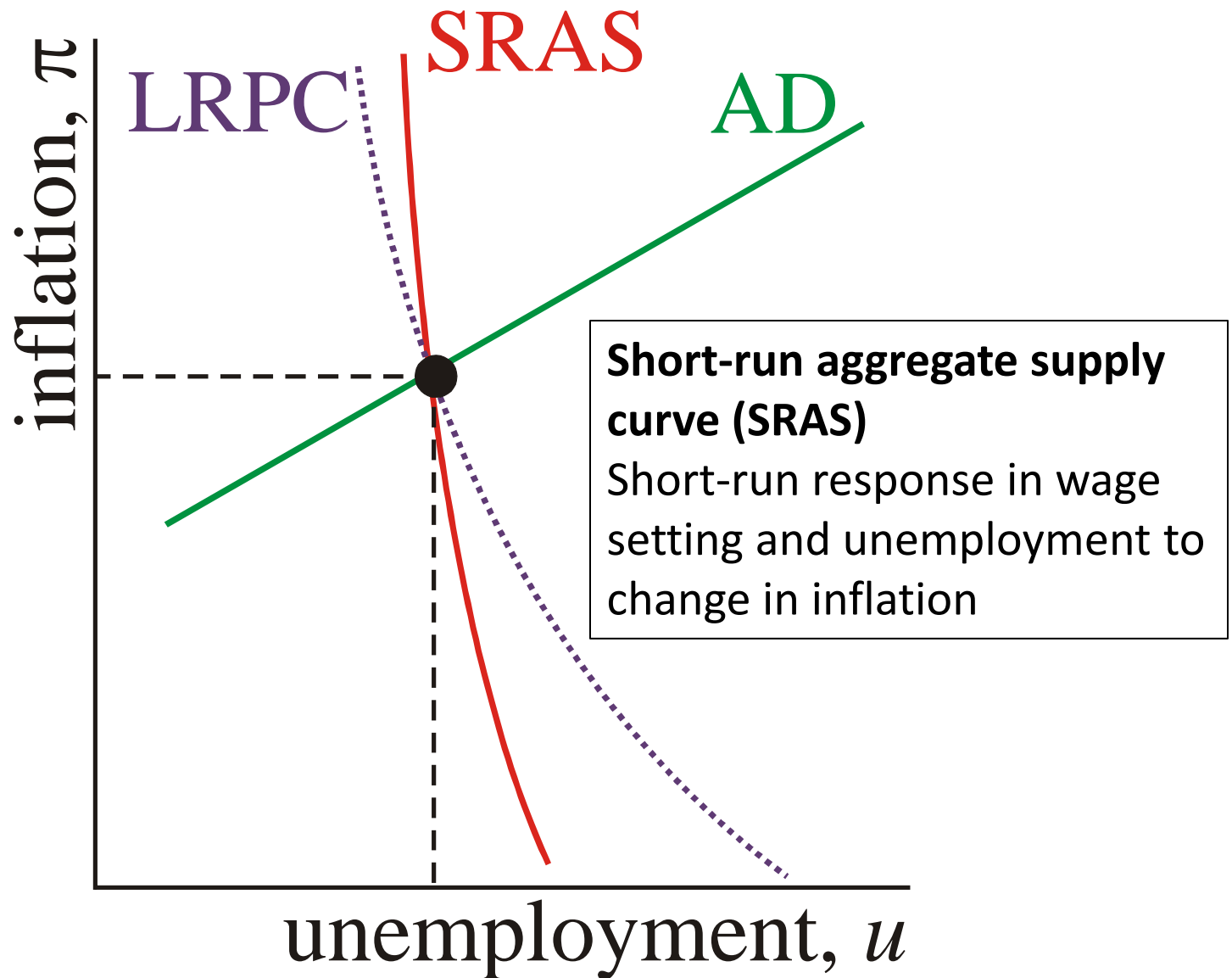
# SRPC bent in two ways



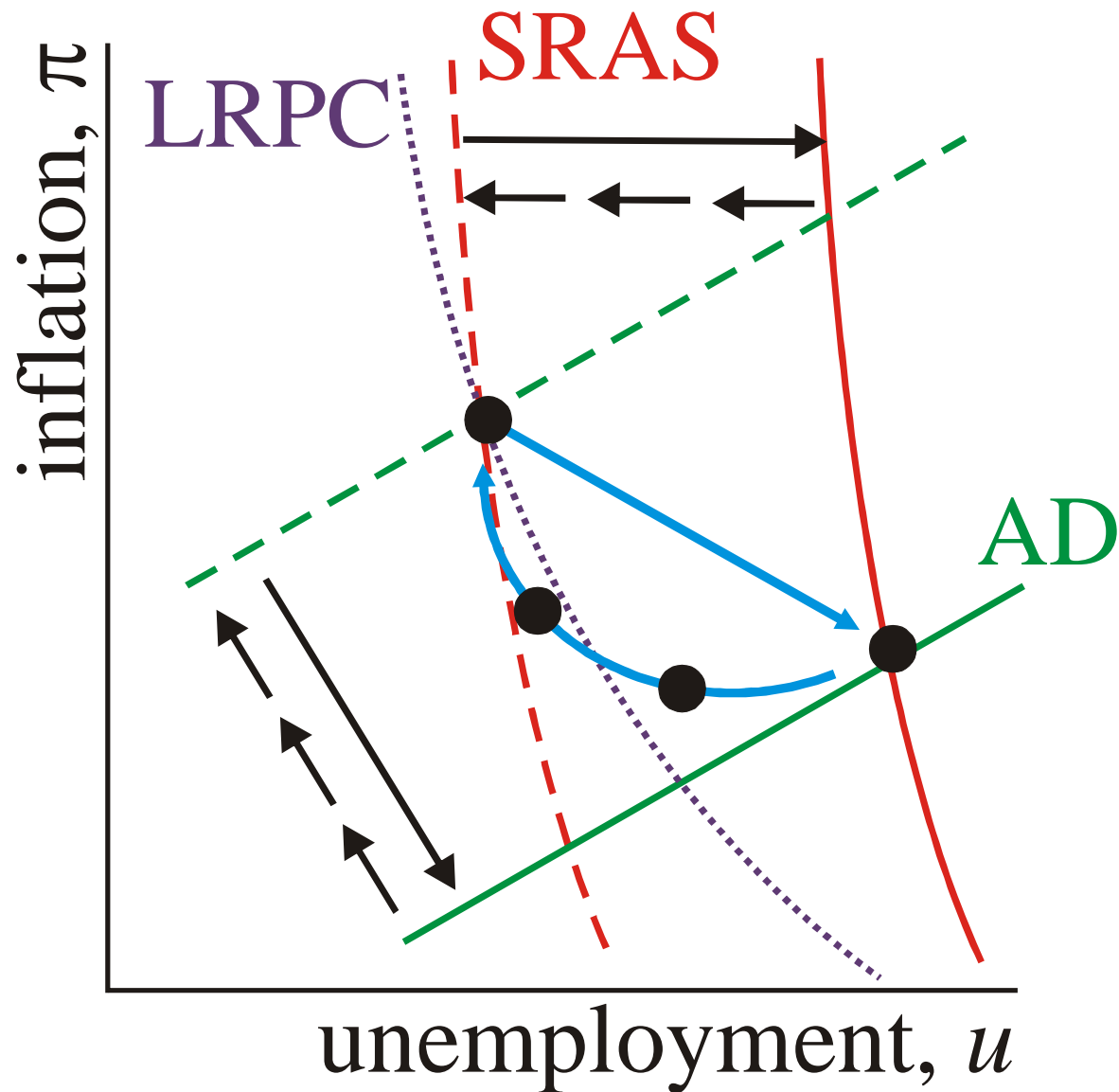
## Short-run Phillips curve (SRPC):

1. Initial response depends on degree of DNWR.
2. Bent path back to steady state due to pent up wage deflation.

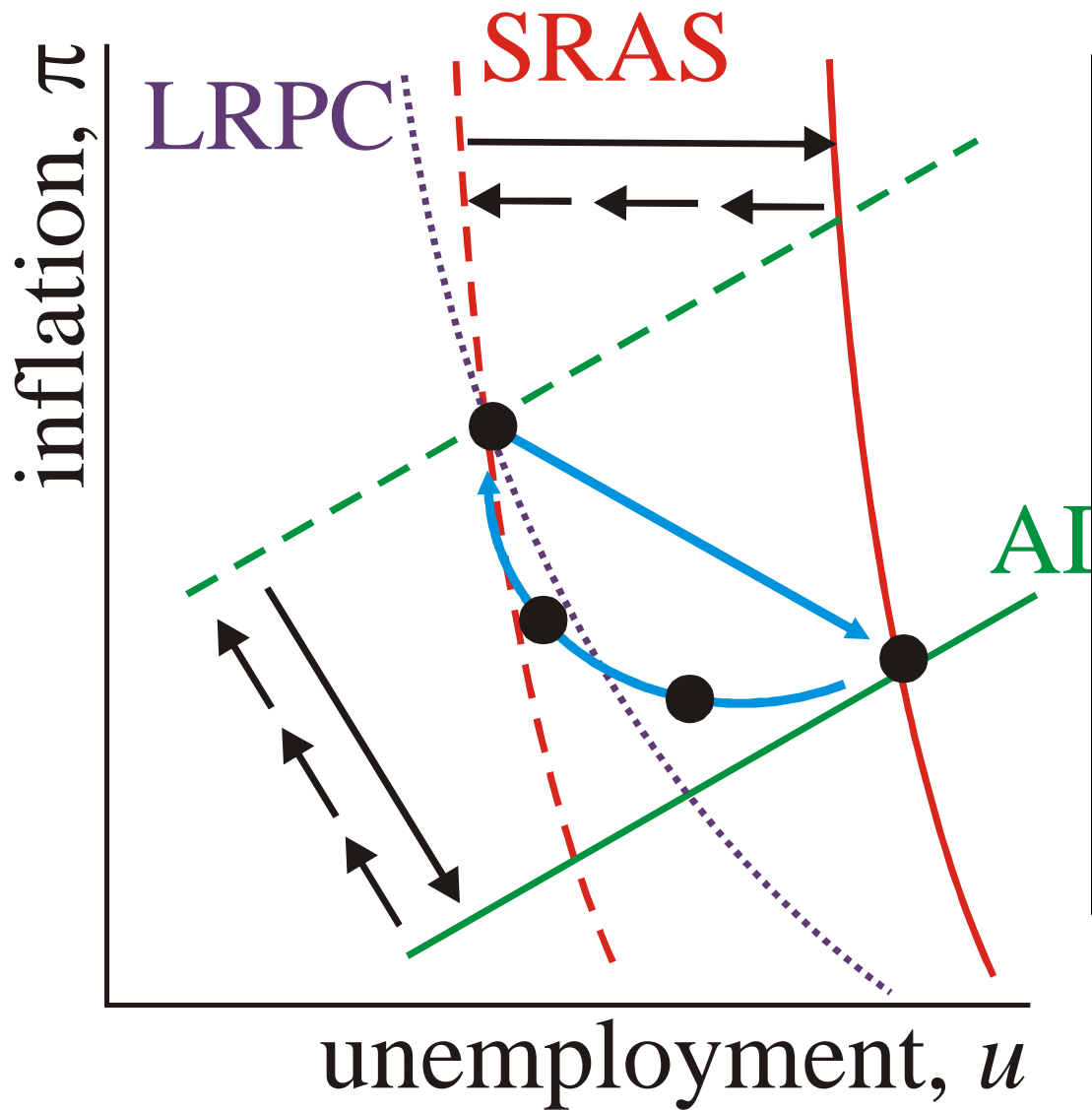
# Bending induced by shift in SRAS



# Bending induced by shift in SRAS



# Shock also acts as supply shock



DNWR make position of SRAS depend on discount rate and future inflation. Curve shifts outward in response to shock

## Part II: Results

# **LONG-RUN (STEADY-STATE) AND SHORT-RUN (TRANSITIONAL DYNAMICS) TRADE-OFFS**

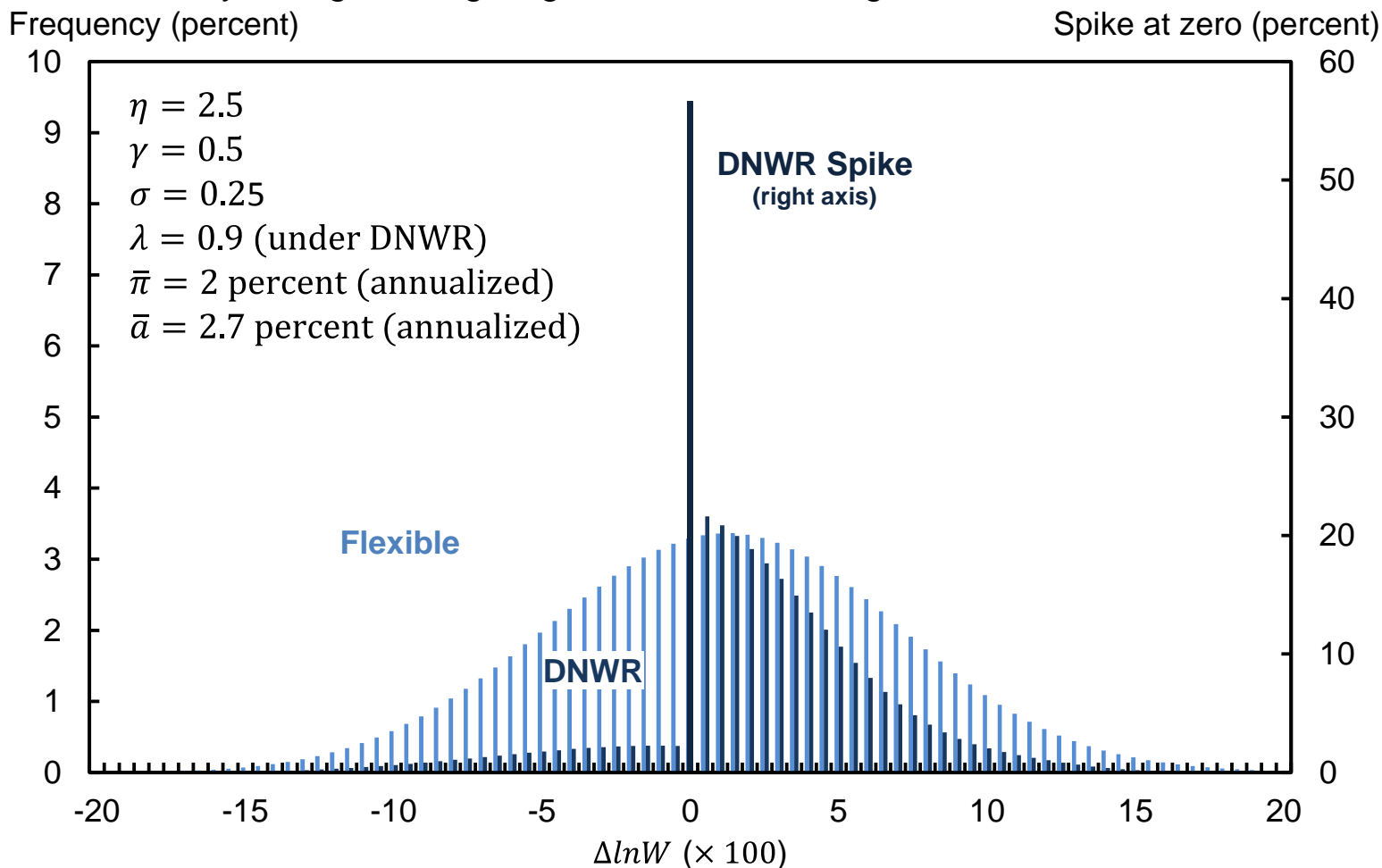
Steady State

**REPLICATE LONG-RUN  
INFLATION-UNEMPLOYMENT  
TRADE-OFF**

# Distortion due to downward wage rigidities

## Steady-State Density of Log Wage Changes

Quarterly changes in log wage under flexible wages and DNWR



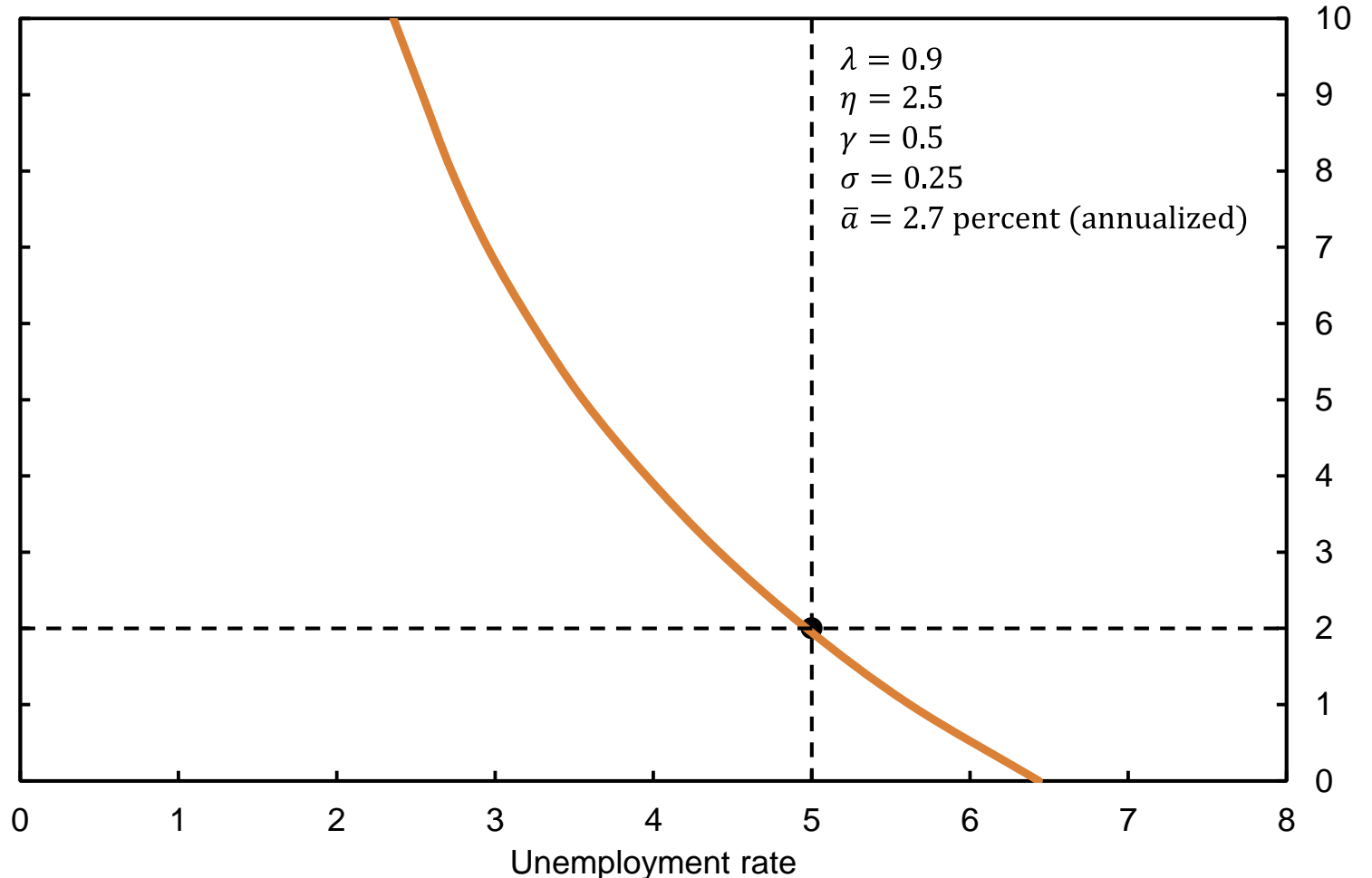
Source: Authors' calculations

# Long-run unemployment-inflation trade-off

## Long-Run Phillips Curve

Steady-state trade off between unemployment and inflation

Inflation (annualized rate)



Source: Author's calculations



Transitional Dynamics

# **SLOPE AND CURVATURE OF SHORT-RUN PHILLIPS CURVE**

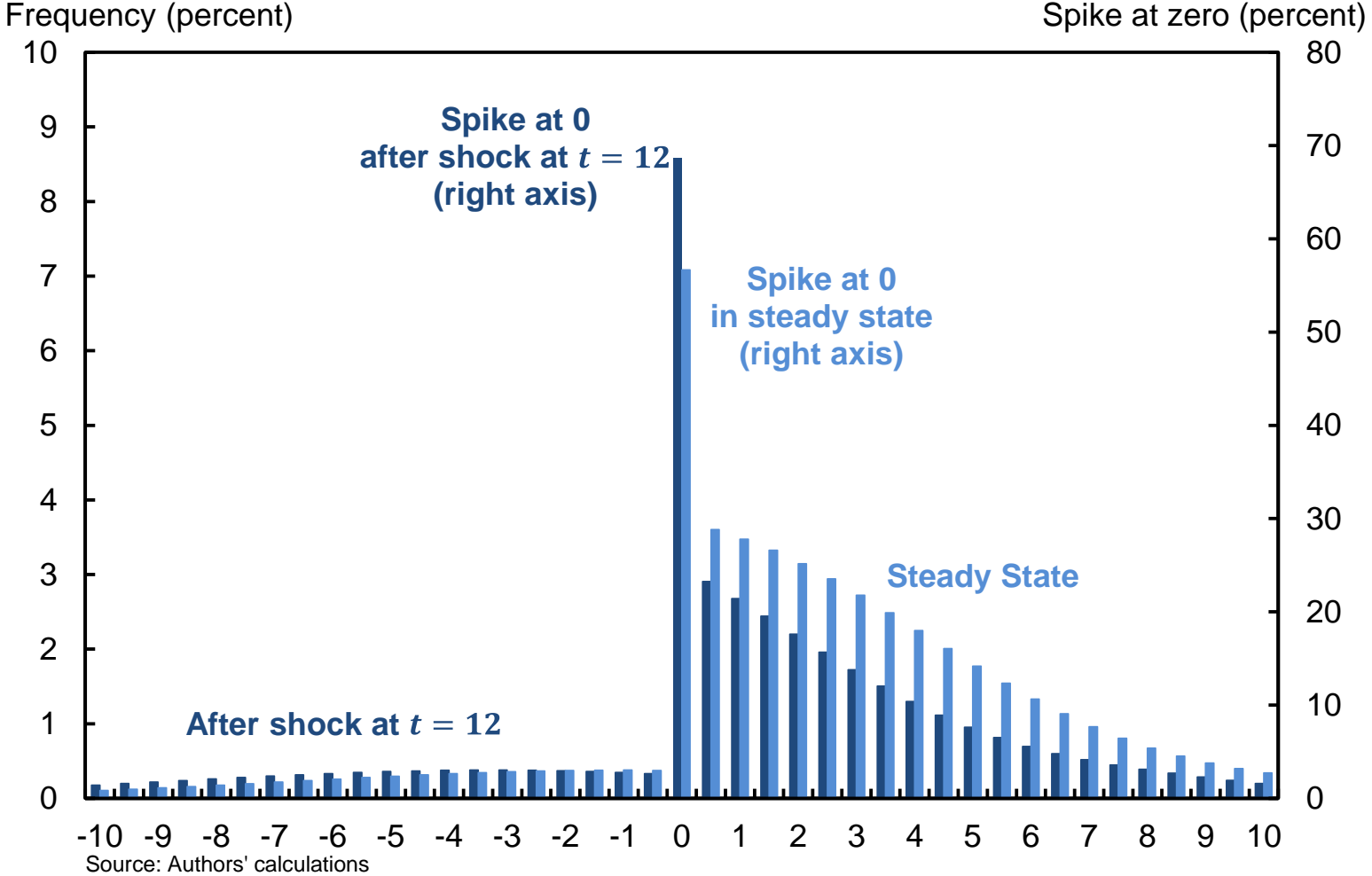
Result 1

# **NON-NORMAL DISTRIBUTION OF LOG WAGE CHANGES**

# Shift in distribution of wage changes

## Distribution of quarterly log wage changes

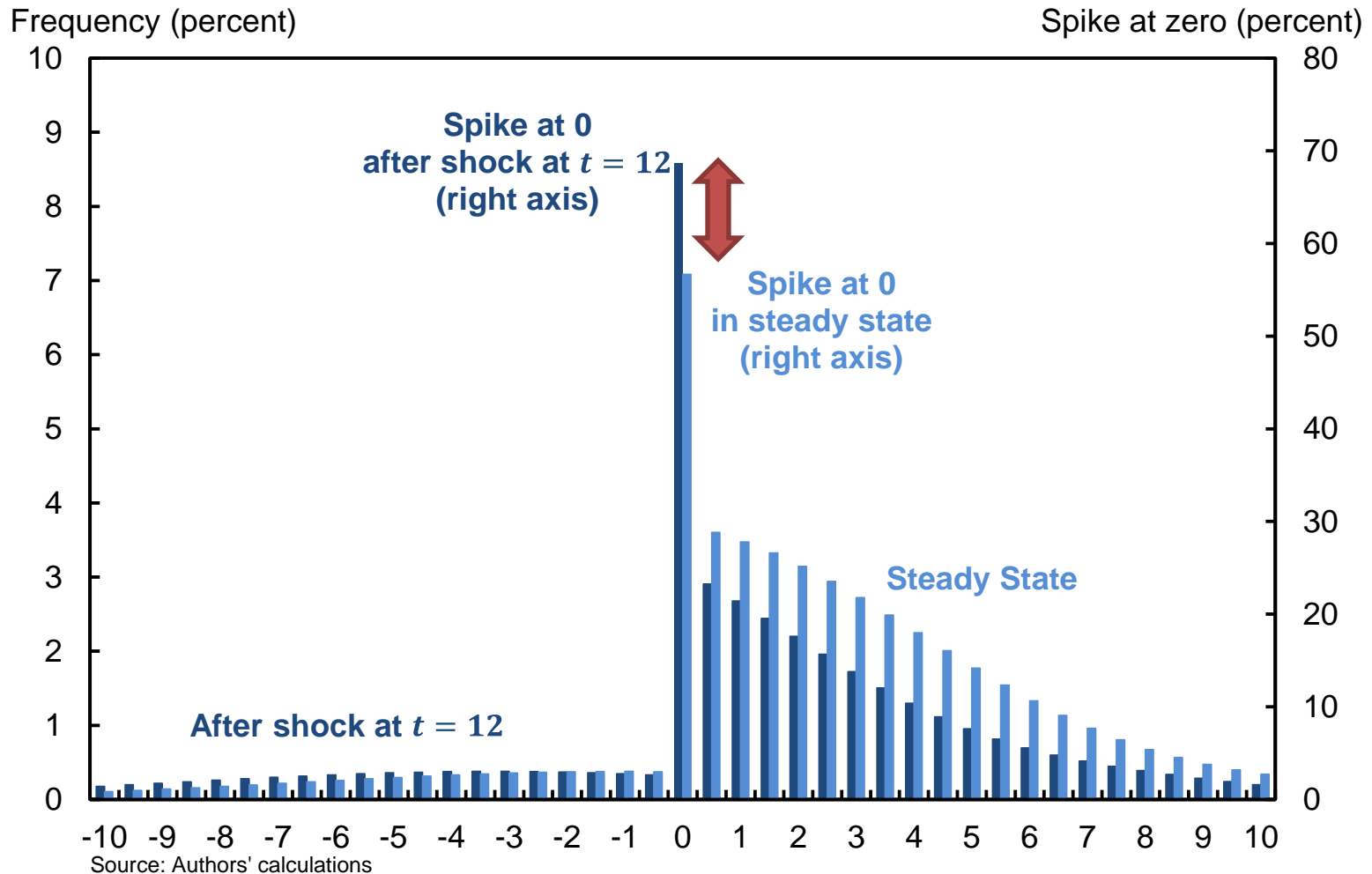
In steady state at time  $t = 0$  and after shock at  $D_1 = -0.03$  at  $t = 12$ .



# Increase of spike at zero

## Distribution of quarterly log wage changes

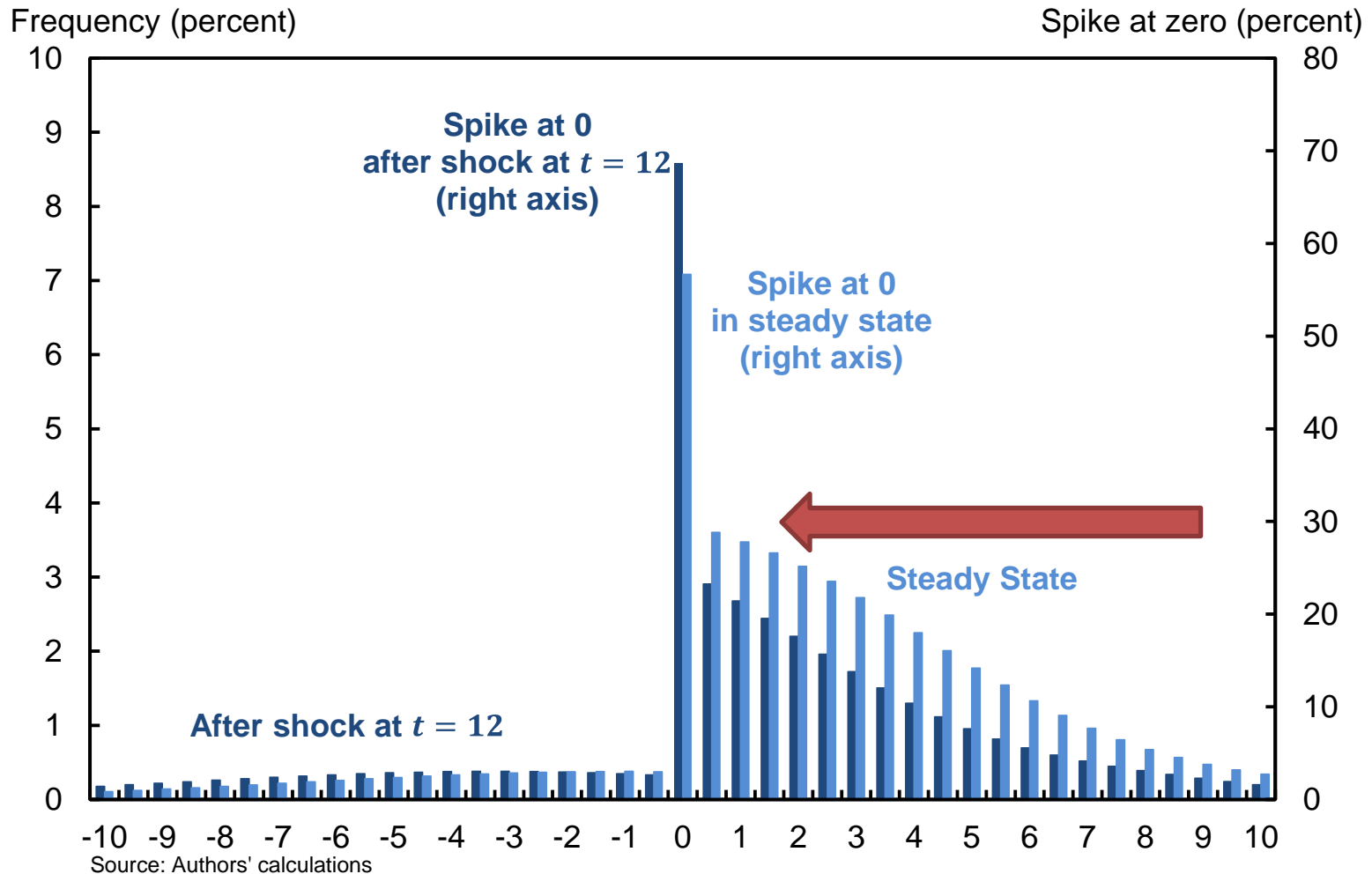
In steady state at time  $t = 0$  and after shock at  $D_1 = -0.03$  at  $t = 12$ .



# Compression of wage increases

## Distribution of quarterly log wage changes

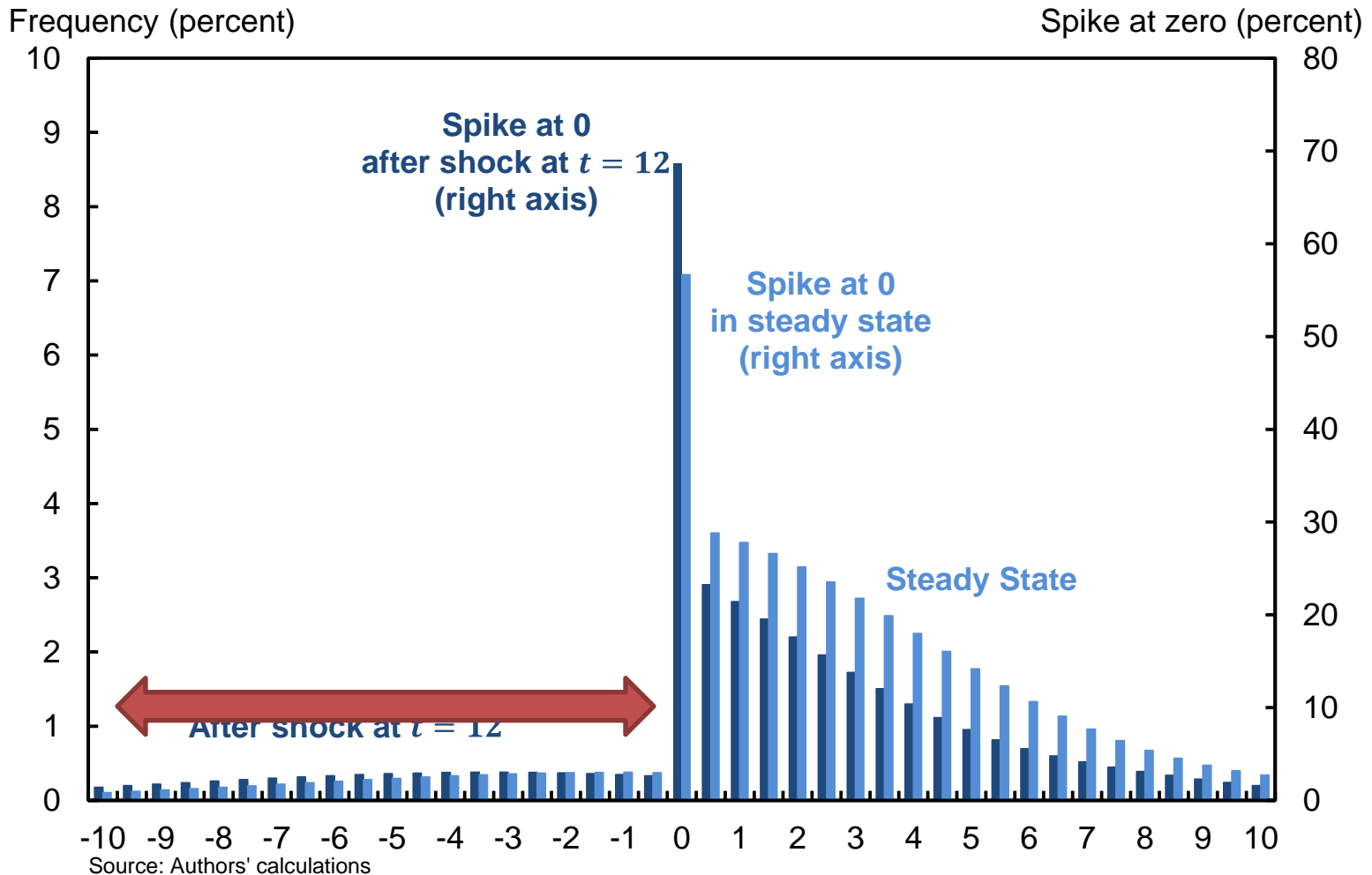
In steady state at time  $t = 0$  and after shock at  $D_1 = -0.03$  at  $t = 12$ .



# Not many more wage cuts

## Distribution of quarterly log wage changes

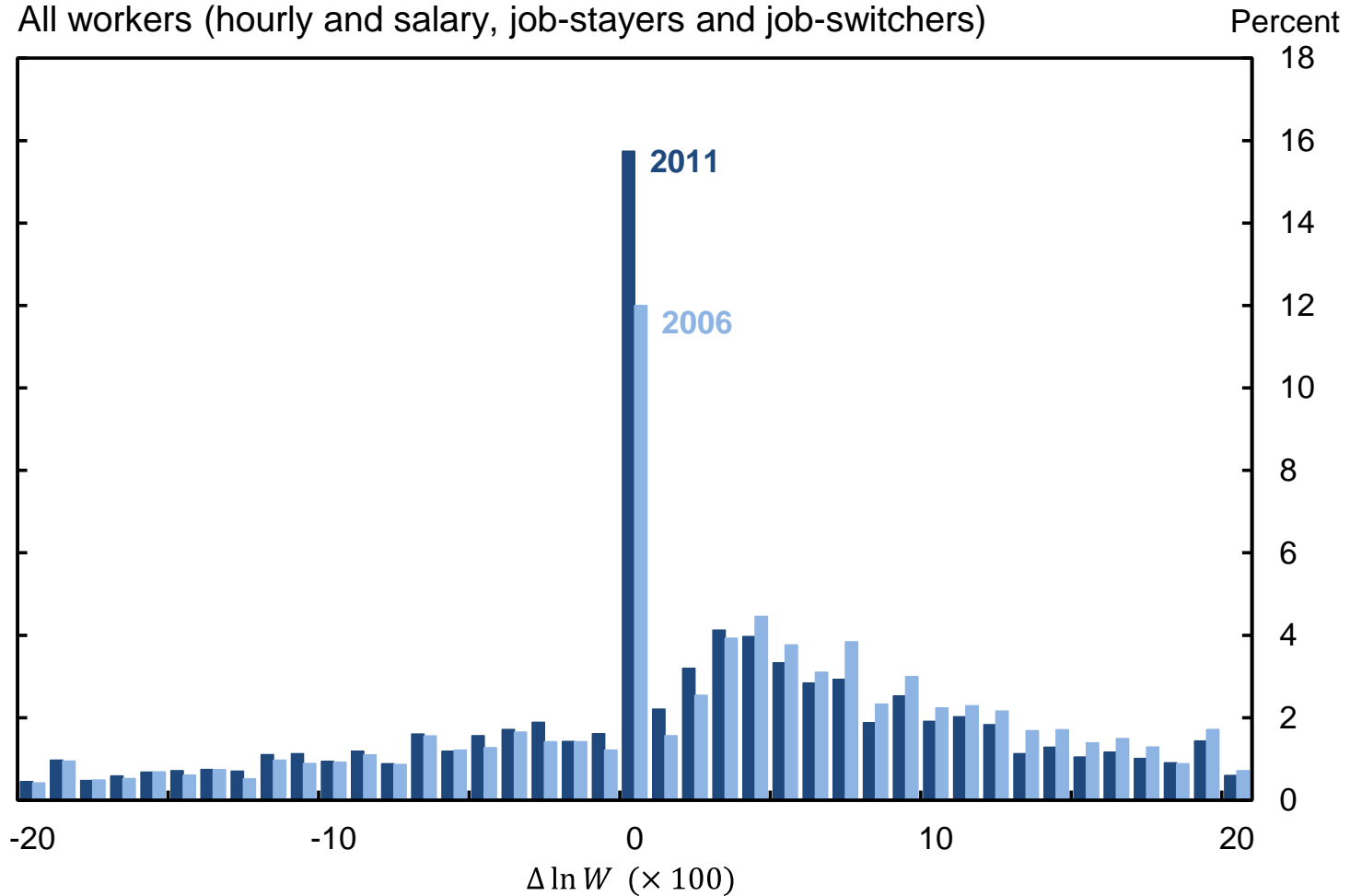
In steady state at time  $t = 0$  and after shock at  $D_1 = -0.03$  at  $t = 12$ .



# This is the data-equivalent

## Distribution of 12-month change in log wages

All workers (hourly and salary, job-stayers and job-switchers)



Result 2

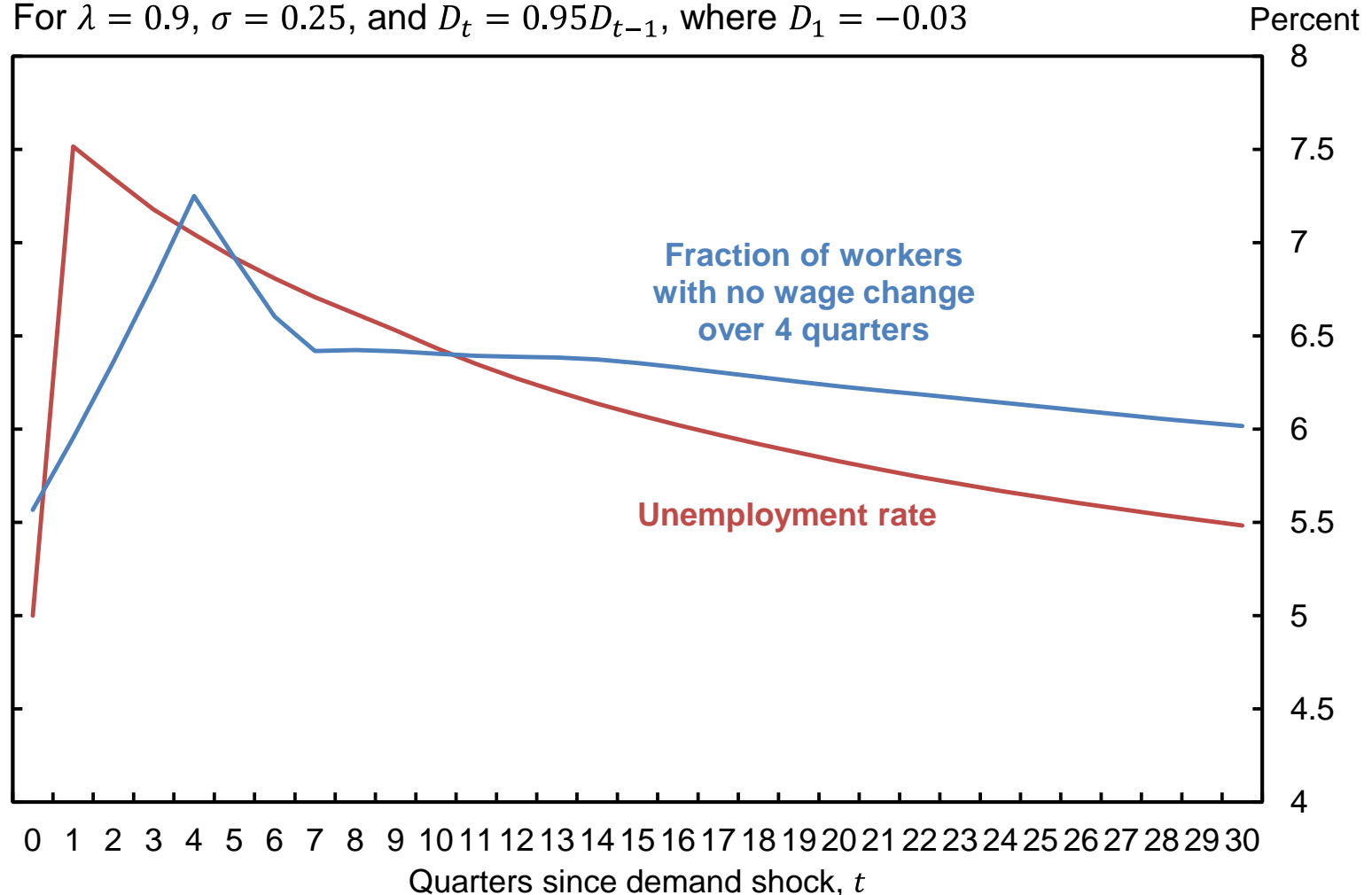
**SPIKE AT ZERO  
COUNTERCYCLICAL**



# Spike at zero peaks after shock

## Unemployment rate and spike at zero wage changes

For  $\lambda = 0.9$ ,  $\sigma = 0.25$ , and  $D_t = 0.95D_{t-1}$ , where  $D_1 = -0.03$

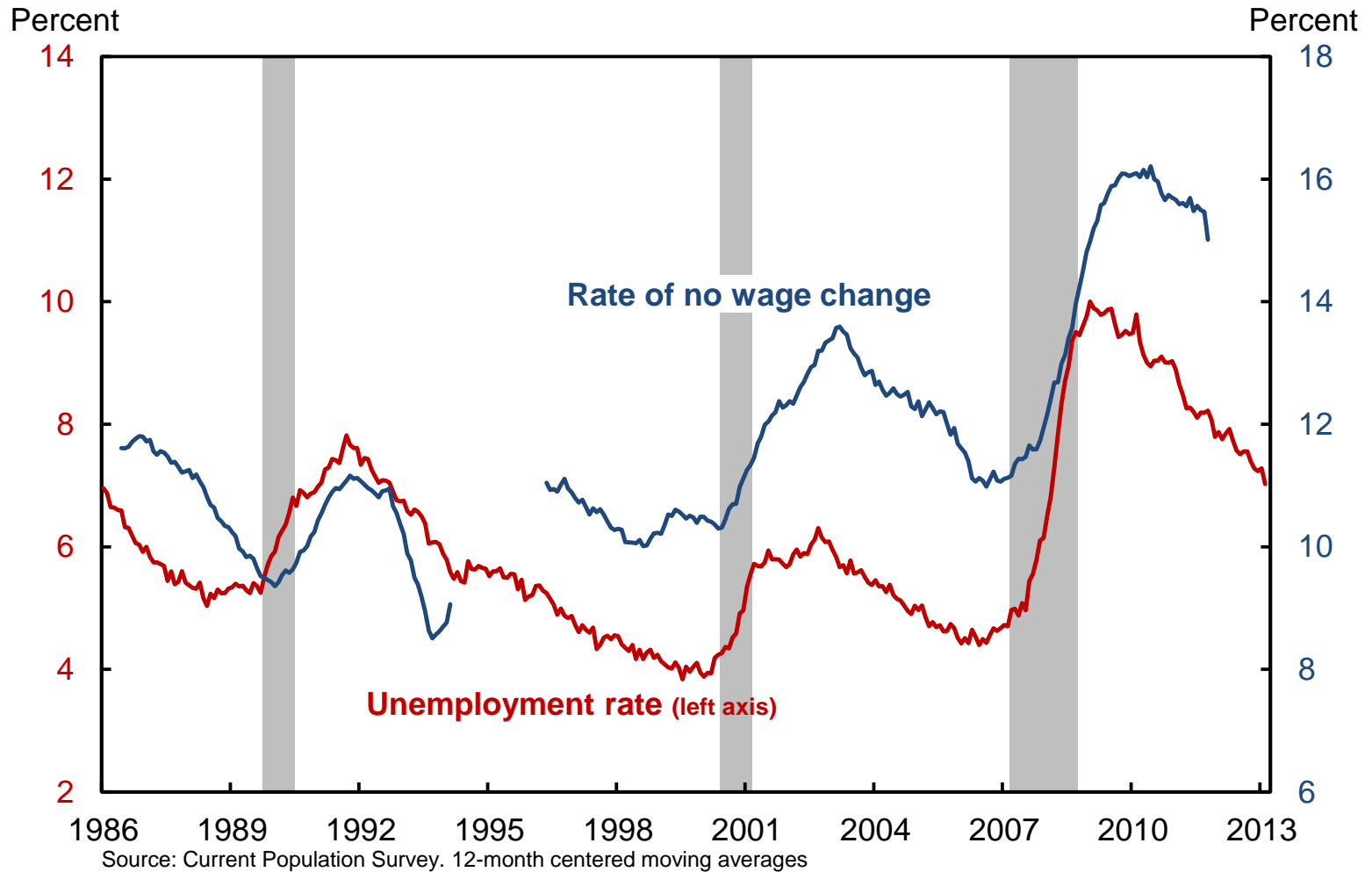


Source: Authors' calculations

# Remember the data?...

## Unemployment rate and rate of no wage change

Zero 12-month wage change; All types of workers (hourly, salary, and job switchers, and job stayers)



Result 3

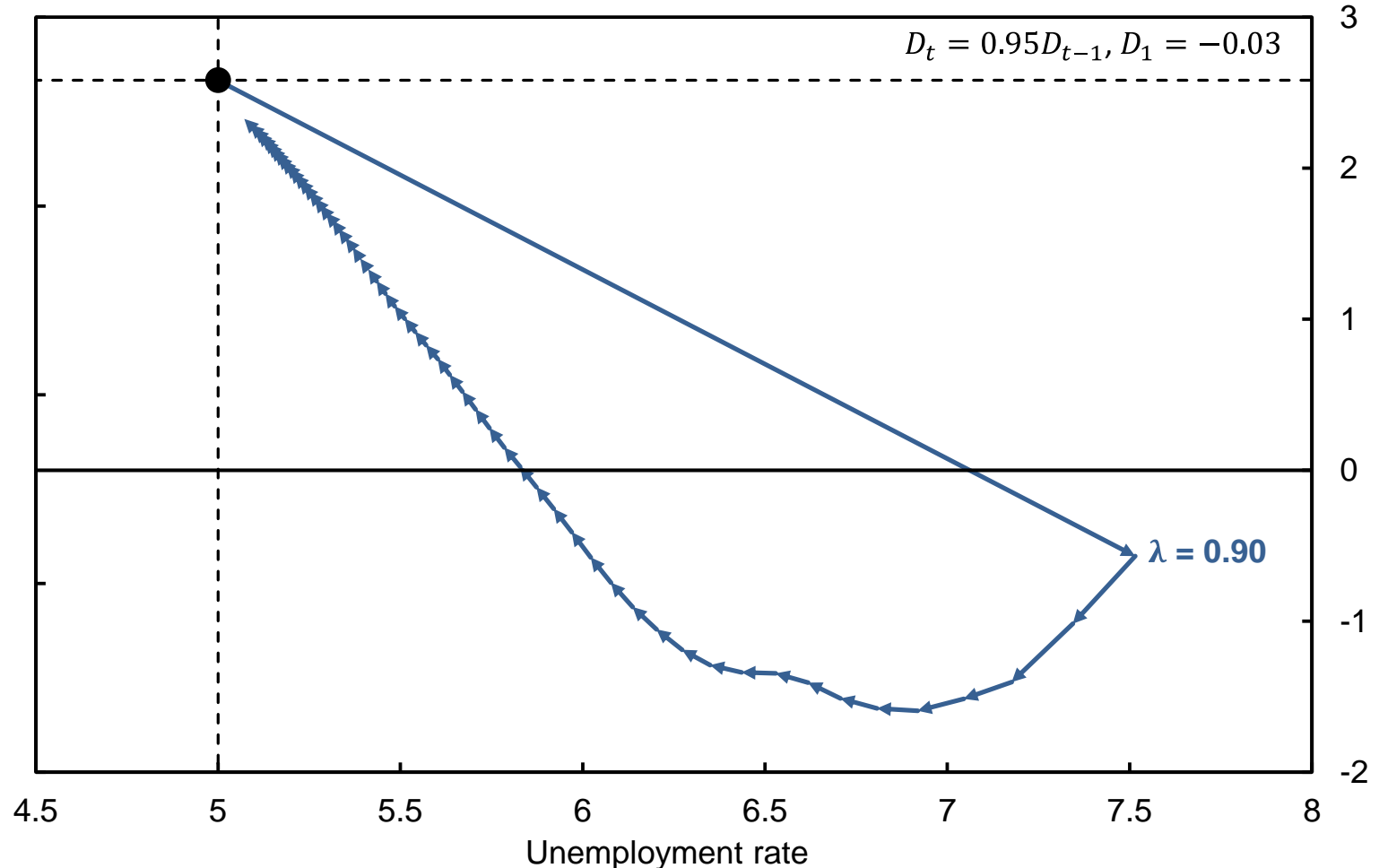
# WAGE PHILLIPS CURVE IS BENT

# Wage Phillips curve bent

## Short-run Wage Phillips Curve - benchmark simulation

For three degrees of downward nominal wage rigidities

Wage growth gap (annualized)



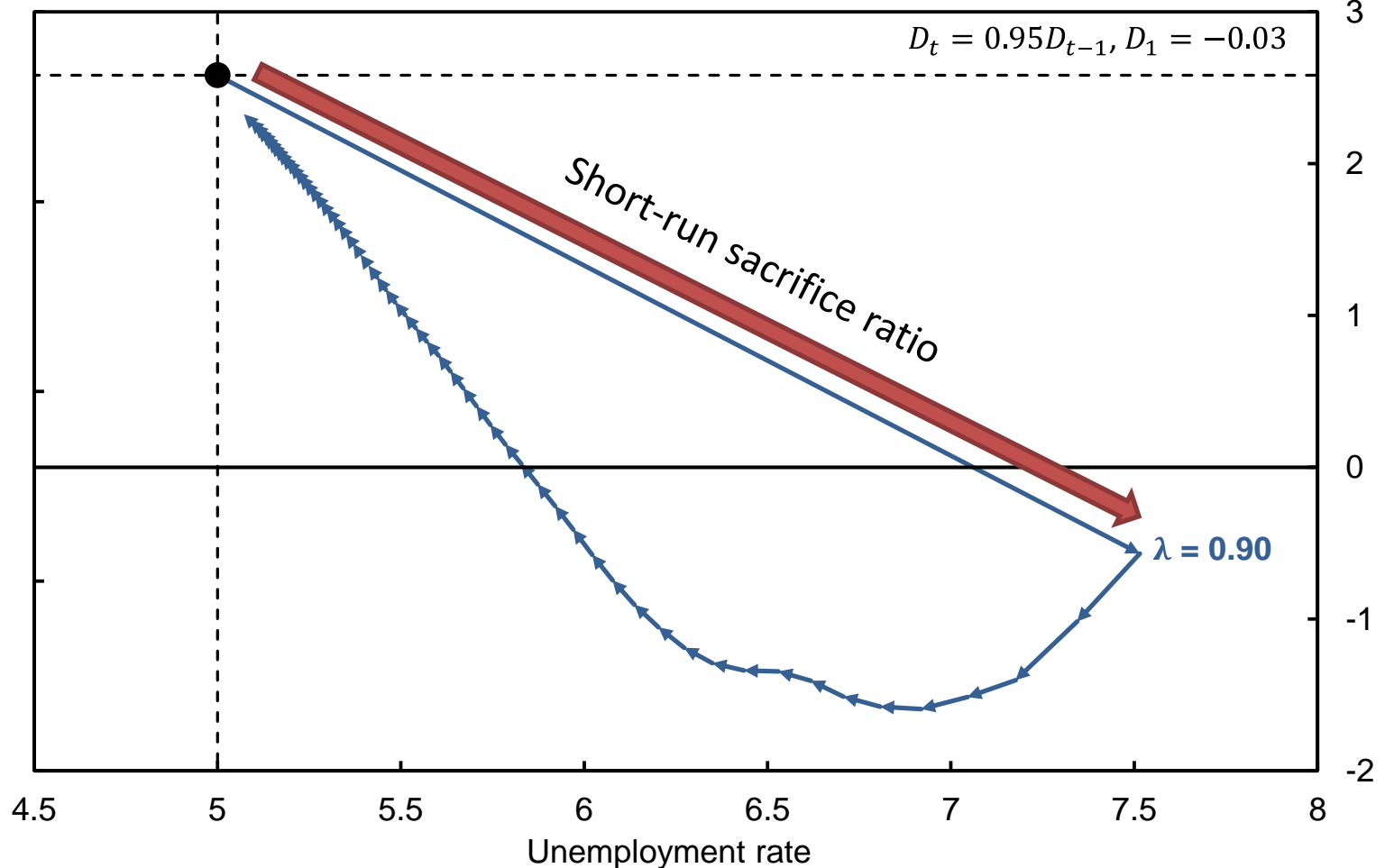
Source: Authors' calculations

# Unemployment spikes after shock

## Short-run Wage Phillips Curve - benchmark simulation

For three degrees of downward nominal wage rigidities

Wage growth gap (annualized)



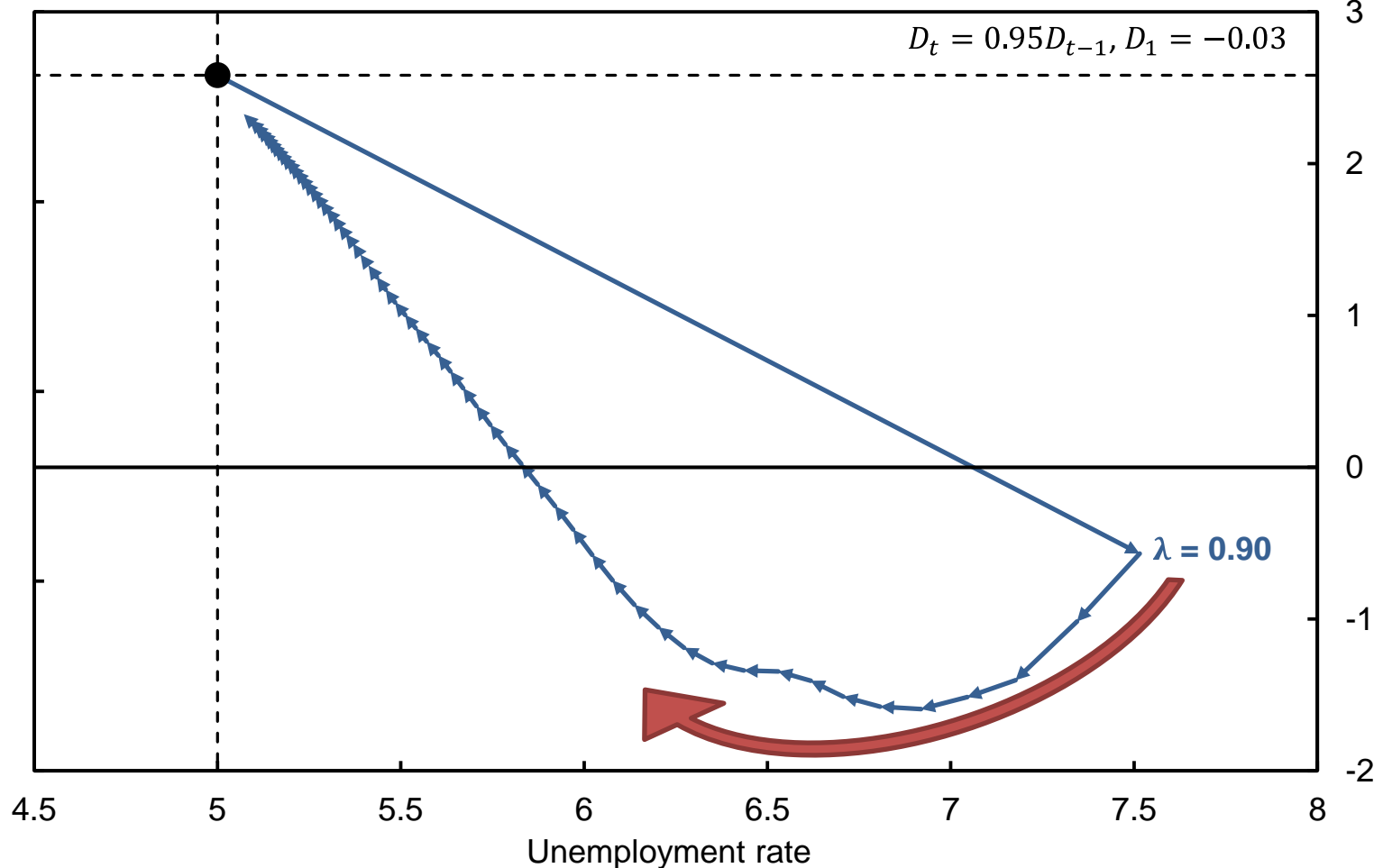
Source: Authors' calculations

# Pent up wage deflation realized during recovery

## Short-run Wage Phillips Curve - benchmark simulation

For three degrees of downward nominal wage rigidities

Wage growth gap (annualized)



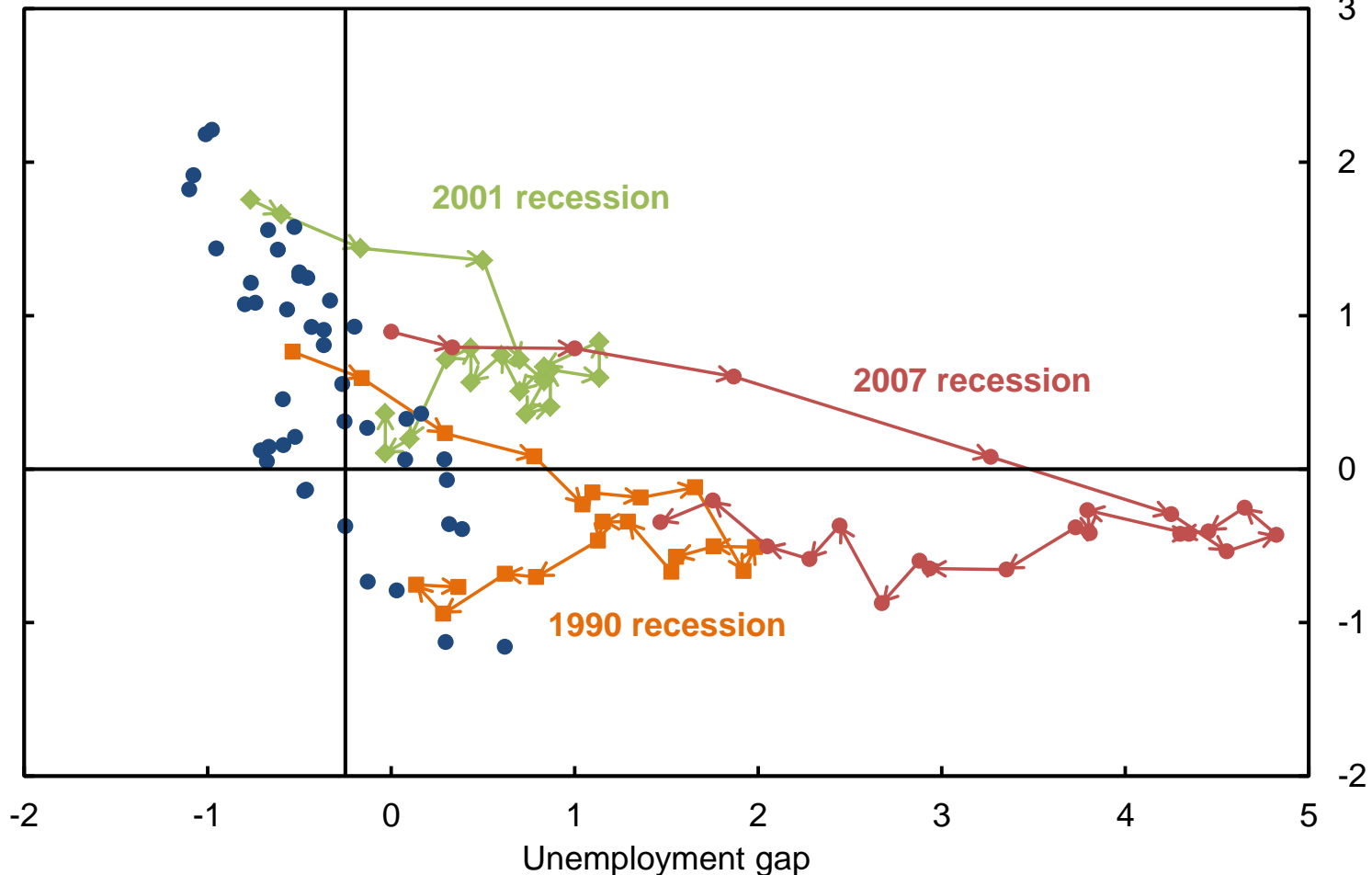
Source: Authors' calculations

# Here is the empirical equivalent

## U.S. Wage Phillips Curve: 1986-2012

Nominal wage growth is 4Q change

Nominal wage growth gap



Source: Bureau of Labor Statistics and authors' calculations

# Conclusion

- Record-high fraction of U.S. workers with wage frozen in aftermath of Great Recession.
- Even as unemployment rate has declined, wage growth has continued to slow.
- Dynamics of simple model of downward nominal wage rigidities is qualitatively consistent with facts.
- Downward nominal wage rigidities have played a role in shaping dynamics of wage growth and unemployment **during last 3 U.S. business cycles.**
- Downward nominal wage rigidities **also important in Europe.**

Dickens et al. (2007), Bonin and Radowski (2011), Whelan (2012), Schmidt-Grohe and Uribe (2013)