

# **The Interplay Among Inflation, Productivity, and Potential Real GDP**

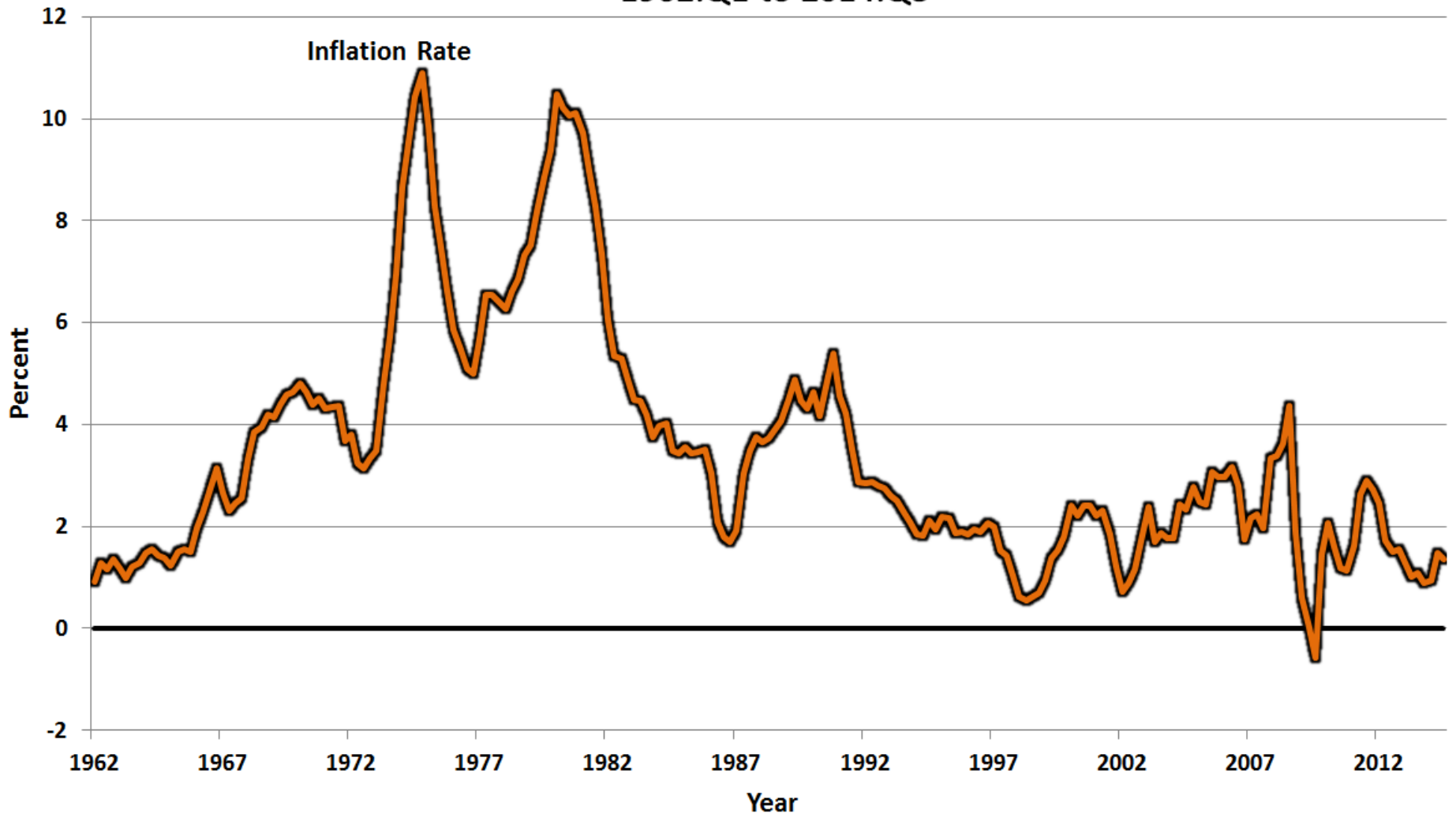
**Robert J. Gordon, Northwestern University  
Presented at Seminar,  
Council of Economic Advisers,  
Washington, November 14, 2014**

# **Inflation and Productivity Growth: Mutual Feedback**

- **Changes in the productivity trend represent one of four supply-shift variables in the inflation equation**
- **The inflation equation endogenously estimates the NAIRU**
- **The unemployment gap (“u-gap”) implied by that NAIRU is then used to separate trend vs. cycle for real GDP, total economy productivity, and other components of the output identity.**

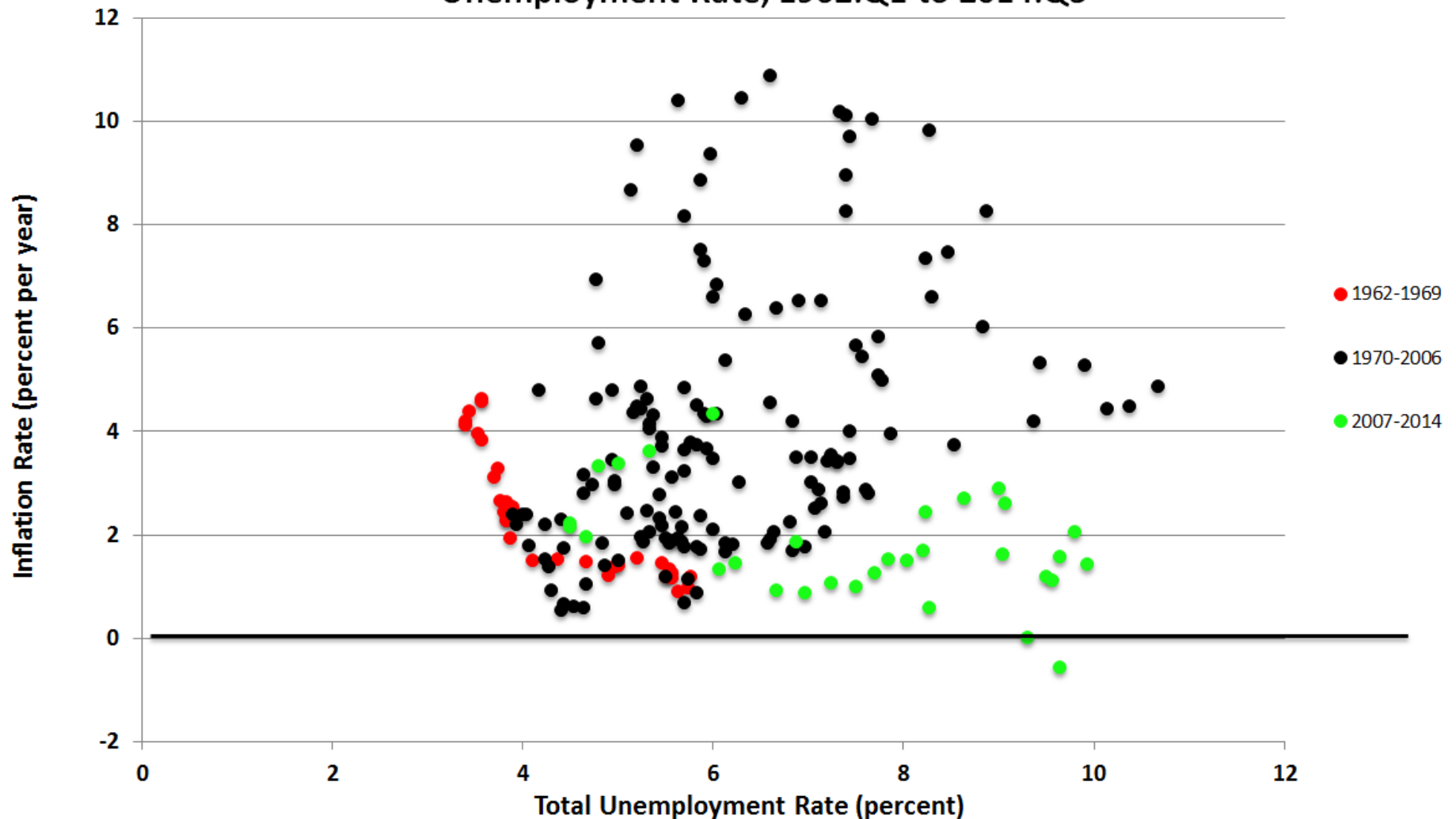
# The Time Series to Be Explained

Figure A. Four Quarter Changes in Headline Inflation Rate  
1962:Q1 to 2014:Q3



# Have You Ever Seen A Scatter Plot With a Lower Correlation?

Figure 1b. Four Quarter Changes in Headline Inflation Rate vs Total Unemployment Rate, 1962:Q1 to 2014:Q3



# **Why Should Inflation Be Related Only to Unemployment?**

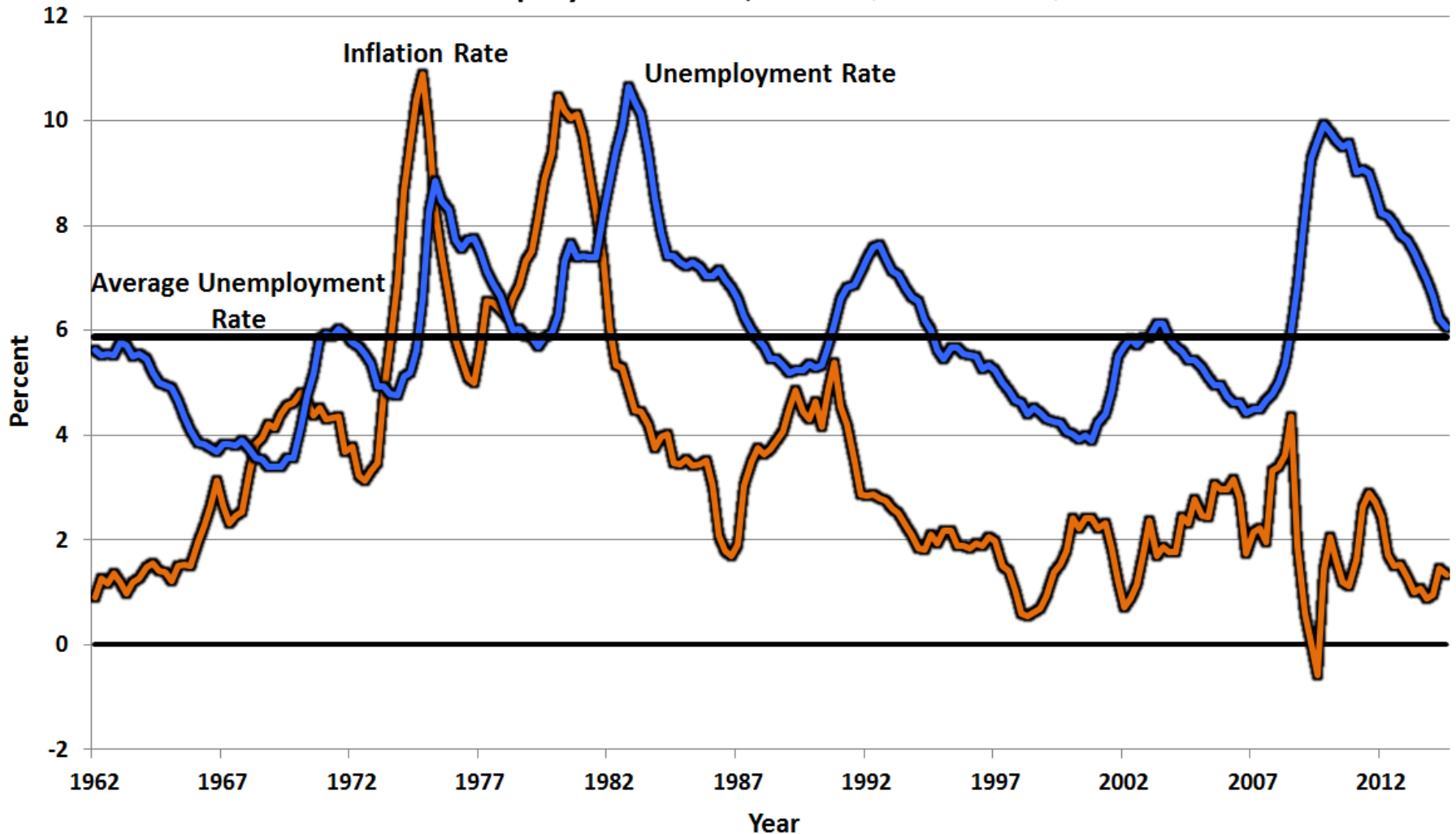
- **This casts aside microeconomics as it was developed more than 100 years ago.**
- **Does the price of oil have one determinant, the demand for oil?**
- **Of course not, the closing of a refinery in Iraq can raise the price of oil**
- **Also true of macroeconomics – the u-gap represents the demand side but the supply side matters as well.**

# **Inflation Depends on Demand and Supply**

- **This theory was introduced into macroeconomics in early 1975, almost 40 years ago.**
- **“Alternative Responses of Policy to Adverse Supply Shocks,” BPEA, 1975, no. 1, pp. 183-206.**
- **It has been part of macro textbooks since 1978.**
- **An adverse supply shock, e.g., a 6-fold increase of the price of oil as in 1972-74, chews up consumer expenditures and leaves less remaining to buy non-oil/energy products**
- **The rest of the economy outside the energy sector goes into recession.**
- **Price flexibility for energy and price rigidity for non-energy**

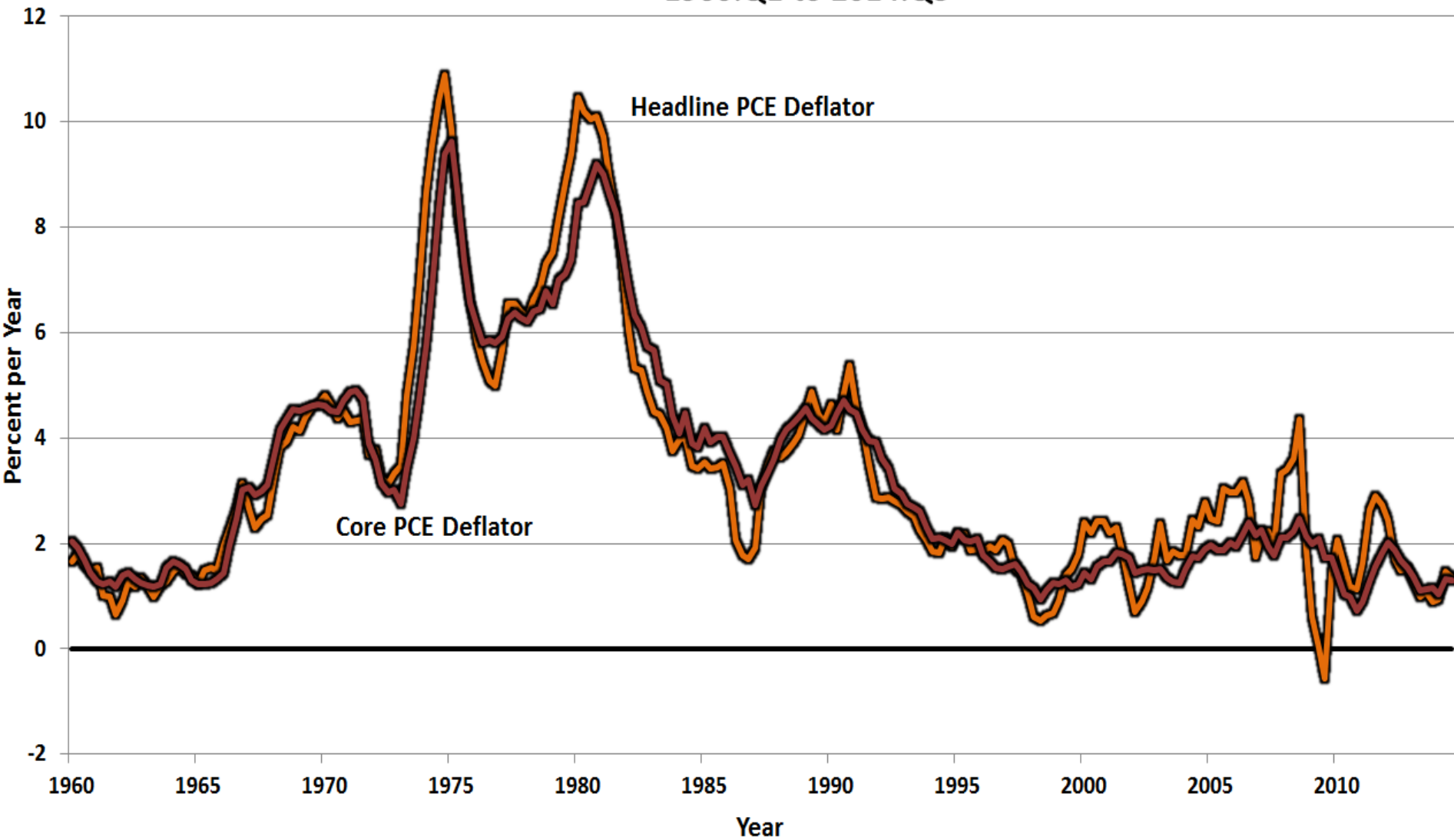
# Here You See the Supply Shocks in Action: 1974, 1979-80, 1998-99

Figure 1a. Four Quarter Changes in Headline Inflation Rate vs Total Unemployment Rate, 1962:Q1 to 2014:Q3



# Headline vs. Core Inflation

Figure 3a. Four Quarter Changes of Headline and Core PCE Deflator, 1960:Q1 to 2014:Q3





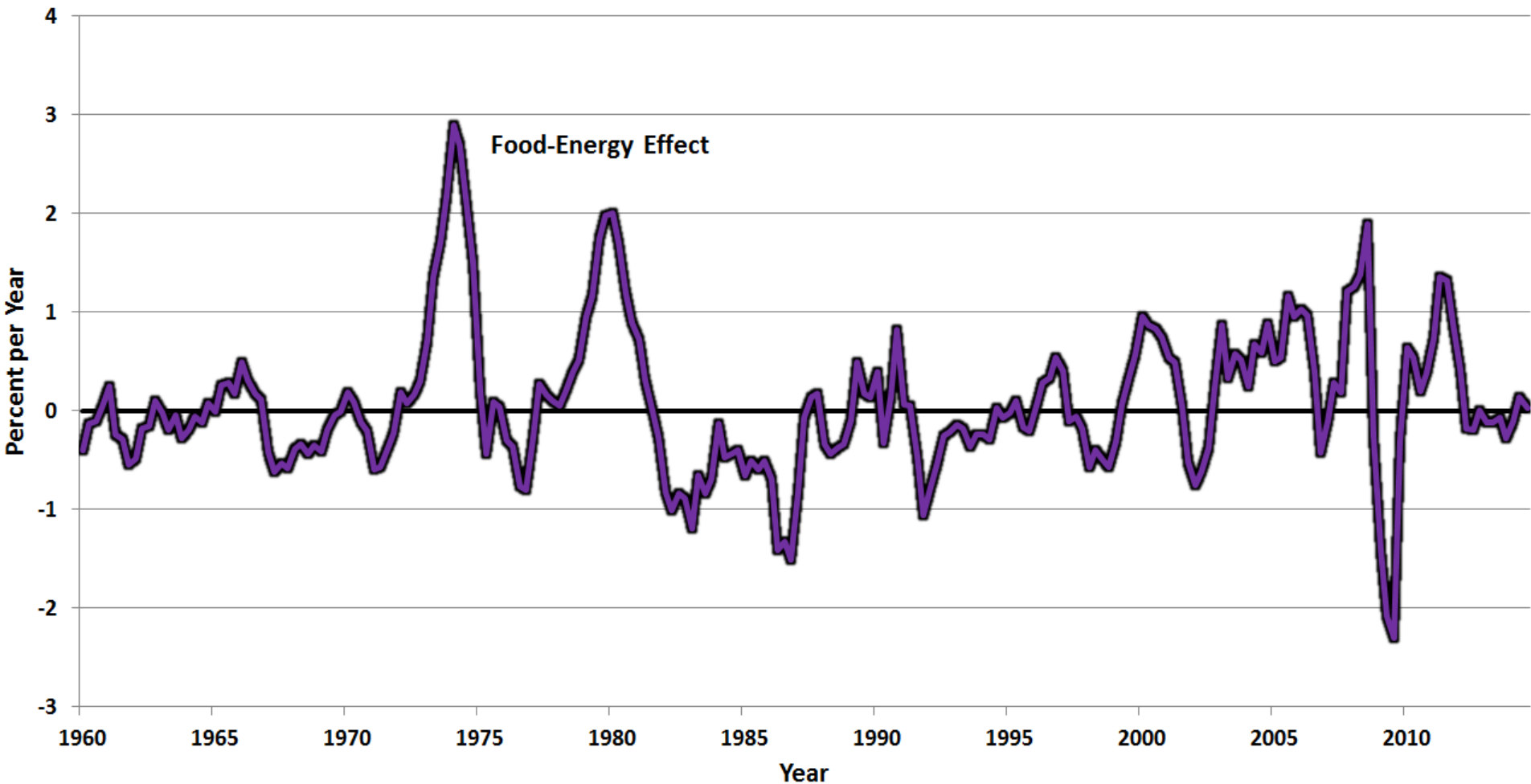
# **The Vintage 1980**

## **“Triangle Model” of Inflation**

- **Current specification is 34 years old, introduced in 1980**
- **Inflation depends on Inertia**
  - **Lagged inflation, with freely estimated weights over the past six years.**
- **Inflation depends on demand**
  - **“ugap,” the deviation of Unemployment from NAIRU**
- **Inflation depends on supply**
  - **The food-energy effect, difference between headline and core**
  - **Relative price of nonoil nonfood imports**
  - **Change in the total-economy productivity trend**
  - **Nixon price controls “on” held down inflation, “off” released it**

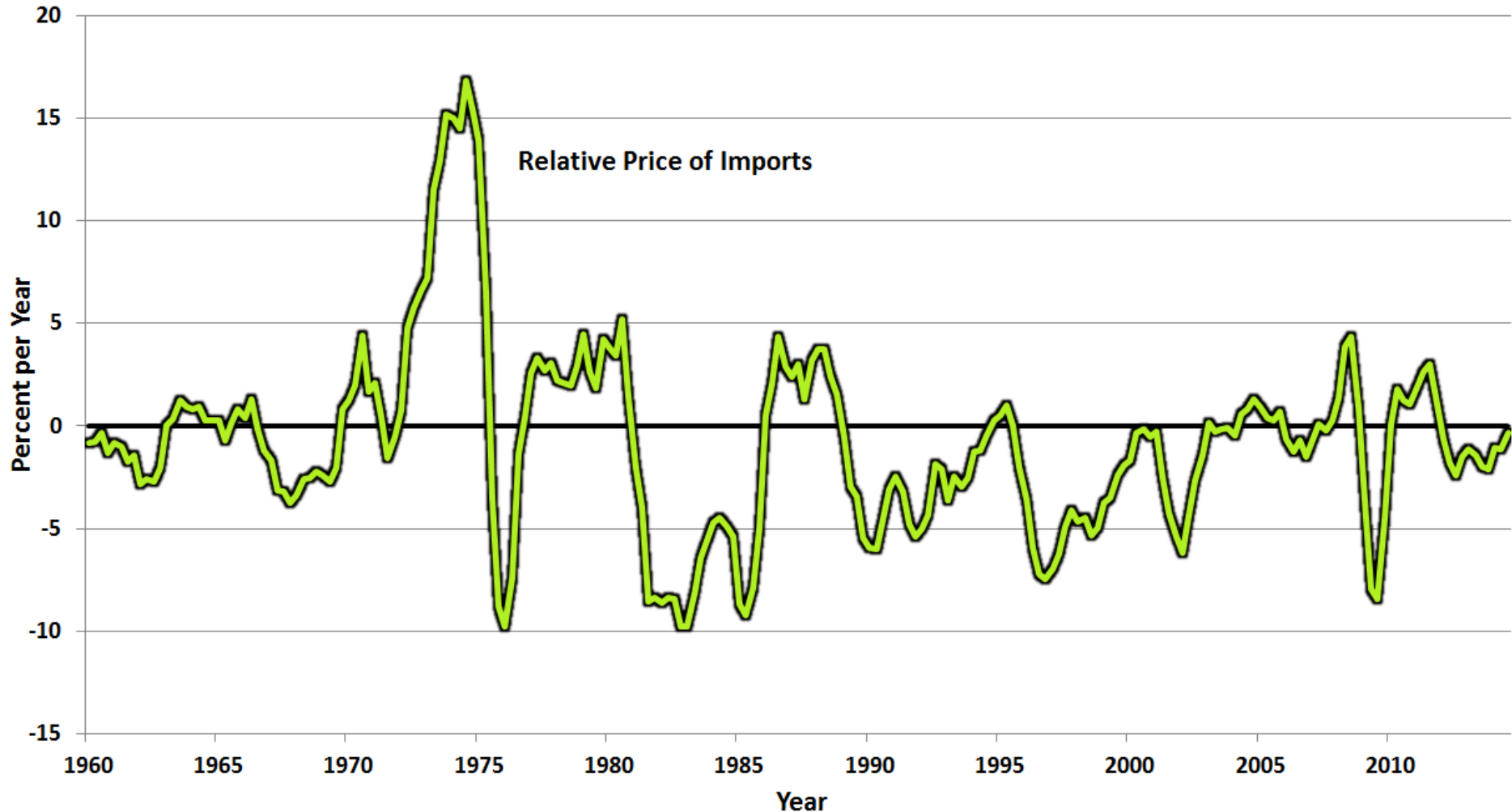
# The Food-Energy Effect is the Difference Between Headline and Core Inflation

Figure 3b. Four Quarter Changes of Food-Energy Effect, 1960:Q1 to 2014:Q3



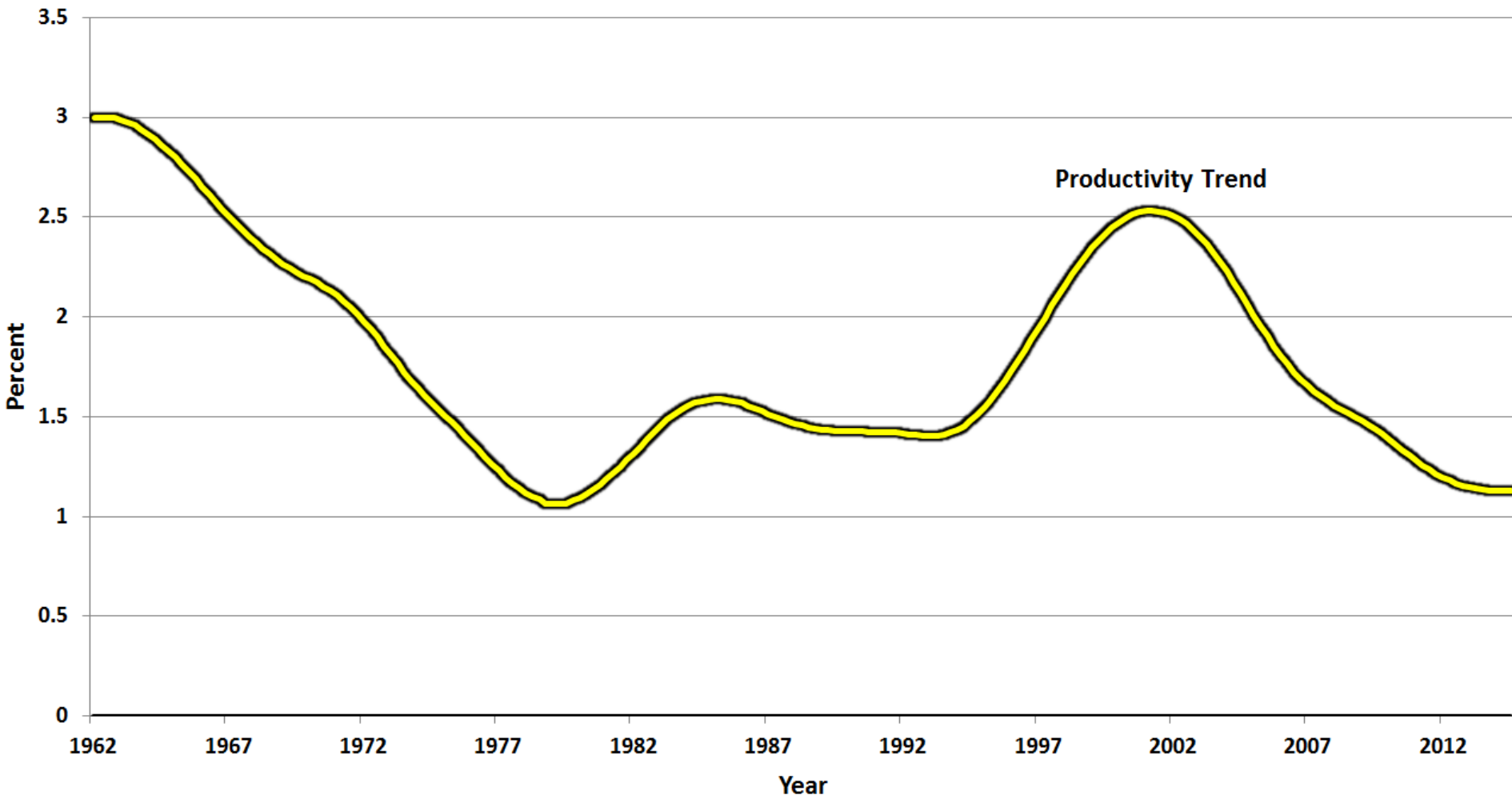
# The Relative Price of Nonoil, nonfood Imports Also Matters (Change of scale)

Figure 4a. Four Quarter Changes of Relative Price of Imports, Non-Food Non-Oil, 1960:Q1 to 2014:Q3



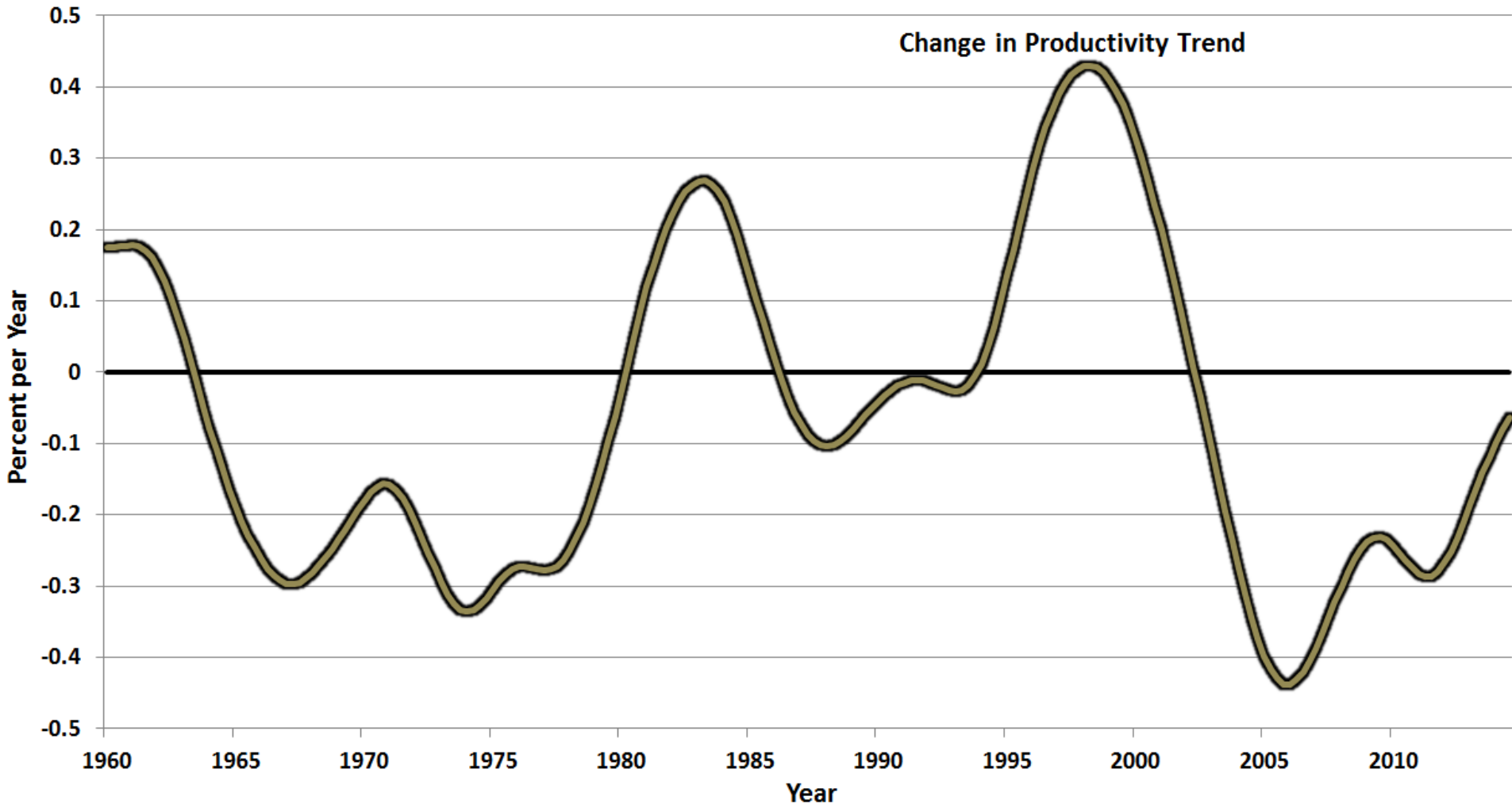
# Productivity Growth Matters a Lot: Here is the Productivity Growth Trend

Figure F. Change in Productivity Trend, 1962:Q1 to 2014:Q3



# Change in Productivity Trend Helps to Explain Inflation Behavior

Figure 4b. Eight Quarter Changes of Productivity Trend, 1960:Q1 to 2014:Q3

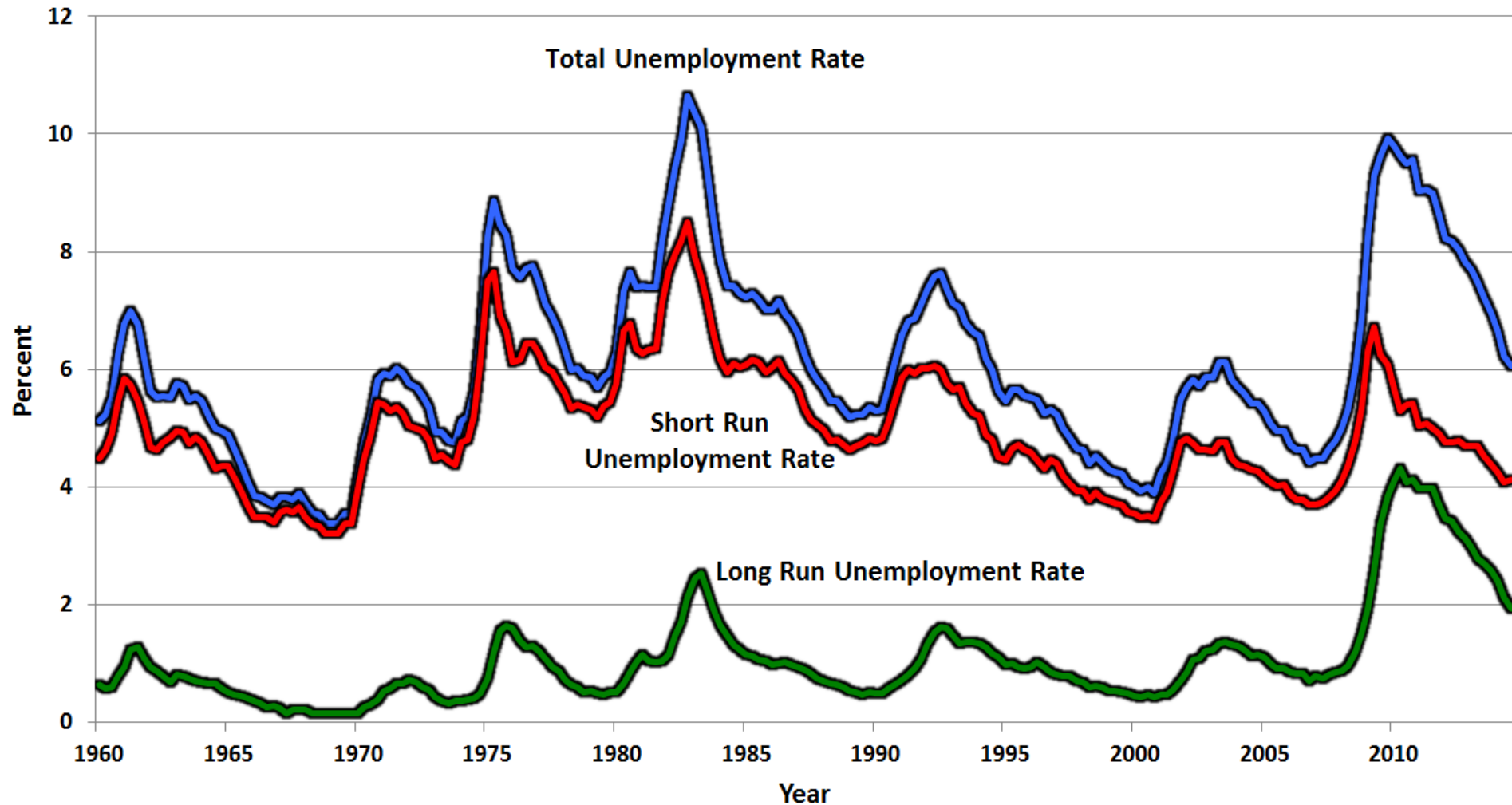


# Which Unemployment Rate to Drive the Inflation Process?

- All the literature before my 2013 WP used the total unemployment rate
- In past year there has been a big debate about whether short-term unemployment (< 6 months) matters more for wages and inflation than long-term unemployment (> 6 months).
- The two measures behave identically until 2009, then very different

# Which Unemployment Rate Drives Inflation?

Figure 6. Total, Short Run, and Long Run Unemployment Rate, 1960:Q1 to 2014:Q3



# Debate Whether the LTU Are Disconnected from the Labor Market

- Part of this is real: skills atrophy when workers are out of work for 6 months, 1 year, even 5 years
- All the decline in LTU over the past year is more than accounted for by labor-force dropping out. *The average long-term unemployed person leaves the labor force rather than taking a job.*
- Employers are described as rejecting applications from LTU, looking for gaps of 6 months or more in their employment experience. Employers use the lack of employment as a “signal” that something else is wrong with the applicant.



# Triangle Model, Changes Since 1980

- $p_t = a(L)p_{t-1} + b(L)D_t + c(L)z_t + e_t$ .
- Variables, lag lengths, Nixon control dummy, all as specified in 1980.
- 1997, switch from demographically adjusted NAIRU to endogenously estimated TV-NAIRU (Staiger, Stock, Watson – dual articles in 1997 JEP).
- 2005, change treatment of productivity trend
- 2013
  - allow food-energy coefficient to change
  - add distinction between STU and LTU

**Table 2****Triangle Model: Estimated Equations for Quarterly Changes in the Headline PCE Deflator, Total vs. Short Term Unemployment**

Variable	Lags	1962:Q1 to 2006:Q4				1962:Q1 to 2014:Q3			
		TU		STU		TU		STU	
Lagged Dependent Variable	1-24 <sup>a</sup>	1.01	**	1.01	**	1.00	**	1.01	**
Unemployment Gap	0-4	-0.48	**	-0.75	**	-0.34	**	-0.68	**
Relative Price of Imports, NFNO	1-4	0.03		0.03		0.01		0.02	
Food-Energy Effect Full Period	0-4	1.16	**	1.15	**	1.10	**	1.18	**
Food-Energy Effect Late Period	0-4	-0.40	*	-0.40	*	-0.48	**	-0.49	**
Productivity Trend Change	1 5	-0.75	*	-0.66	*	-0.93	**	-0.80	**
Nixon Controls "on"	0	-1.88	**	-1.69	**	-1.75	**	-1.68	**
Nixon Controls "off"	0	1.92	**	1.89	**	1.90	**	1.89	**
Adj. R2		0.94		0.95		0.94		0.95	
S.E.E		0.61		0.60		0.62		0.60	
S.S.R		55.41		54.93		70.21		65.09	
Dynamic Simulations		2007:Q1 to 2014:Q3							
Mean Error		0.37		0.07					
Error in 2014:Q3		-1.02		-0.52					
Root Mean-Square Error		1.03		0.72					

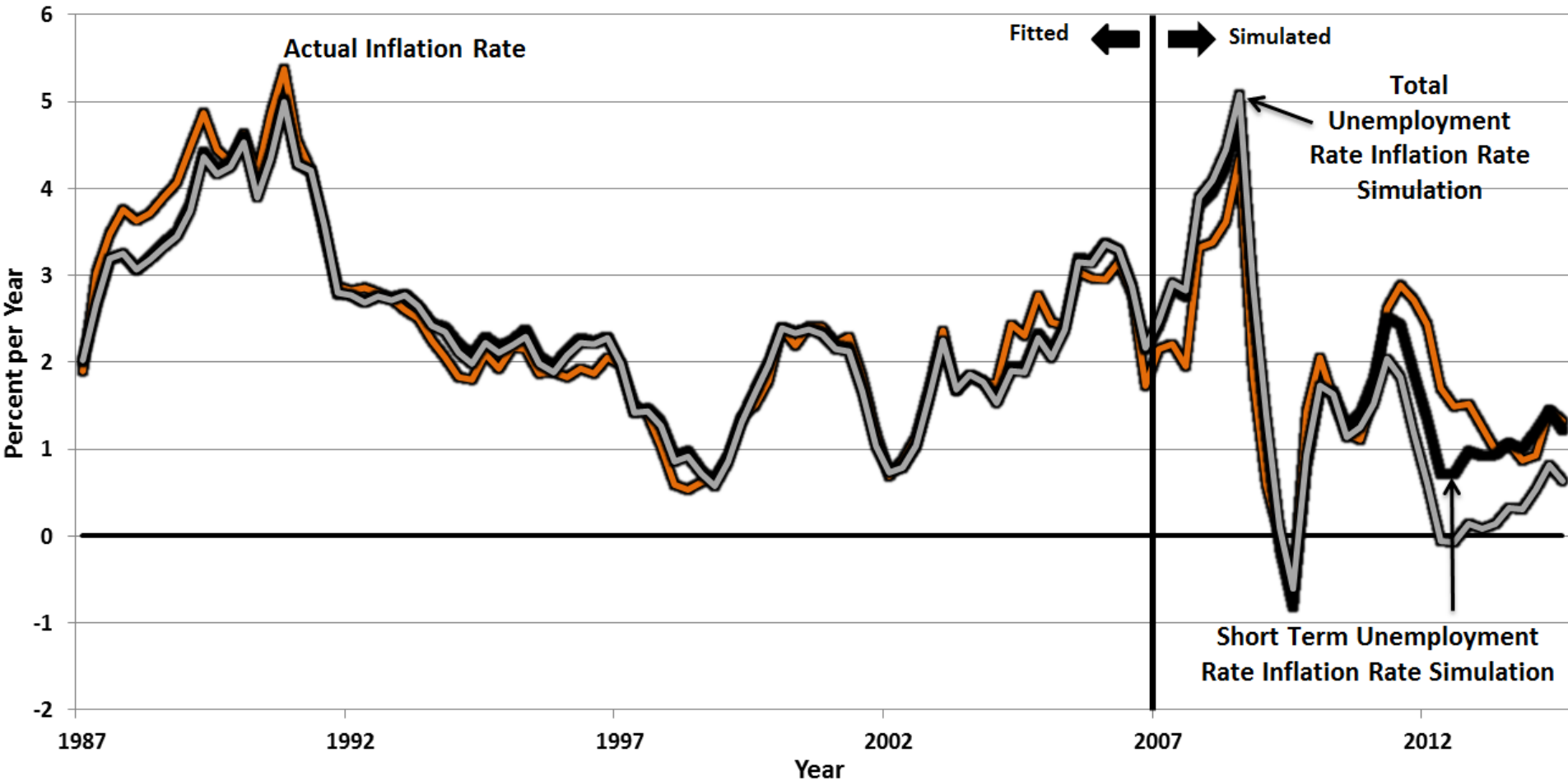
a) Lagged dependent variable is entered as the four-quarter moving average for lags 1, 5, 9, 13,

b) \*indicates coefficient or sum of coefficients is statistically significant at the 5 percent level, \*\* indicates significance at the 1 percent level.

# Triangle Model

## Dynamic Simulation 2007-2014

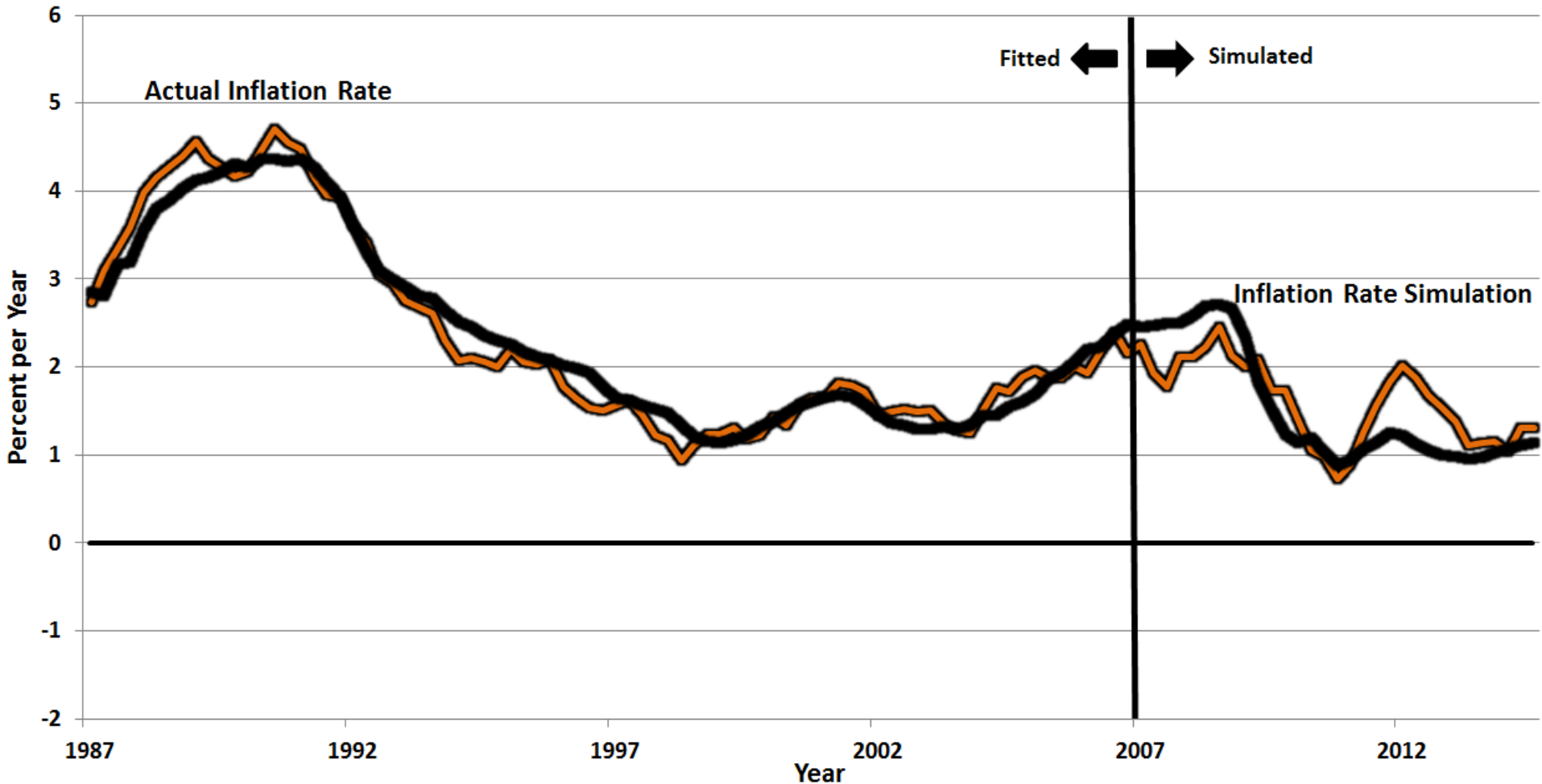
Figure 7b. Actual vs Simulated Headline Inflation Rate, 2006:Q4 Sample End, Total vs Short Term Unemployment, 1987:Q1 to 2014:Q3



# What About Core Inflation?

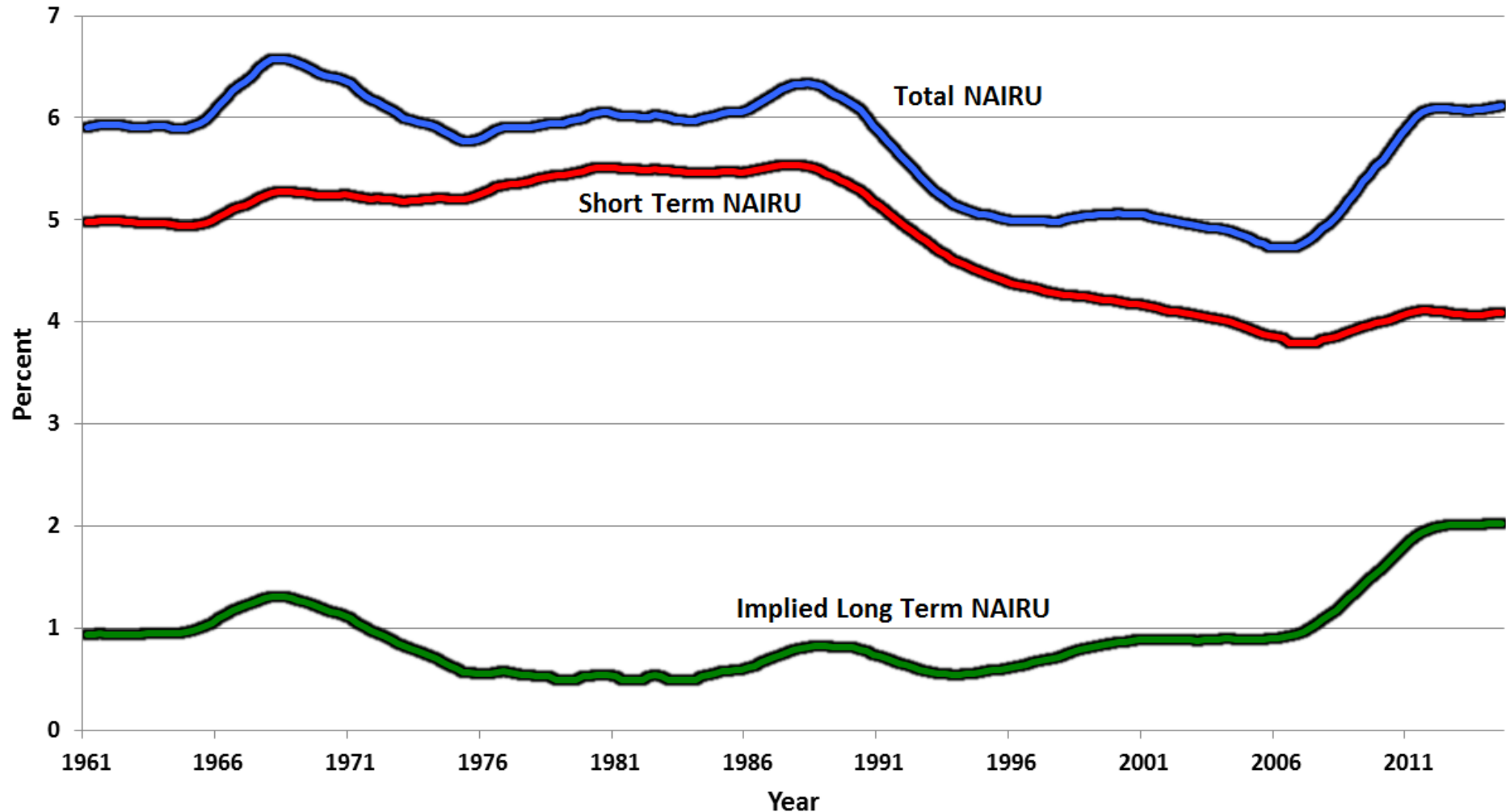
## Same Results

Figure 11b. Actual vs Simulated Core Inflation Rate, 2006:Q4 Sample End, Triangle Model, Short Term Unemployment Rate, 1987:Q1 to 2014:Q3



# Implication for the Fed's Unemployment Target

Figure 9. Total, Short Term, and Implied Long Term NAIURU, 1961:Q1 to 2014:Q3



# Future Inflation: What if the Fed goes for 5% Total Unemployment? What about 6%?

Figure 3b. Total Unemployment Extrapolation, Rising vs. Non-Rising Inflation Projections, 1987:Q1 to 2024:Q4

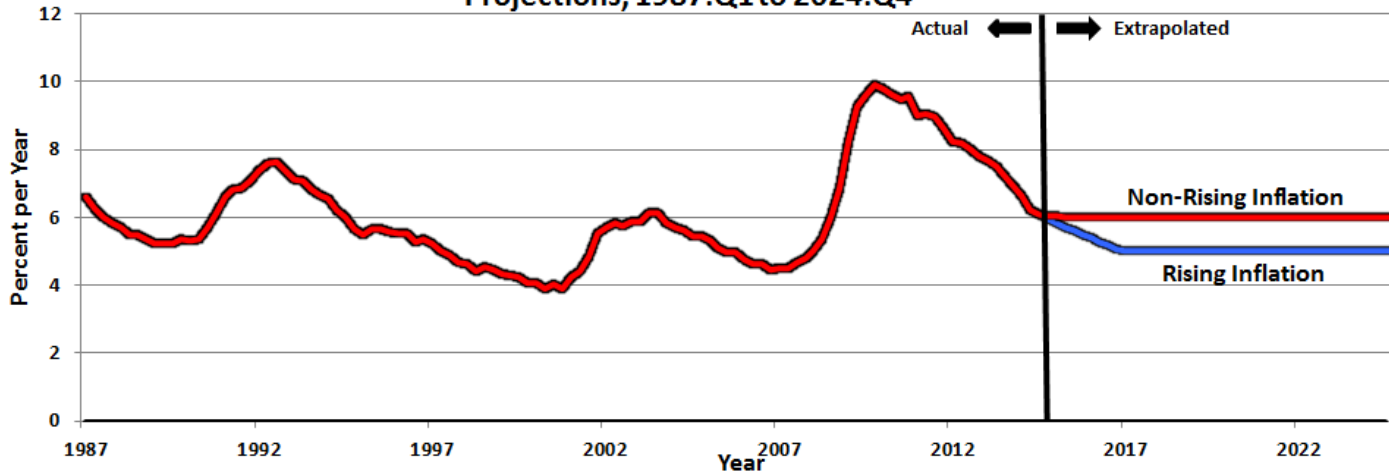
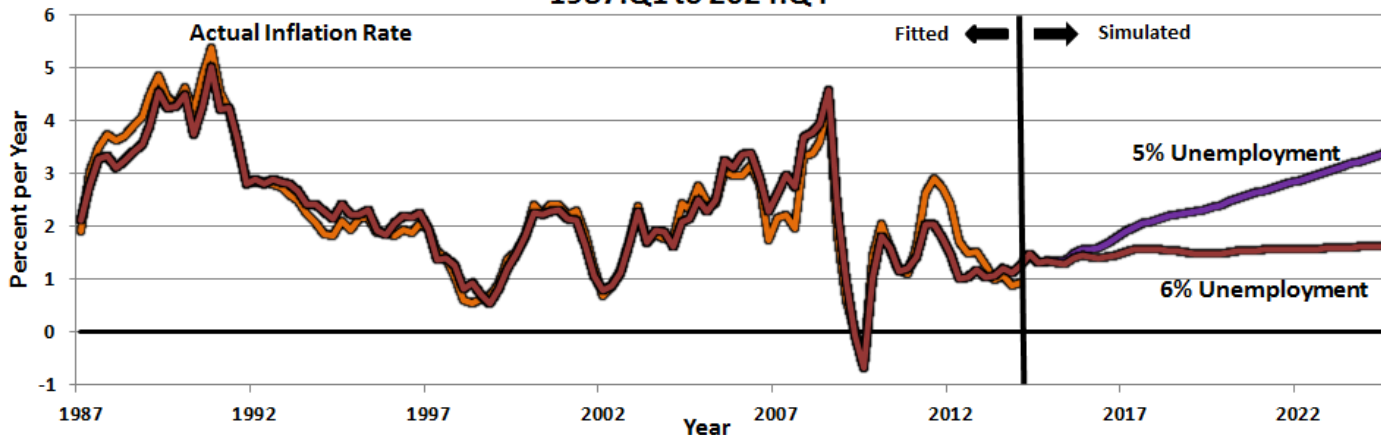


Figure 10a. Triangle Model Headline Inflation Rate Projections, 2014:Q1 Sample End, 5% vs 6% Total Unemployment, 1987:Q1 to 2024:Q4



# The Golden Path of Unemployment that Leads to 2% Inflation

Figure 3b. Total Unemployment Extrapolation, Golden Path to a 2% Inflation Rate,  
1987:Q1 to 2024:Q4

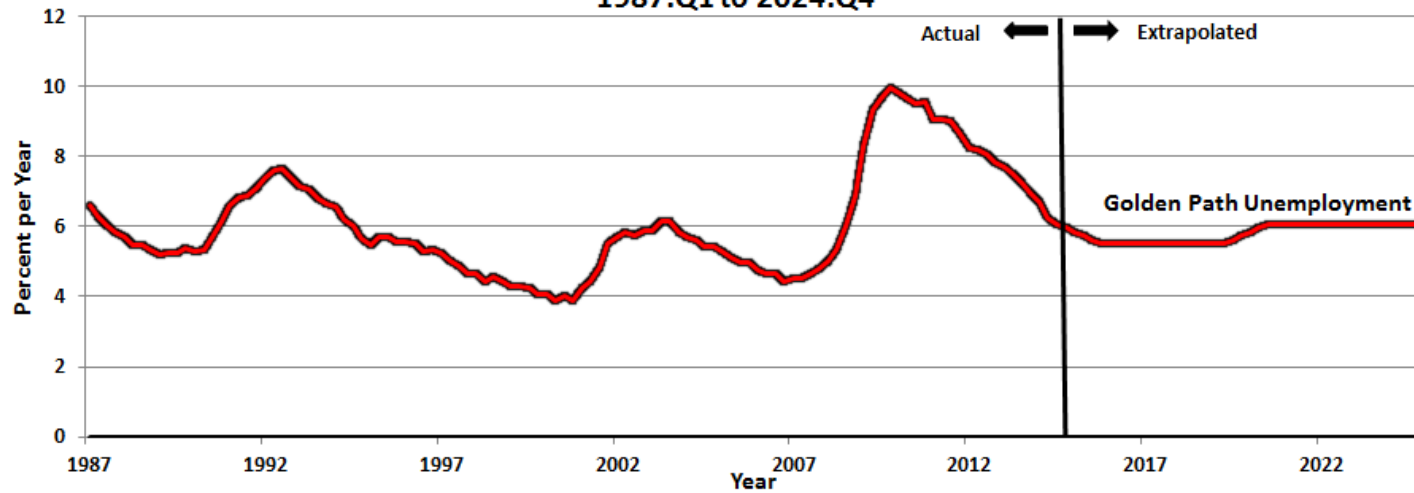
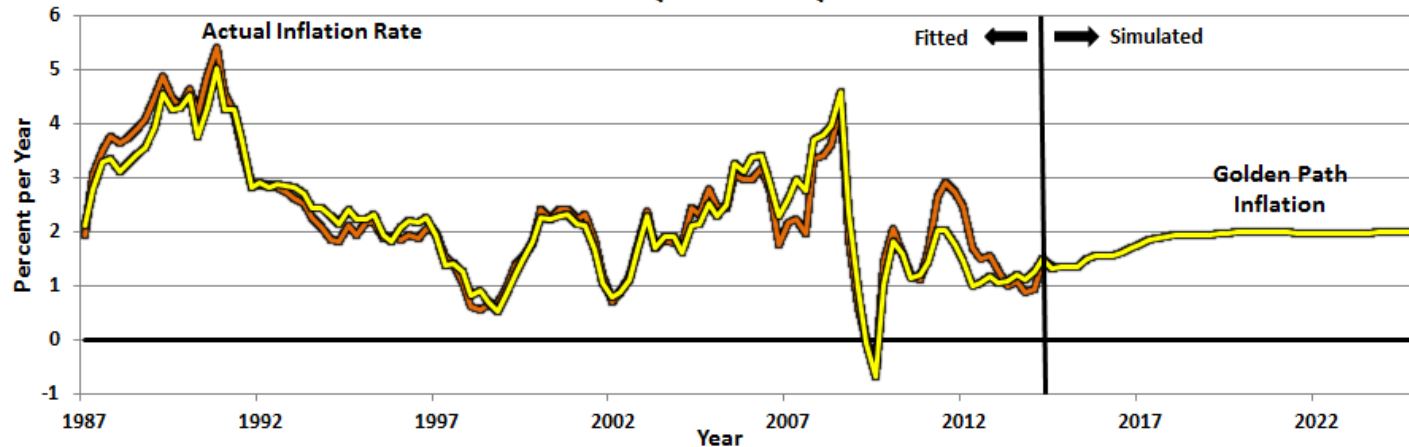


Figure 10a. Triangle Model Headline Inflation Rate Projections,  
2014:Q3 Sample End, Golden Path of Total Unemployment,  
1987:Q1 to 2024:Q4



# Now Use U-gap to Split Output Identity into Cycle and Trend

- **Basic Tool: the Output Identity**

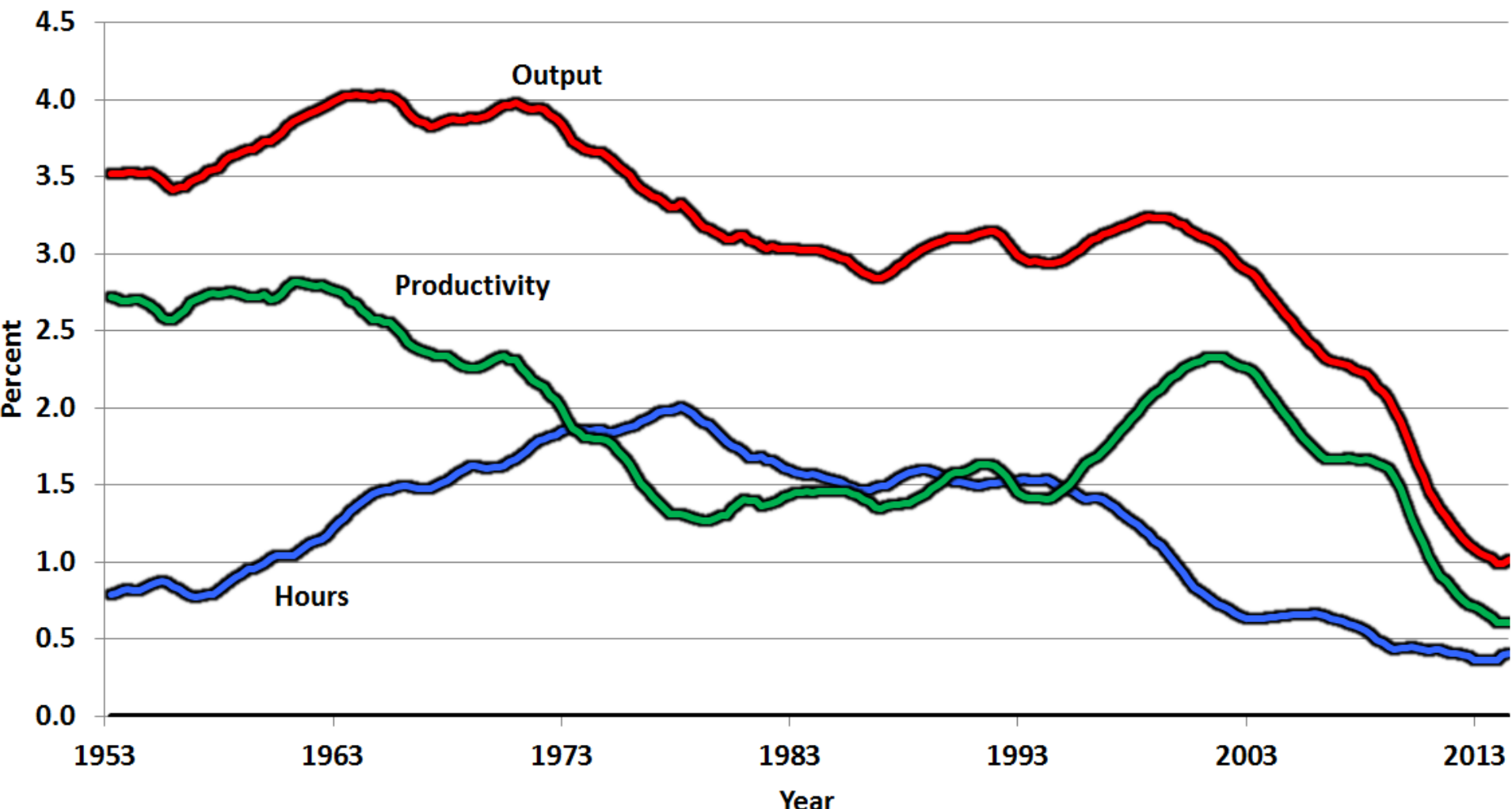
$$Y \equiv \frac{Y}{H^P} \cdot \frac{H^P}{H^H} \cdot \frac{H^H}{E^H} \cdot \frac{E^H}{L} \cdot \frac{L}{N} \cdot N$$



# Growth Rate Version

$$y \equiv y-h + r + h-e + e-l + l-n + n$$

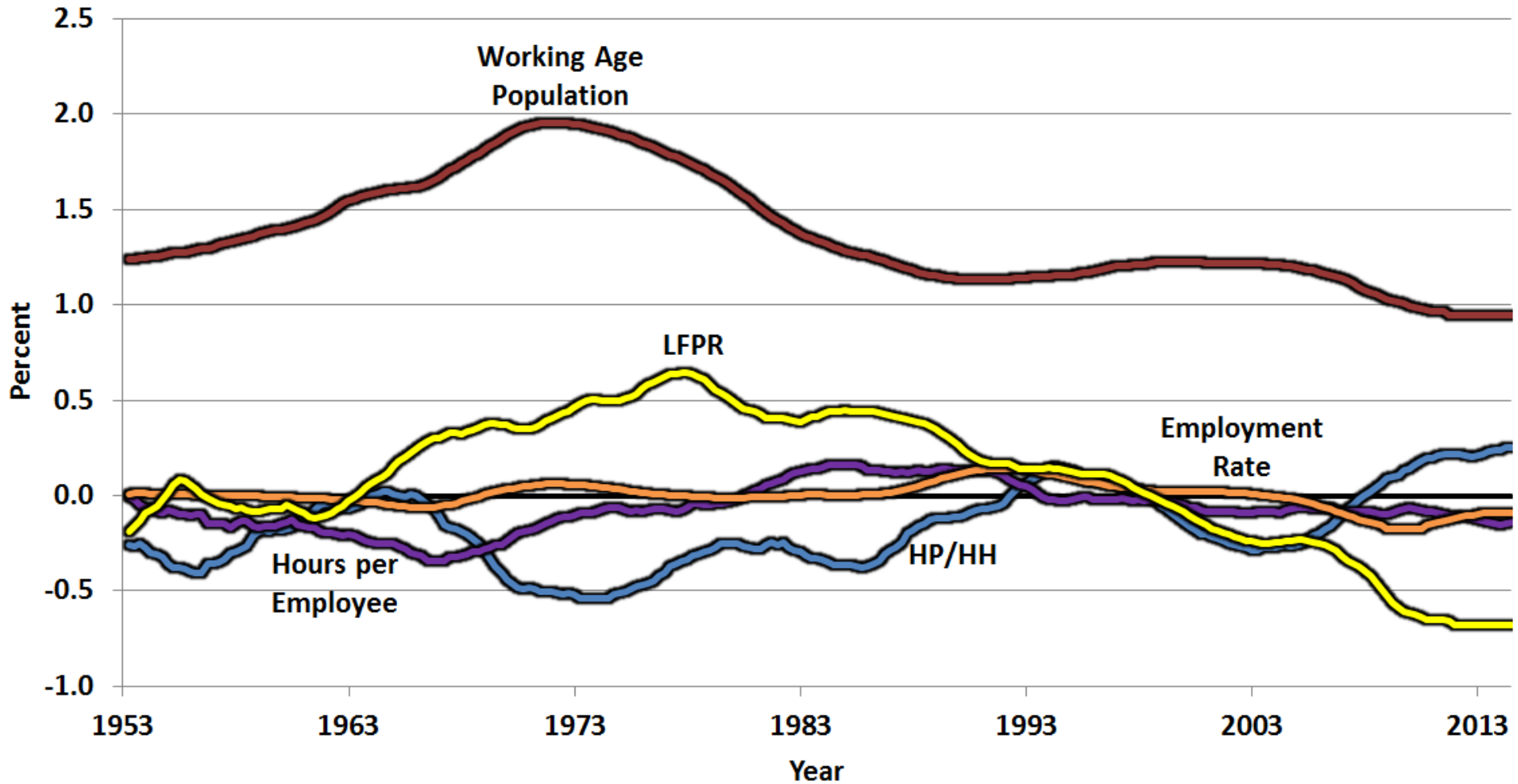
Figure 3. Kalman Growth Trends of Output, Hours, and Productivity, 1953:Q1 to 2014:Q3



**Division of Real GDP Growth  
Between Hours and Productivity**

	<b>Real GDP</b>	<b>Aggregate Hours</b>	<b>Output per Hour</b>
<b>2009:Q3-2013:Q3</b>	<b>2.13</b>	<b>1.41</b>	<b>0.72</b>
<b>2013:Q3-2014:Q3</b>	<b>2.32</b>	<b>1.82</b>	<b>0.50</b>
<b>2009:Q3-2014:Q3</b>	<b>2.17</b>	<b>1.49</b>	<b>0.68</b>

Figure 4. Kalman Growth Trends of Payroll/Household Hours Ratio, Hours per Employee, Employment Rate, LFPR, and Population, 1953:Q1 - 2014:Q3



## **Exercise: Choose Three Alternative Paths of the Unemployment Rate**

- **Path 1. Conservative, little further decline in U rate**
- **Path 2. Medium, unemployment drops to 5% but then returns to 5.5%**
- **Path 3. Aggressive. Unemployment drops to 4.8% and stays there forever.**

Figure 1. Extrapolated Total Unemployment Rate, NAIRU, and Unemployment Gap, Versions 1 through 3, 2014:Q2 to 2020:Q4

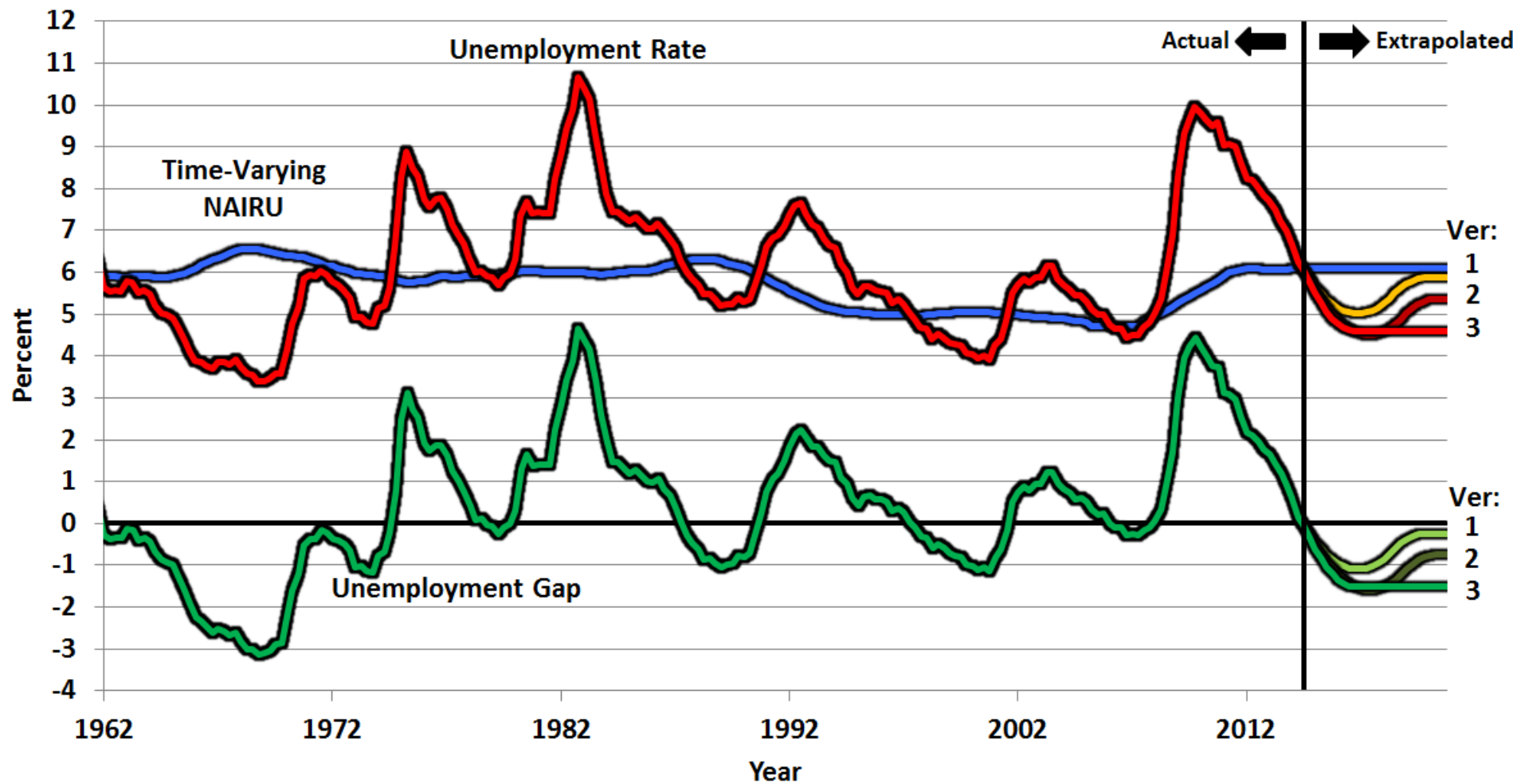


Figure 6. Four Quarter Growth Rate of Productivity and LFPR, Actual and Extrapolated, Versions 1 through 3, 2007:Q1 to 2020:Q4

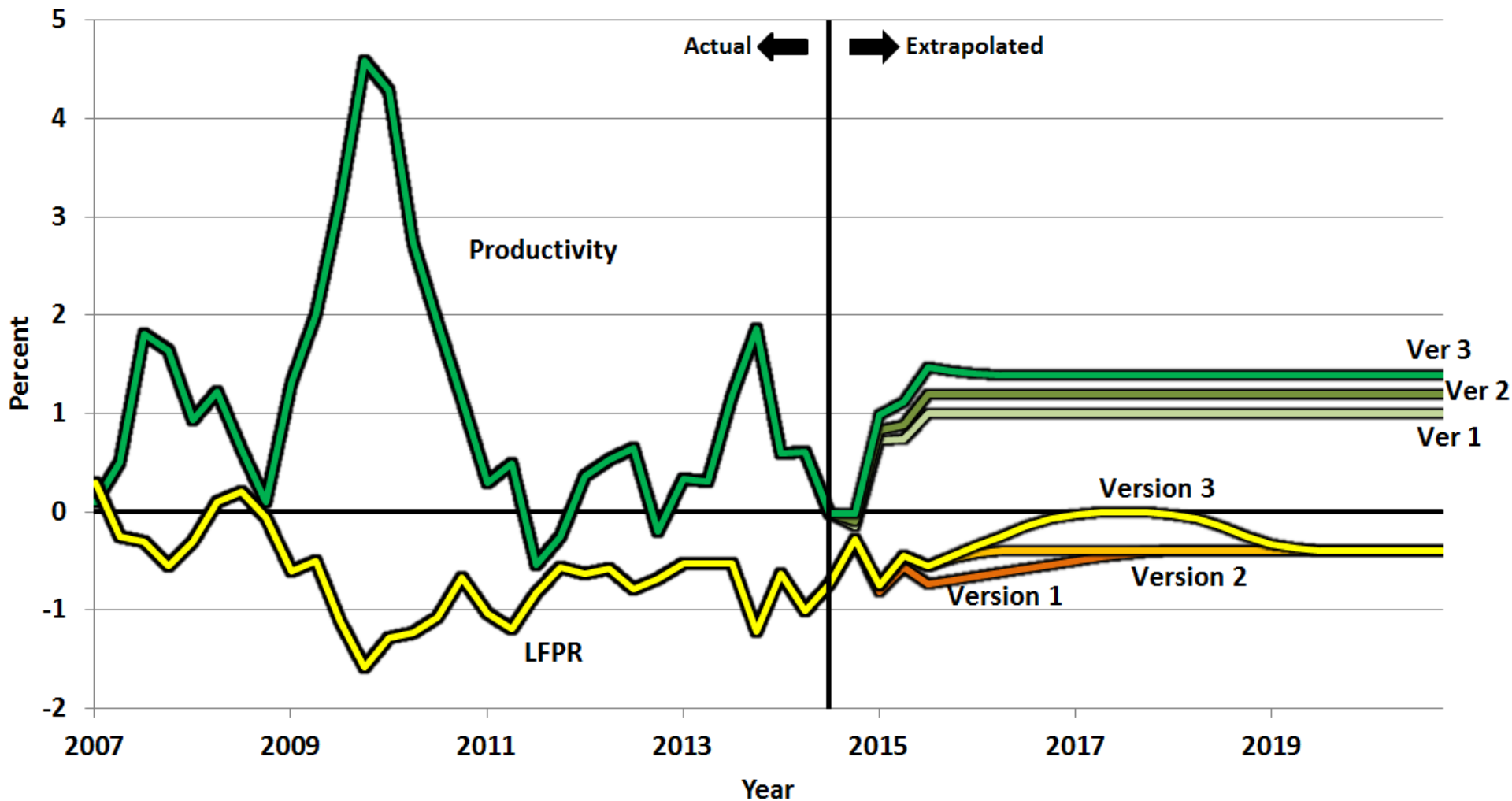


Figure 7. Four Quarter Growth Rate of Output, Actual and Extrapolated, Versions 1 through 3, 2007:Q1 to 2020:Q4

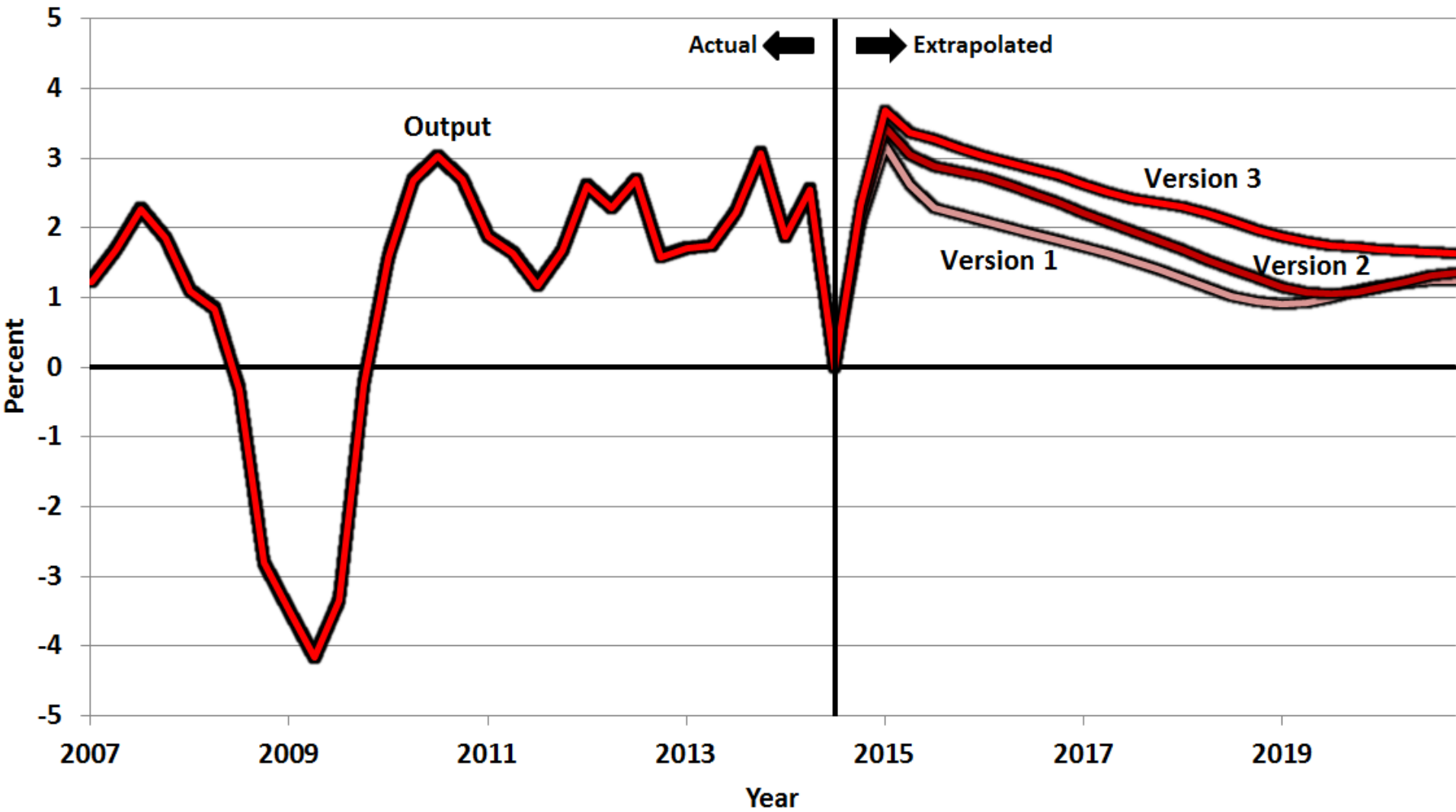




Figure 8. Projected Kalman Growth Trend of Output, Versions 1 through 3, 1990:Q1 to 2020:Q4

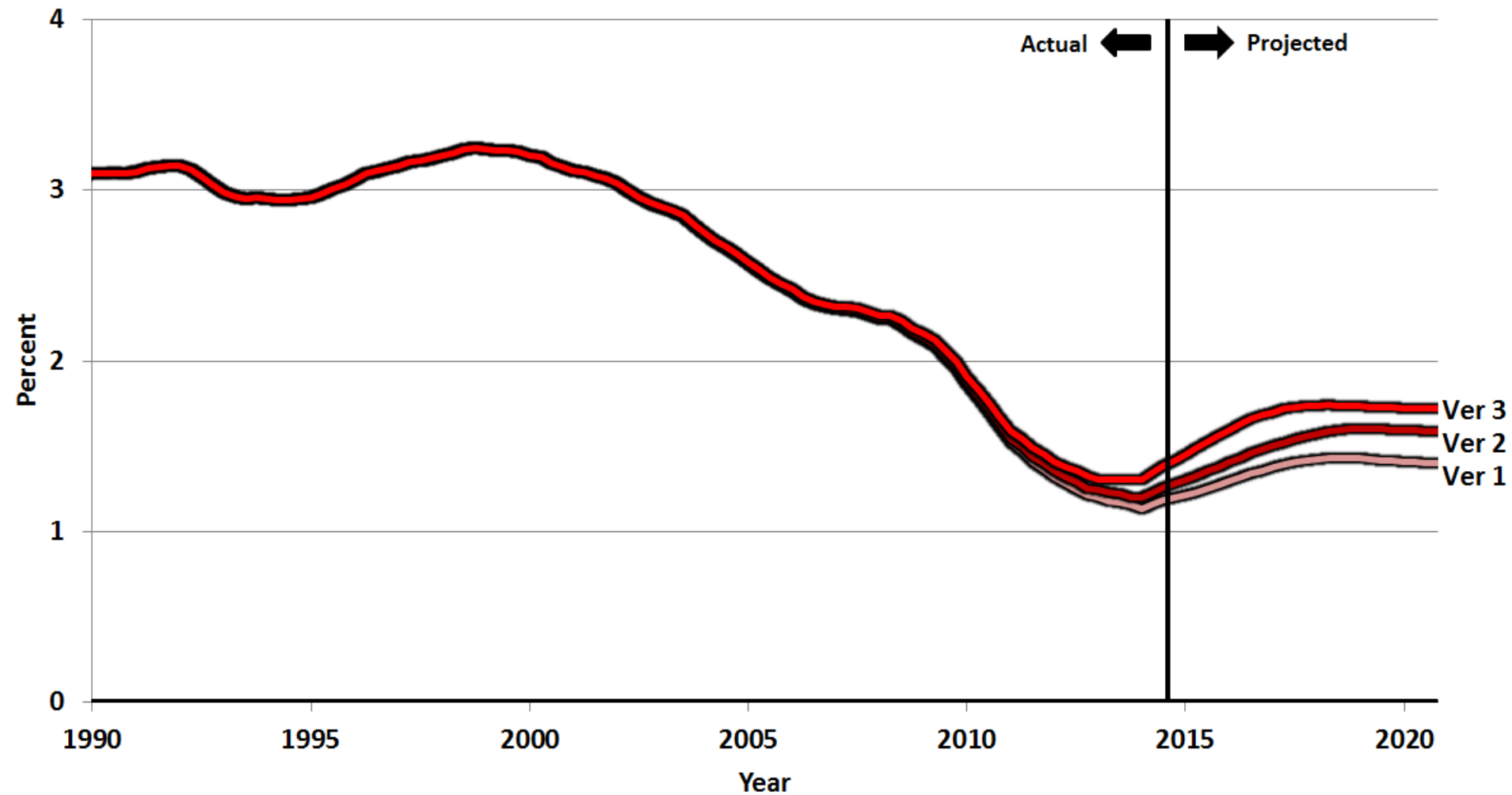


Figure 9. Projected Kalman Growth Trend of Labor Productivity, Versions 1 through 3, 1990:Q1 to 2020:Q4

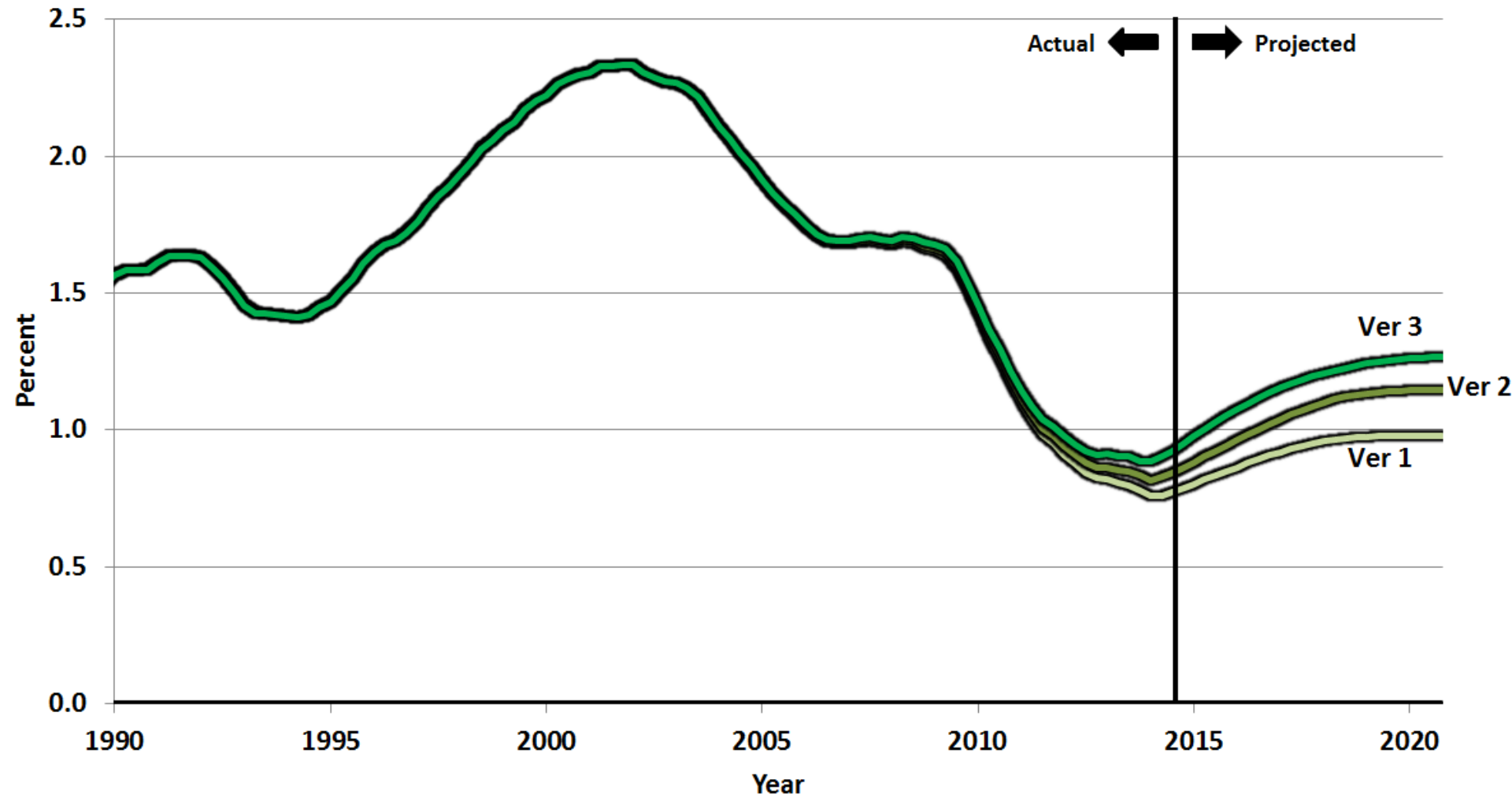
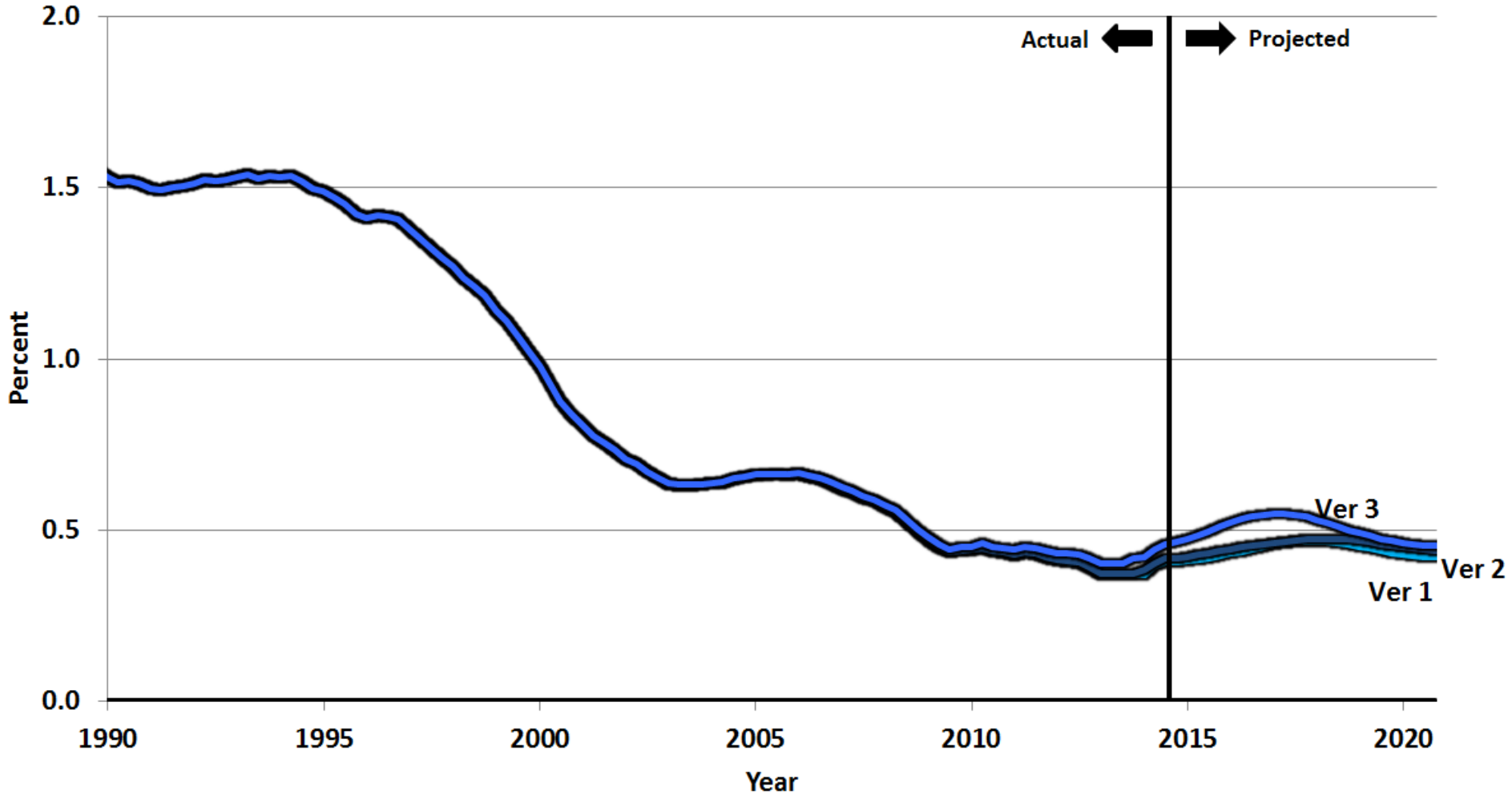
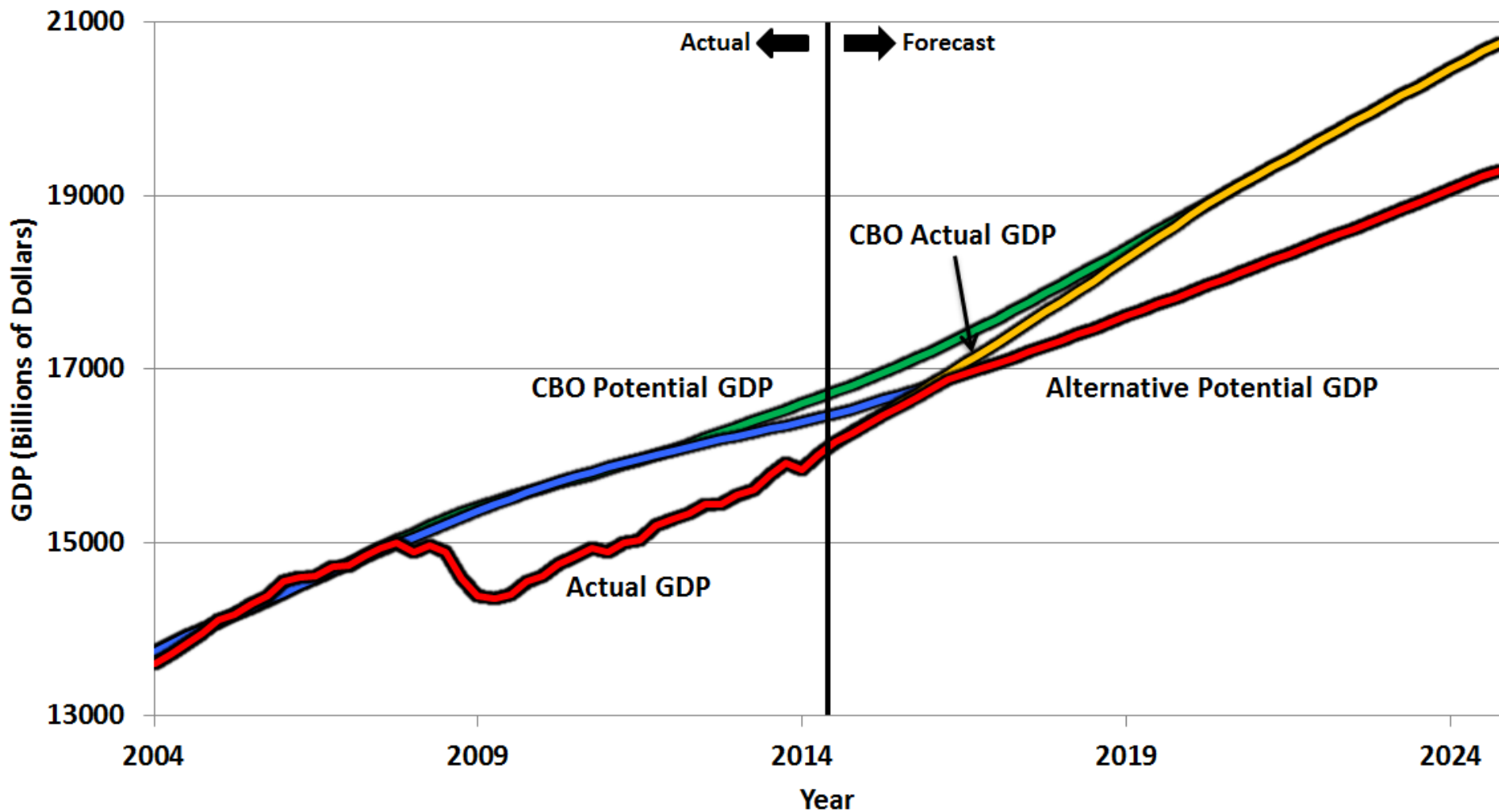


Figure 10. Projected Kalman Growth Trend of Hours, Versions 1 through 3, 1990:Q1 to 2020:Q4



**Figure 11. Actual GDP vs. Potential GDP, CBO vs. Alternative Measures, 2004:Q1 to 2024:Q4**



**Figure 12. Debt/GDP, Actual and Forecast, CBO and Alternative Projections, 2004:Q1 to 2024:Q4**

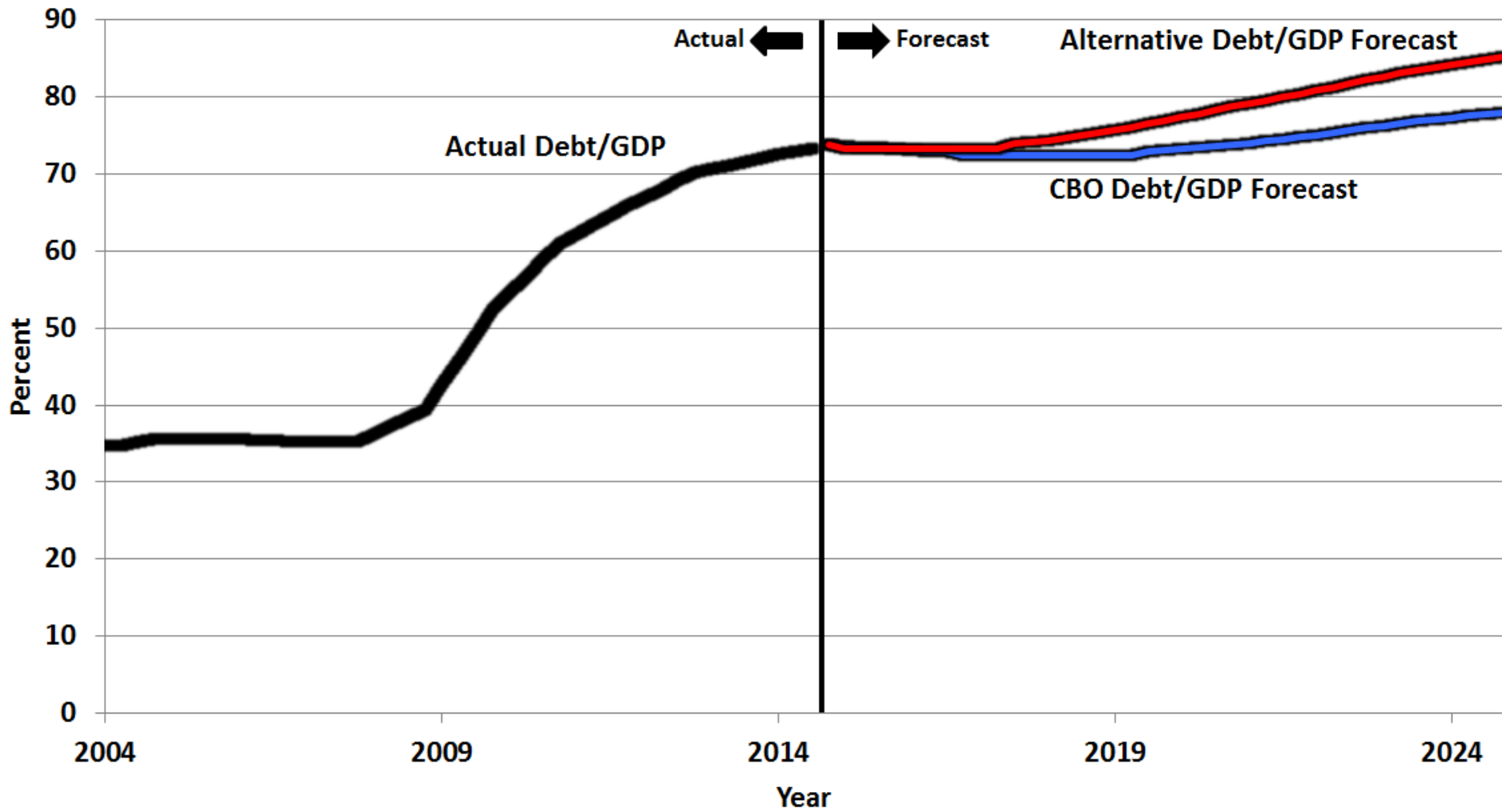
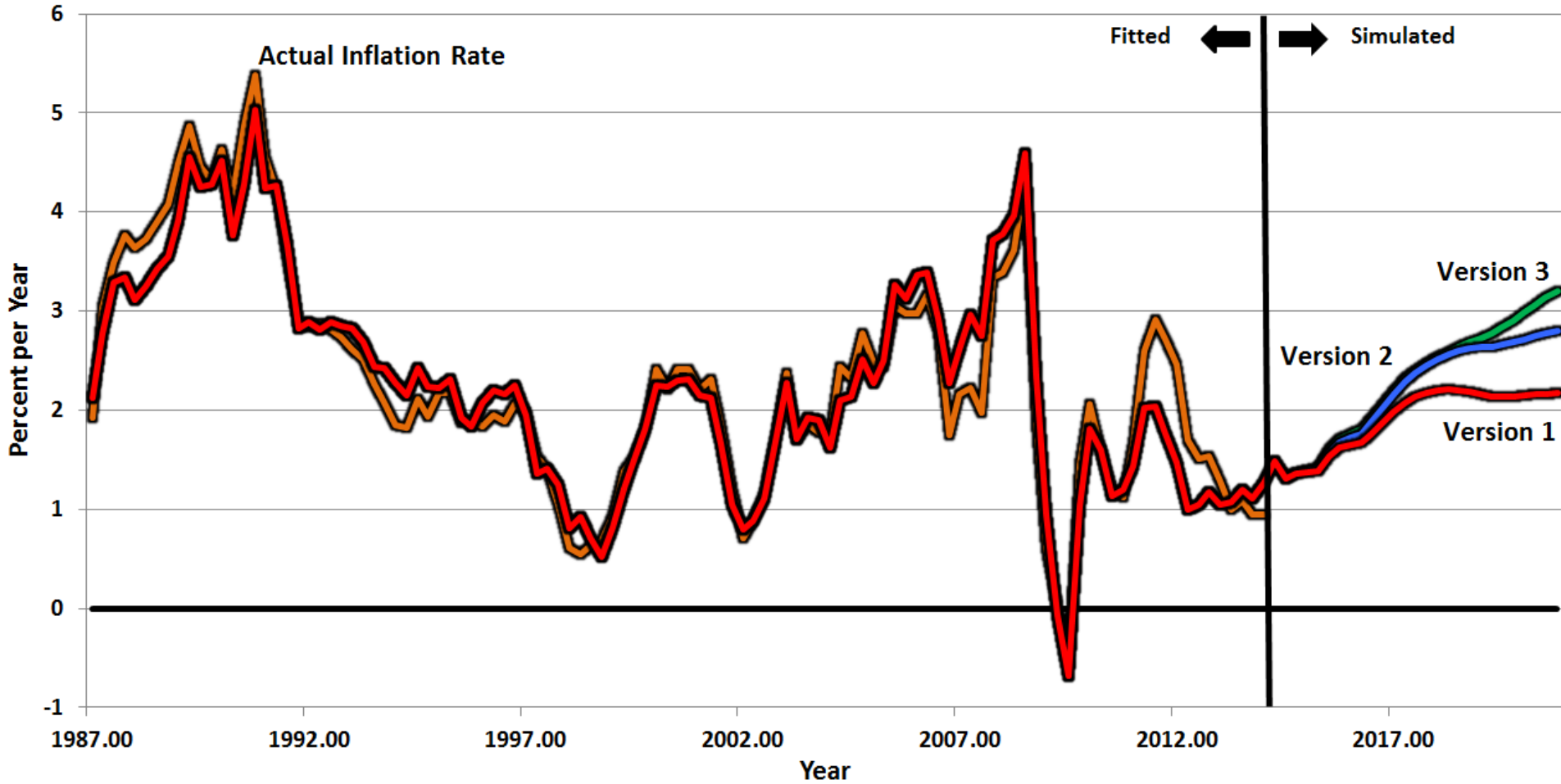


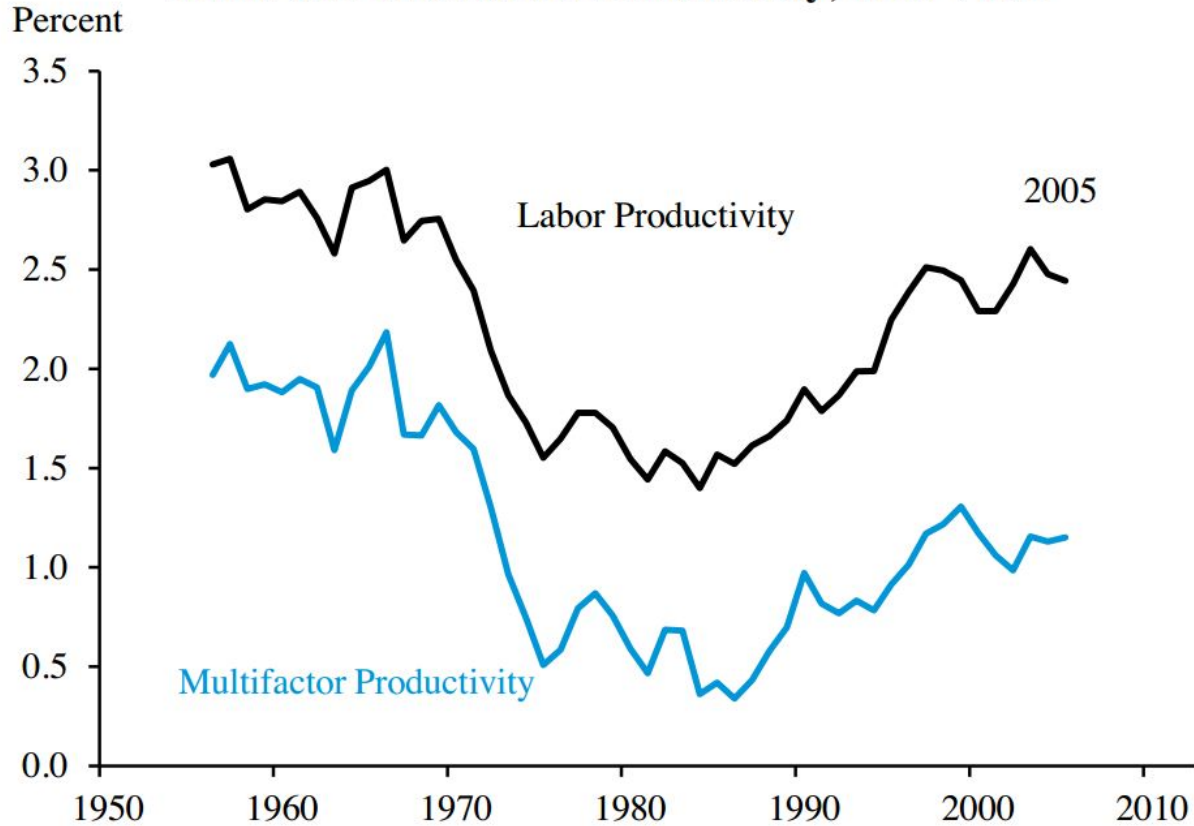
Figure 3a. Triangle Model Headline Inflation Rate Projections,  
2014:Q1 Sample End, Versions 1 through 3,  
1987:Q1 to 2020:Q4



# **Broader Conclusions for Methodology and Policy**

- **The triangle model works**
  - **Futility of looking at current inflation**
  - **Inflation result of paths 1 vs 2 vs 3 visible only in 2017**
- **Total-economy productivity is a crucial lynchpin between production and household side of the statistical system**
- **All economic analysis of present and future should be forced through the iron grip of the output identity, which cannot be wrong**

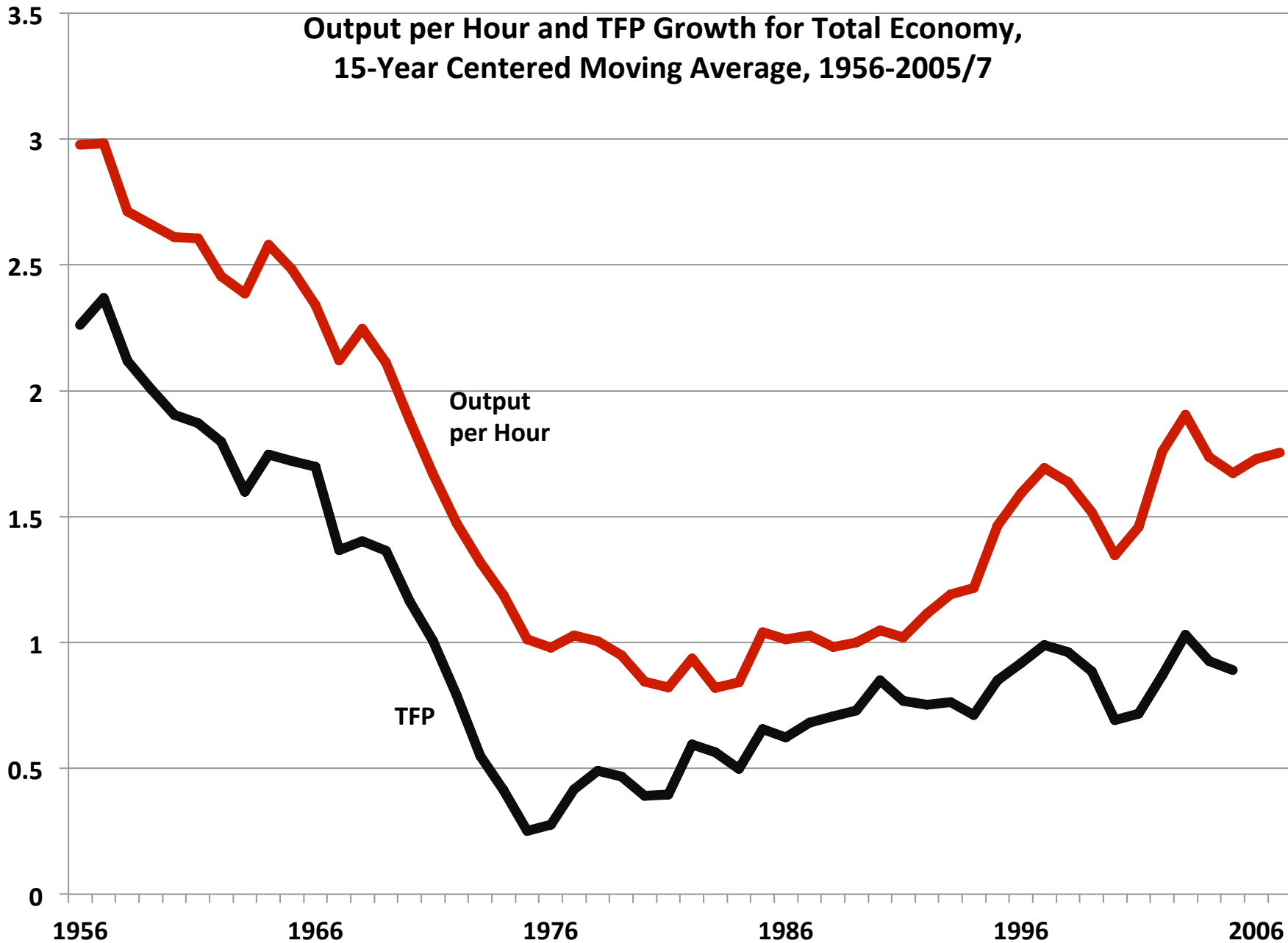
Figure 5-2  
**15-Year Centered Moving Average of Annual Growth Rates for  
Labor and Multifactor Productivity, 1956–2005**



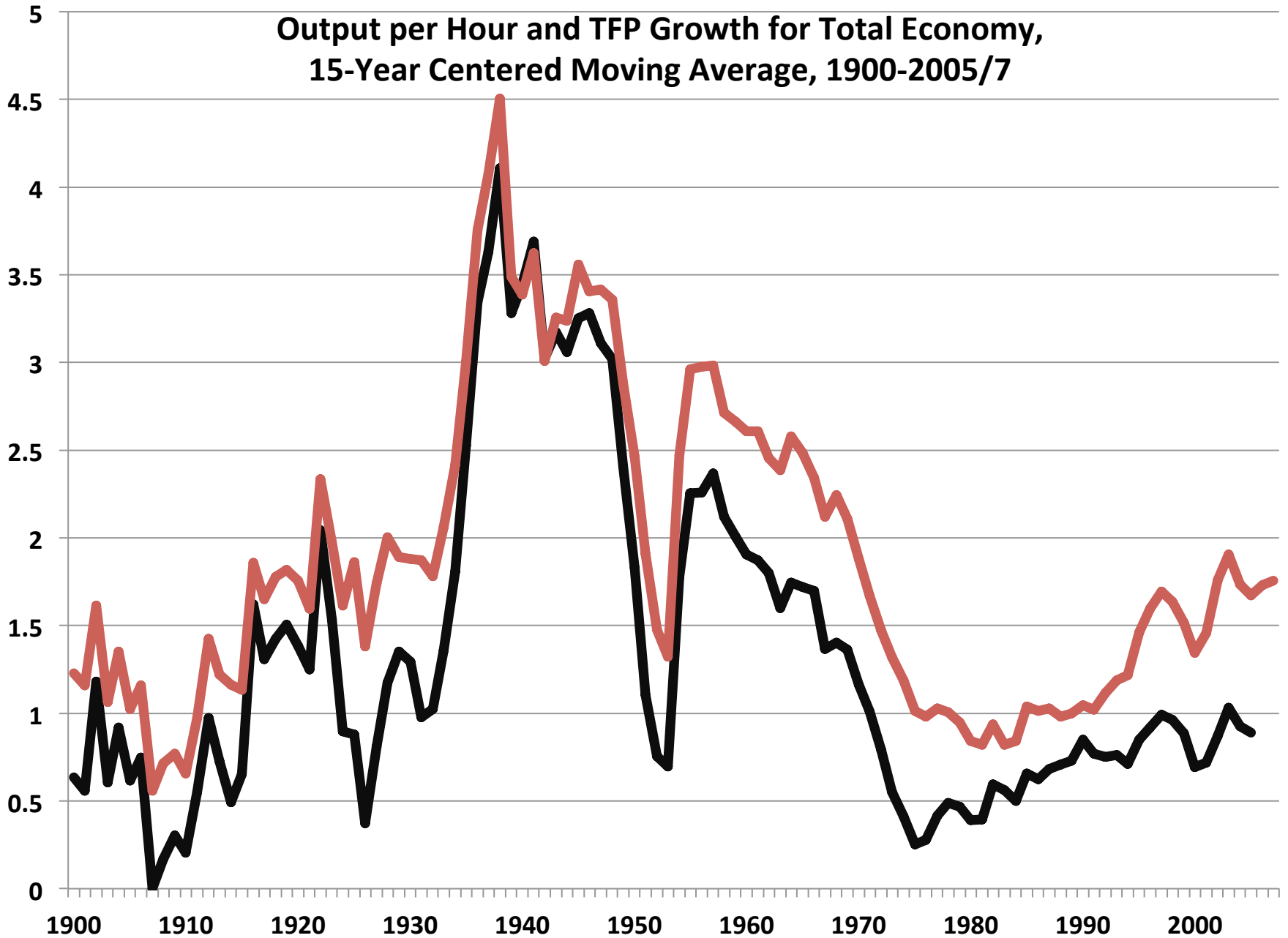
Source: Bureau of Labor Statistics, Productivity and Costs, Multifactor Productivity;  
CEA Calculations.



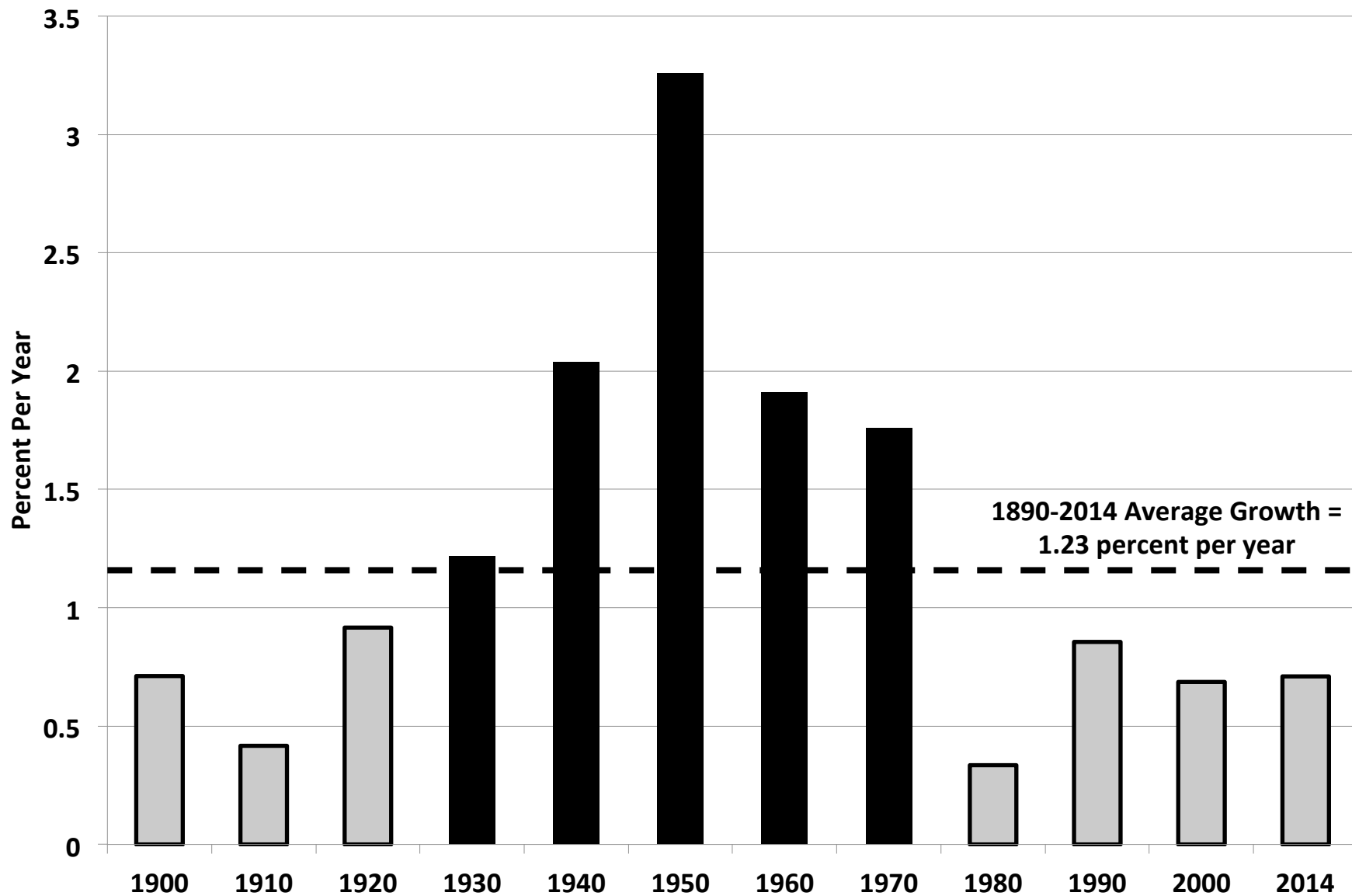
**Output per Hour and TFP Growth for Total Economy,  
15-Year Centered Moving Average, 1956-2005/7**



**Output per Hour and TFP Growth for Total Economy,  
15-Year Centered Moving Average, 1900-2005/7**



**Figure 17-2. Annual Growth Rate of Total Factor Productivity for Ten Years  
Preceding Years Shown, Years Ending in 1900 to 2014**



**Real GDP and Total Economy Output per Hour,  
Annual Growth Rates Between Q3 of Each Year, 2004-2014**

