The Interplay Among Inflation, Productivity, and Potential Real GDP

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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.
- 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

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 AreDisconnected 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

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<td></td>
<td></td>
<td>TU</td>
<td>STU</td>
<td>TU</td>
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<td>Lagged Dependent Variable</td>
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<td>Food-Energy Effect Full Period</td>
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<td>Food-Energy Effect Late Period</td>
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<td>Productivity Trend Change</td>
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<td>Nixon Controls &quot;on&quot;</td>
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<td>S.S.R</td>
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<td>Dynamic Simulations</td>
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<td>2007:Q1 to 2014:Q3</td>
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<td>Mean Error</td>
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<td>Error in 2014:Q3</td>
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<td>Root Mean-Square Error</td>
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<td>1.03</td>
<td>0.72</td>
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*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 NAIRU, 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
<table>
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<th>Real GDP</th>
<th>Aggregate Hours</th>
<th>Output per Hour</th>
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<td>2009:Q3-2013:Q3</td>
<td>2.13</td>
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<td>2013:Q3-2014:Q3</td>
<td>2.32</td>
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<td>2009:Q3-2014:Q3</td>
<td>2.17</td>
<td>1.49</td>
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Figure 4. Kalman Growth Trends of Payroll/Household Hours Ratio, Hours per Employee, Employment Rate, LFPR, and Population, 1953:Q1 - 2014:Q3

- Working Age Population
- LFPR
- Employment Rate
- Hours per Employee
- HP/HH

Year:
- 1953
- 1963
- 1973
- 1983
- 1993
- 2003
- 2013

Percent:
- 2.5
- 2.0
- 1.5
- 1.0
- 0.5
- 0.0
- -0.5
- -1.0
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

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

1890-2014 Average Growth = 1.23 percent per year
Real GDP and Total Economy Output per Hour,
Annual Growth Rates Between Q3 of Each Year, 2004-2014