A **jobless growth recovery** is a situation in which: (Bernanke 2009)

- Output **growth** recovers,

- but employment does not.

A **liquidity trap** is a situation in which:

- the nominal interest rate is zero.

- inflation is below target.
Historical Examples of the Joint Occurrence of a Jobless Growth Recovery and a Liquidity Trap.


2. Euro Area: 2008-present

3. United States: 2008-present
Japan 1991-2000
Recovery in Real Per Capita GDP Growth . . .

Japan, 1989-2001, yoy

... without recovery in employment → jobless growth recovery

Unemployment rate, Japan, 1989-2001

Rates stuck at zero . . .
Japan, 1989-2001

... and inflation below target. → Liquidity Trap

Year-over-Year Growth of GDP Deflator, Japan, 1989-2001

Euro Area: 2008-present
Recovery in Real Per Capita GDP Growth . . .
Euro Area, 2005Q1-2014Q2

Vertical lines: CEPR business cycle dates, 2008Q1, 2009Q2, 2011Q3
Without recovery in employment → Jobless Growth Recovery

Unemployment Rate, Euro Area, 2000Q1-2015Q1

Vertical lines: CEPR business cycle dates, 2008Q1, 2009Q2, 2011Q3
Interest Rates near zero ...

Euribor Rate, 2005-2015Q1

Vertical lines: CEPR business cycle dates, 2008Q1, 2009Q2, 2011Q3
...and inflation below target. → Liquidity Trap

Year-over-Year Growth of HICP, Euro Area 2005-2015Q1

Vertical lines: CEPR business cycle dates, 2008Q1, 2009Q2, 2011Q3
United States: 2008-present
Recovery in Real Per Capita GDP Growth... 

United States, YoY, 2005Q1-2014Q4

Vertical lines: NBER recession dates, 2007Q4 and 2009Q2
... without recovery in employment  → jobless growth recovery

U.S. Civilian Employment-Population Ratio, 2005Q1-2015Q1

Vertical lines: NBER recession dates, 2007Q4 and 2009Q2
Rates stuck at zero

U.S. Federal Funds Rate: 2005Q1-2015Q1

Vertical lines: NBER recession dates, 2007Q4 and 2009Q2
Inflation (slightly) below target → Liquidity Trap

U.S. YOY change in GDP Deflator 2005Q1-2014Q4

Vertical lines: NBER recession dates, 2007Q4 and 2009Q2
This paper:

1. develops a theoretical model that predicts that a confidence shock can lead the economy into a liquidity trap with a jobless growth recovery.

2. shows that recovery is *job-creating* when liquidity trap is caused by natural rate shocks.

3. offers an unconventional exist strategy: eliminate liquidity trap by raising nominal rates.
Four Elements of our Argument:

1. Downward Nominal Wage Rigidity.

2. Monetary Policy follows a Taylor Rule.

3. The Zero Lower Bound On Nominal Interest Rates.

4. A Downward Revision in Inflation Expectations.
Element 1: Downward Nominal Wage Rigidity.

\[ W_t \geq \gamma(u_t) W_{t-1}, \]

where

- \( W_t \) nominal wage rate
- \( u_t \), unemployment rate

Assumption: \( \gamma'(u) < 0 \), \( \pi^* > \frac{\gamma(0)}{\mu} > \bar{\beta} \)
Firms

Production function:

\[ Y_t = X_t F(h_t); \quad \text{with} \quad X_t/X_{t-1} = \mu > 1 \]

Labor demand:

\[ P_t X_t F'(h_t) = W_t \]
Households

Preferences:

\[ E_0 \sum_{t=0}^{\infty} e^{\xi_t \beta^t} U(C_t) \]

Budget constraint:

\[ P_tC_t + B_t + T_t = W_t h_t + R_{t-1}B_{t-1} + \Phi_t \]

Inelastic Labor Supply:

\[ h_t \leq \bar{h} \]
The Labor Market

\[ P_t X_t F'(h_t) = W_t \]

\[ h_t \leq \bar{h} \]

\[ W_t \geq \gamma(u_t)W_{t-1} \]

\[ (\bar{h} - h_t) (W_t - \gamma(u_t)W_{t-1}) = 0 \]
Involuntary Unemployment Due to Downward Nominal Wage Rigidity

\[
\frac{W_t}{P_t} = X_t \alpha \bar{h}_t^{\alpha - 1}
\]

\[
\frac{W_t}{P_t} \geq \gamma (\bar{h} - h_t) \frac{W_{t-1}}{P_t}
\]

\[
\alpha X_t \bar{h}^{\alpha - 1}
\]

\[
h^{\text{bust}}
\]

\[
\bar{h}
\]

\[
h_t
\]
A Key Inflation Threshold

Involuntary Unemployment arises when real wages exceed the full employment real wage, \( \alpha X_t \bar{h}^{\alpha-1} \).

Real wages exceed full employment real wages, when wage inflation, \( \gamma(0) \), exceeds price inflation, \( \pi_t \), by more than the rate of growth of TFP, \( \mu \). Hence

\[
\text{If } \frac{\gamma(0)}{\pi_t} > \mu, \text{ then } u_t > 0.
\]
Elements 2 and 3: Taylor Rule and Zero Lower Bound on Nominal Interest Rates.

\[ R_t = \max \left\{ 1, R^* + \alpha \pi_t (\pi_t - \pi^*) + \alpha_y \ln \left( \frac{Y_t}{Y_t^*} \right) \right\} \]

where

- \( R_t \geq 1 \), gross nominal interest rate
- \( \pi^* \), inflation target
- \( Y_t^* \), full-employment output
- \( \alpha \tilde{\pi} \beta > 1, \quad \alpha_y \geq 0 \)
Equilibrium: Let $w_t \equiv \frac{W_t}{P_tX_t}$ and $c_t \equiv C_t/X_t$

$$e^{\xi_t} U'(c_t) = \tilde{\beta} R_t E_t \left[ \frac{e^{\xi_t+1} U'(c_{t+1})}{\pi_t+1} \right]$$

$$R_t = \max \left\{ 1, \frac{\pi^*}{\beta} + \alpha \pi (\pi_t - \pi^*) + \alpha y \ln \left( \frac{F(h_t)}{F(\bar{h})} \right) \right\}$$

$$c_t = F(h_t)$$

$$w_t = F'(h_t)$$

$h_t \leq \bar{h}$ and $w_t \geq \frac{\gamma(u_t)}{\pi_t \mu} w_{t-1}$; where $u_t \equiv \frac{\bar{h} - h_t}{\bar{h}}$

$$(\bar{h} - h_t) \left( w_t - \frac{\gamma(u_t)}{\pi_t \mu} w_{t-1} \right) = 0$$
Multiple Steady States

Proposition 1 (Existence of a Full-Employment Steady State)  
There exists a unique full-employment steady state ($u = 0$). Moreover, at the full-employment steady state the inflation rate equals the inflation target $\pi^*$.  

Proposition 2 (Existence of an Unemployment Steady State)  
There exists a unique unemployment steady state ($u = \bar{u} > 0$). Moreover, at the unemployment steady state the economy is in a liquidity trap ($R = 1$ and $\pi = \pi^L < \pi^*$).
Element 4: A Downward Revision in Expectations.

Before agents expected:

$$\lim_{t \to \infty} E_0 \pi_t = \pi^*$$

Now agents expect:

$$\lim_{t \to \infty} E_0 \pi_t = \pi^L < \pi^*$$

“Mr. Draghi and his peers are afraid that consumers and investors will increasingly see low inflation as the new normal, creating a self-fulfilling prophecy.” NYT, page B7, November 22, 2014.
Proposition 3 (Liquidity Trap) Suppose that \( \xi_t = 0 \) and deterministic for \( t \geq 0 \). Further, assume that \( \pi_0 < \pi^* \). Then, in any perfect foresight equilibrium,

\[
\pi_{t+1} = \begin{cases} 
\pi_t < \pi^* & \text{if } \pi_t \geq \frac{\gamma(0)}{\mu} \\
\frac{\gamma(0)}{\mu} < \pi^* & \text{if } \pi_t < \frac{\gamma(0)}{\mu} 
\end{cases}, \quad \text{for all } t \geq 0.
\]

Furthermore, there exists a finite integer \( T \geq 0 \) such that \( \pi_T < \frac{\gamma(0)}{\mu} \).

Proposition 4 (Chronic Involuntary Unemployment) Suppose that \( \xi_t = 0 \) and deterministic for \( t \geq 0 \). Further, assume that \( \pi_0 < \pi^* \). Then, in any perfect foresight equilibrium \( u_t > 0 \) for all \( t \geq T \), where \( T \geq 0 \) is the finite integer defined in proposition 3.
Calibrated Example:

\[ F(h) = h^\alpha; \text{ with } \alpha = 0.75 \]

\[ u(c) = c^{1-\sigma}/(1 - \sigma); \text{ with } \sigma = 2 \]

\[ X_t = 1.015^{1/4}X_{t-1}; \]

\[ \tilde{\beta} = 1.04^{-1/4}; \text{ real rate of 4 percent} \]

\[ \pi^* = 1.02^{1/4}; \text{ inflation target of 2 percent} \]

\[ \alpha_\pi = 1.5 \]

\[ \alpha_y = 0.125 \]

\[ \gamma(u_t) = \gamma_1 \cdot (1 - u_t)^{\gamma_2}; \gamma_1 = 1.02^{1/4}; \gamma_2 = 0.19. \]
Dynamics Under Lack of Confidence Shock: $\pi_0 < \pi^*$
Results are robust to allowing for capital accumulation

\[ Y_t = K_t^{1-\alpha}(X_t h_t)^\alpha \]
A Great Contraction With Capital Accumulation

Nom. Int. Rate % pa

Inflation, % pa

Real Int Rate, % pa

Emp Ratio, %

\[ \ln(y_t), \text{ index} \]

\[ \ln(\text{inv}_t), \text{ index} \]

\[ \ln(w_t), \text{ index} \]
Did Real Wage Growth Exceed TFP Growth in the Recovery? — Evidence from U.S.

Average Annual TFP Growth from 2008 to 2011 was 0.65% (Fernald)

Average Annual Real Wage Growth from 2008 to 2011 was 1.1% (Daly et al.)

Hence real wage growth exceeded TFP growth by 0.45 percent per year, for a total of 1.35 percent over the period 2008-2011.
Alternative Hypothesis:

What if inflationary expectations are well anchored (i.e., loss of confidence shocks are ruled out by assumption)?

Specifically, consider the response to a decline in the natural rate of interest (following Eggertson and Woodford, 2003)

\[
\text{Natural Rate of Interest} = \beta^{-1} e^{\xi_t - \xi_{t+1}}
\]

Exercise: Assume that the natural rate falls from its steady-state value of 4 percent per year to -2 percent per year for 10 quarters and then returns to 4 percent forever.
Proposition 5 (Recoveries With Job Creation) Suppose that assumptions 1 and 2 hold and that $w_{-1} = F'(\bar{h})$. Then, in any perfect-foresight equilibrium with well-anchored inflationary expectations unemployment converges monotonically to zero in finite time. That is, $u_{t+1} \leq u_t$ for all $t \geq 0$ and there $\exists T > 0$ such that $u_{T+j} = 0$ for all $j \geq 0$. 
A Contraction With A Job-Creating Recovery:
Response to a Persistent Decline In The Natural Rate
Exiting The Slump with Truly Unconventional Monetary Policy

Interest rate policy:

\[ R_t = \begin{cases} 
\max \left\{ 1, \frac{\pi^*}{\beta} + \alpha \pi (\pi_t - \pi^*) + \alpha_y \ln \left( \frac{F(h_t)}{F(h)} \right) \right\} & \text{if } s_t = 0 \\
R^* & \text{if } s_t = 1
\end{cases} \]

\[ s_t = \begin{cases} 
1 & \text{if } R_j = 1 \text{ for any } 0 \leq j < t \\
0 & \text{otherwise}
\end{cases} \]
Exiting the Slump with Truly Unconventional Policy

**Interest Rate**

**Inflation**

**Output Growth Rate**

**Employment Rate**

---

Taylor Rule

Exit Strategy
Exit Strategy in Model with Capital

Nom. Int. Rate % pa

Inflation, % pa

Real Int Rate, % pa

Emp Ratio, %

$\ln(y_t)$, index

$\ln(\text{inv}_t)$, index

$\ln(w_t)$, index

Solid Line: Taylor Rule

Dashed Line: Exit Strategy
Conclusions

• When inflationary expectations are well anchored, standard model cannot explain jobless growth recoveries and a prolonged liquidity trap.

• However, when the economy suffers a negative confidence shock that lowers long-run inflation expectations, then the model presented can account for jobless growth recoveries and a prolonged liquidity trap.

• If there is a negative confidence shock, then truly unconventional monetary policy, i.e., raising nominal rates, can jolt the economy out of the slump.
Extras
Steady State Equilibria:

\[ c_t = c, \ h_t = h, \ w_t = w, \ \pi_t = \pi, \ R_t = R \]

Euler equation becomes:

\[ \pi = \tilde{\beta}R \]

Policy rules becomes:

\[ R = \max \left\{ 1, \frac{\pi^*}{\tilde{\beta}} + \alpha_\pi (\pi - \pi^*) + \alpha_y \ln \left( \frac{F(h)}{F(\bar{h})} \right) \right\} \]

Slackness becomes:

\[ (\bar{h} - h) \left( 1 - \frac{\gamma(u)}{\pi \mu} \right) = 0 \]
Japan 1989-2001

Employment-to-Population Ratio

Percent

Year


59 60 61 62 63

60 61 62 63
Year-over-Year Growth of HICP ex Food and Energy
Euro Area 2005-2015Q1

Vertical lines: CEPR business cycle dates, 2008Q1, 2009Q2, 2011Q3
Bernanke’s Definition of a Jobless Recovery:

“Given this weakness in the labor market, a natural question is whether we might be in for a so-called jobless recovery, in which output is growing but employment fails to increase.”


Source: Derived from Bloomberg data on the price of inflation caps and floors.
Source: Federal Reserve Bank of Cleveland.
Evidence On Downward Nominal Wage Rigidity

• Downward nominal wage rigidity is the central friction in the present model ⇒ natural to ask if it is empirically relevant.

• Downward wage rigidity is a widespread phenomenon:
  — Evident in micro and macro data.
  — Rich, emerging, and poor countries.
  — Developed and underdeveloped regions of the world.

• Byproduct: Will obtain an estimate of the parameter $\gamma$ governing wage stickiness in the model (useful for quantitative analysis).
Probability of Decline, Increase, or No Change in Wages

U.S. data, SIPP panel 1986-1993, between interviews one year apart.

<table>
<thead>
<tr>
<th></th>
<th>Interviews One Year apart</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males</td>
</tr>
<tr>
<td>Decline</td>
<td>5.1%</td>
</tr>
<tr>
<td><strong>Constant</strong></td>
<td>53.7%</td>
</tr>
<tr>
<td>Increase</td>
<td>41.2%</td>
</tr>
</tbody>
</table>

Source: Gottschalk (2005)

- Large mass at ‘Constant’ suggests nominal wage rigidity.

- Small mass at 'Decline' suggests downward nominal wage rigidity.
Distribution of Non-Zero Nominal Wage Changes
United States 1996-1999

Source: Barattieri, Basu, and Gottschalk (2012)
Evidence From The Great Contraction Of 2007
Distribution of Nominal Wage Changes, U.S. 2011

Source: Daly, Hobijn, and Lucking (2012).

Figure 2
Distribution of observed nominal wage changes

Sources: Current Population Survey (CPS) and authors' calculations.
Micro Evidence On Downward Nominal Wage Rigidity From Other Developed Countries


- Switzerland: Fehr and Goette (2005).

Evidence From Informal Labor Markets

• Kaur (2012) examines the behavior of nominal wages, employment, and rainfall in casual daily agricultural labor markets in rural India (500 districts from 1956 to 2008).

• Finds asymmetric nominal wage adjustment:
  — $W_t$ increases in response to positive rainfall shocks
  — $W_t$ fails to fall, labor rationing, and unemployment are observed in response to negative rain shocks.

• Inflation (uncorrelated with local rain shocks) tends to moderate rationing and unemployment during negative rain shocks, suggesting downward rigidity in nominal rather than real wages.
Evidence From the Great Depression, 1929-1933

- Enormous contraction in employment: 31% between 1929 and 1931.

- Nonetheless, during this period nominal wages fell by 0.6% per year, while consumer prices fell by 6.6% per year. See the figure on the next slide.

- A similar pattern is observed during the second half of the Depression. By 1933, real wages were 26% higher than in 1929, in spite of a highly distressed labor market.
Nominal Wage Rate and Consumer Prices, United States
1923:1-1935:7

Evidence From the Great Depression In Europe

- Countries that left the gold standard earlier recovered faster than countries that remained on gold.
  - Left Gold Early (sterling bloc): United Kingdom, Sweden, Finland, Norway, and Denmark.
  - Countries That Stuck To Gold (gold bloc): France, Belgium, the Netherlands, and Italy.

- Think of the gold standard as a currency peg (a peg not to a currency, but to gold).

- When sterling-bloc left gold, they effectively devalued, as their currencies lost value against gold.

- Look at the figure on the next slide. Between 1929 and 1935, sterling-bloc countries experienced less real wage growth and larger increases in industrial production than gold-bloc countries.
Changes In Real Wages and Industrial Production, 1929-1935

Evidence From Emerging Countries

• Argentina: pegged the peso at a 1-to-1 rate with the dollar between 1991 and 2001.

• Starting in 1998, the economy was buffeted by a number of large negative shocks (weak commodity prices, large devaluation in Brazil, large increase in country premium, etc.).

• Not surprisingly, between 1998 and 2001, unemployment rose sharply.

• Nonetheless, nominal wages remained remarkably flat.

• This evidence suggests that nominal wages are downwardly rigid, and that $\gamma$ is about 1.

• Why $\gamma \approx 1$? The slackness condition $(\bar{h} - h_t)(W_t - \gamma W_{t-1})$ (recall $\epsilon_t = 1$ during this period), implies that if unemployment is growing, wages must grow at the gross rate $\gamma$. 
Argentina 1996-2006

Nominal Exchange Rate ($E_t$)

Unemployment Rate + Underemployment Rate

Nominal Wage ($W_t$)

Real Wage ($W_t/E_t$)

Implied Value of $\gamma$: Around unity.
Evidence From Peripheral Europe (2008-2011)

- Look at the table on the next slide.

- Between 2008 and 2011, all countries in the periphery of Europe experienced increases in unemployment. Some very large increases.

- In spite of this context of extreme duress, nominal hourly wages experienced significant increases in most countries and modest declines in very few.

- The slide following the table explains how to use the information in the table to infer a range for $\gamma$. 
# Unemployment, Nominal Wages, and $\gamma$

## Evidence from the Eurozone

<table>
<thead>
<tr>
<th>Country</th>
<th>Unemployment Rate 2008Q1 (in percent)</th>
<th>Unemployment Rate 2011Q2 (in percent)</th>
<th>Wage Growth $\frac{W_{2011Q2}}{W_{2008Q1}}$ (in percent)</th>
<th>Implied Value of $\gamma$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulgaria</td>
<td>6.1</td>
<td>11.3</td>
<td>43.3</td>
<td>1.028</td>
</tr>
<tr>
<td>Cyprus</td>
<td>3.8</td>
<td>6.9</td>
<td>10.7</td>
<td>1.008</td>
</tr>
<tr>
<td>Estonia</td>
<td>4.1</td>
<td>12.8</td>
<td>2.5</td>
<td>1.002</td>
</tr>
<tr>
<td>Greece</td>
<td>7.8</td>
<td>16.7</td>
<td>-2.3</td>
<td>0.9982</td>
</tr>
<tr>
<td>Ireland</td>
<td>4.9</td>
<td>14.3</td>
<td>0.5</td>
<td>1.0004</td>
</tr>
<tr>
<td>Italy</td>
<td>6.4</td>
<td>8.2</td>
<td>10.0</td>
<td>1.007</td>
</tr>
<tr>
<td>Lithuania</td>
<td>4.1</td>
<td>15.6</td>
<td>-5.1</td>
<td>0.996</td>
</tr>
<tr>
<td>Latvia</td>
<td>6.1</td>
<td>16.2</td>
<td>-0.6</td>
<td>0.9995</td>
</tr>
<tr>
<td>Portugal</td>
<td>8.3</td>
<td>12.5</td>
<td>1.91</td>
<td>1.001</td>
</tr>
<tr>
<td>Spain</td>
<td>9.2</td>
<td>20.8</td>
<td>8.0</td>
<td>1.006</td>
</tr>
<tr>
<td>Slovenia</td>
<td>4.7</td>
<td>7.9</td>
<td>12.5</td>
<td>1.009</td>
</tr>
<tr>
<td>Slovakia</td>
<td>10.2</td>
<td>13.3</td>
<td>13.4</td>
<td>1.010</td>
</tr>
</tbody>
</table>

Distribution of Nominal Wage Changes, 2011, USA

Source: Elsby et al. (2013). Hourly workers in the same employer.
Avg real GDP per capita grew by 1.1 percent between 2012Q4 and 2009Q2. (avg since 1990: 1.2 %)
U.S. Unemployment Rate: 2005-2012

Source: Erceg and Levin (2013)
Table 1: Demographic Factors and the Recent Evolution of the LFPR

<table>
<thead>
<tr>
<th>Demographic Group</th>
<th>Population Share</th>
<th>Labor Force Participation Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2007 Actual</td>
<td>2007 Actual</td>
</tr>
<tr>
<td></td>
<td>2007 Projection</td>
<td>Change (2007 to 2012)</td>
</tr>
<tr>
<td></td>
<td>Actual</td>
<td>Projection</td>
</tr>
<tr>
<td>16 to 24 yrs</td>
<td>16.1</td>
<td>-0.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-0.2</td>
</tr>
<tr>
<td>25 to 54 yrs</td>
<td>54.2</td>
<td>-2.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-3.1</td>
</tr>
<tr>
<td>55 to 64 yrs</td>
<td>14.0</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.8</td>
</tr>
<tr>
<td>65 and older</td>
<td>15.6</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.6</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

Note: The columns labelled "Projection" refer to the BLS labor force projections published in November 2007.

Source: Erceg and Levin (2013)
“It was a relief just to find something,” said Amie Crawford, 56, of Chicago. After four months looking for a new job as an interior designer, which she had been for 30 years before the recession, she accepted a position as a part-time cashier at a quick-service health-food cafe called Protein Bar.

She keeps asking for more hours, but her manager's response is always the same.

“He tells me, ‘I try to give you as many hours as I can, but everybody wants as many hours as they can,’ ” Ms. Crawford said.
Involuntary Part−Time Workers: 2002:Jan to 2013:March, LNS12032197

Data Source: Bureau of Labor Statistics.
Real Wage Growth Held up Relatively Well During the 2008 Recession

Figure 1
Inflation and wage growth through business cycles

Source: Bureau of Labor Statistics and authors’ calculations.

Source: Daly et al. April 2012.
Assumption 1  The function $\gamma(u_t)$ satisfies

$$\gamma'(u_t) < 0,$$

and

$$\gamma(0) > \tilde{\beta}\mu,$$

where $\tilde{\beta} \equiv \beta \mu^{-\sigma}$.

Assumption 2  The parameters $R^*$, $\pi^*$, and $\alpha_\pi$ satisfy:

$$R^* \equiv \frac{\pi^*}{\tilde{\beta}} > 1,$$

$$\alpha_\pi \tilde{\beta} > 1,$$

$$\pi^* > \frac{\gamma(0)}{\mu}.$$
Dynamics Effects of a Fundamental Shock Under the Exit Strategy

Solid Line: Taylor Rule    Dashed Line: Exit Strategy
Calibration of the Degree of Downward Wage Rigidity, 
\[ \gamma(u) = \gamma_1 (1 - u)^{\gamma_2} \]

- Set \( \gamma_1 = 1.02^{1/4} \Rightarrow \) At the full-employment steady state, nominal wages must grow at a rate of 2% per year or higher. Weak restriction: due to productivity growth, lower bound on nominal wages does not bind in the intended steady state.

- Set \( \gamma_2 \) so that if unemployment is 5 percent above the natural rate, then wages can fall frictionlessly by up to 2 percent per year.

This is a conservative criterion: Between 2008 and 2010, US unemployment increased from 5 to 10 percent, but nominal hourly wages did not fall. They actually grew by 3 percent per year.