THE ROUTES INTO AND OUT OF THE ZERO LOWER BOUND

Robert E. Hall
Hoover Institution and Department of Economics
Stanford University

Advanced Workshop for Central Bankers

September 7, 2013
<table>
<thead>
<tr>
<th>Year(s)</th>
<th>Output</th>
<th>Productivity</th>
<th>Factor utilization</th>
<th>Capital contribution</th>
<th>Population</th>
<th>Labor-force participation</th>
<th>Employment rate</th>
<th>Hours per week</th>
<th>Labor quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>2008</td>
<td>95.3</td>
<td>99.3</td>
<td>97.8</td>
<td>99.8</td>
<td>99.7</td>
<td>100.0</td>
<td>99.0</td>
<td>99.4</td>
<td>100.3</td>
</tr>
<tr>
<td>2009</td>
<td>88.2</td>
<td>101.6</td>
<td>93.9</td>
<td>99.0</td>
<td>99.5</td>
<td>96.2</td>
<td>97.8</td>
<td>100.7</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>88.1</td>
<td>99.3</td>
<td>97.5</td>
<td>98.0</td>
<td>99.2</td>
<td>95.9</td>
<td>98.4</td>
<td>100.6</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>87.6</td>
<td>98.1</td>
<td>98.5</td>
<td>97.2</td>
<td>98.8</td>
<td>96.5</td>
<td>99.4</td>
<td>100.6</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>87.7</td>
<td>98.1</td>
<td>98.3</td>
<td>96.7</td>
<td>98.9</td>
<td>97.8</td>
<td>97.1</td>
<td>100.6</td>
<td></td>
</tr>
<tr>
<td>Through 2010</td>
<td>11.9</td>
<td>0.7</td>
<td>2.5</td>
<td>2.0</td>
<td>0.8</td>
<td>1.3</td>
<td>4.1</td>
<td>1.6</td>
<td>-0.6</td>
</tr>
<tr>
<td>Through 2012</td>
<td>12.3</td>
<td>1.9</td>
<td>1.7</td>
<td>3.3</td>
<td>1.1</td>
<td>2.2</td>
<td>2.9</td>
<td>0.4</td>
<td>-0.6</td>
</tr>
</tbody>
</table>
Collision of three forces

A decline in output demand—an event without serious consequences in a normal economy
A decline in output demand—an event without serious consequences in a normal economy

The zero lower bound on the nominal interest rate
Collision of three forces

A decline in output demand—an event without serious consequences in a normal economy

The zero lower bound on the nominal interest rate

Low and stable inflation, so that the implied bound on the real interest rate is constraining
The Financial Wedge

The difference between the rate of return to capital and the real interest rate
The Financial Wedge

The difference between the rate of return to capital and the real interest rate

\[ f_t = \frac{1}{q_t} \left[ \alpha \frac{y_t}{k_t} + (1 - \delta)q_{t+1} \right] - 1 - r_t \]
**The Financial Wedge**

The difference between the rate of return to capital and the real interest rate

\[ f_t = \frac{1}{q_t} \left[ \alpha \frac{y_t}{k_t} + (1 - \delta)q_{t+1} \right] - 1 - r_t \]

On the same conceptual footing as the investment wedge in Chari-Kehoe-McGrattan, stated as an interest spread
The Financial Wedge

The difference between the rate of return to capital and the real interest rate

\[ f_t = \frac{1}{q_t} \left[ \alpha \frac{y_t}{k_t} + (1 - \delta)q_{t+1} \right] - 1 - r_t \]

On the same conceptual footing as the investment wedge in Chari-Kehoe-McGrattan, stated as an interest spread

Includes taxes and risk premium
The Financial Wedge
The Ratio of Consumption to Disposable Income

---

The graph shows the ratio of consumption to disposable income from 2006 to 2013. The ratio fluctuates over time, with some years showing a higher ratio and others showing a lower ratio. The peak of the ratio is around 0.94 in 2006, while the lowest is around 0.85 in 2013. The trend overall seems to be decreasing from 2006 to 2013.
Burden of Deleveraging as a Percent of Consumption
Google searches for “withdrawal penalty”
In Equilibrium, the Real Interest Rate is at the Level that Equates Output Demand to Supply
Excess Supply of Output when the ZLB Binds

![Graph showing excess supply of output and interest rate bounded above equilibrium level.](Image)
Real and nominal interest rates

Differ by the rate of inflation
Real and nominal interest rates

Differ by the rate of inflation

Friedman: inflation depends on slack and an inertial term relating to expectations

Central banks are firmly on the Friedman side, as expressed in the New Keynesian Calvo model.
Real and nominal interest rates

Differ by the rate of inflation

Friedman: inflation depends on slack and an inertial term relating to expectations

Sargent: inflation depends on the context
Real and nominal interest rates

Differ by the rate of inflation

Friedman: inflation depends on slack and an inertial term relating to expectations

Sargent: inflation depends on the context

Central banks are firmly on the Friedman side, as expressed in the New Keynesian Calvo model
Recent inflation

Strongly anchored in the 1 to 3 percent per year range
Recent inflation

Strongly anchored in the 1 to 3 percent per year range

Stock-Watson Jackson Hole paper 2010: no support for Friedman
Recent inflation

Strongly anchored in the 1 to 3 percent per year range

Stock-Watson Jackson Hole paper 2010: no support for Friedman

Inflation falls a bit as the economy contracts but does not continue to fall despite several years of slack
**Recent inflation**

Strongly anchored in the 1 to 3 percent per year range

Stock-Watson Jackson Hole paper 2010: no support for Friedman

Inflation falls a bit as the economy contracts but does not continue to fall despite several years of slack

This behavior contrasts to the Great Depression, when extreme deflation occurred.
Two Measures of U.S. Inflation
U.S. Wage Inflation
DMP model

Focuses on the job-creation decision of the employer
DMP model

Focuses on the job-creation decision of the employer

When an employer adds a worker, the employer gains the present value of the difference between the worker’s marginal contribution to revenue (the marginal revenue product of labor) and the worker’s pay
DMP model

Focuses on the job-creation decision of the employer

When an employer adds a worker, the employer gains the present value of the difference between the worker’s marginal contribution to revenue (the marginal revenue product of labor) and the worker’s pay

This present value is the job value
DMP model

Focuses on the job-creation decision of the employer

When an employer adds a worker, the employer gains the present value of the difference between the worker’s marginal contribution to revenue (the marginal revenue product of labor) and the worker’s pay

This present value is the job value

To reach the point where this gain occurs, the employer expends recruiting effort. The net benefit to the employer is the job value less the cost of recruiting a worker. With free entry to hiring, employers push recruiting effort to the point where the net benefit is zero. Thus the job value controls the amount of recruiting effort.
Job value and unemployment

Positive relation between recruiting effort and the speed with which job-seekers find jobs
Job value and unemployment

Positive relation between recruiting effort and the speed with which job-seekers find jobs

When employers are making high effort—posting many vacancies and advertising their existence—job-seekers find jobs quickly
Job value and unemployment

Positive relation between recruiting effort and the speed with which job-seekers find jobs

When employers are making high effort—posting many vacancies and advertising their existence—job-seekers find jobs quickly

Unemployment is then low
MODELS OF FLUCTUATIONS IN JOB VALUE AND THUS IN UNEMPLOYMENT

Walsh: In the New Keynesian model, the marginal revenue product of labor falls in recessions, which lowers the job value
Models of fluctuations in job value and thus in unemployment

Walsh: In the New Keynesian model, the marginal revenue product of labor falls in recessions, which lowers the job value.

Mortensen: Sticky prices result in depressed prices for intermediate products, and the job value falls at firms making those products.
MODELS OF FLUCTUATIONS IN JOB VALUE AND THUS IN UNEMPLOYMENT

Walsh: In the New Keynesian model, the marginal revenue product of labor falls in recessions, which lowers the job value.

Mortensen: Sticky prices result in depressed prices for intermediate products, and the job value falls at firms making those products.

Gertler-Sala-Trigari: Sticky wages result in lower job value when the marginal product of labor falls.
Models of fluctuations in job value and thus in unemployment

Walsh: In the New Keynesian model, the marginal revenue product of labor falls in recessions, which lowers the job value

Mortensen: Sticky prices result in depressed prices for intermediate products, and the job value falls at firms making those products

Gertler-Sala-Trigari: Sticky wages result in lower job value when the marginal product of labor falls

Hall: In times of high risk premiums, when the stock market is low, the same risk premiums result in low discounted values of the future flow of value from a newly hired worker
Job Value from JOLTS Compared to Wilshire Stock-Market Index
ZLB Analysis with Shifts in Both Demand and Supply

Real interest rate = minus inflation

Output

Supply

Demand
Stocks of Business, Residential, and Consumer Physical Capital