LECTURE 8
Monetary Policy at the Zero Lower Bound

October 19, 2011
I. Paul Krugman, “It’s Baaack: Japan’s Slump and the Return of the Liquidity Trap”
Krugman’s Baseline Model – Assumptions (I)

• Discrete time.

• Identical, infinitely-lived agents.

• Representative agent has $U = \sum t D^t \ln c_t$, $0 < D < 1$.

• Each agent receives an endowment $y$ of the consumption good each period.

• Can sell endowment for money, and buy goods with money.

• Economy is competitive and prices are perfectly flexible (!).

• Perfect foresight.
Krugman’s Baseline Model – Assumptions (II)

- Cash-in-advance constraint. Within period t:
  - Agents start with some holdings of money and bonds (from period t-1).
  - There’s then a market for trading money and bonds.
  - Call the representative agent’s holdings after these trades $M_t$ and $B_t$.
  - The cash-in-advance constraint is $c_t \leq M_t/P_t$.
  - After the agent has bought and sold goods, it receives interest on its bond holdings, and any lump-sum taxes or transfers are implemented.
- The cash-in-advance constraint and perfect foresight imply that $c_t = M_t/P_t$ or $i_t = 0$ (or both).
Households’ First-Order Condition

- Suppose the economy is in equilibrium, and consider an agent thinking of spending $1 less on $c_t$ and using the proceeds to increase $c_{t+1}$.

- $MC = \frac{1}{P_t}(1/y)$

- $MB = \frac{[(1+i_t)/P_{t+1}]}{D/y}$

- $=> ... => i_t = \frac{(1/D)(P_{t+1}/P_t) - 1}{(*)}$

- Note that this holds even if $i_t = 0$. 
The Steady State with Constant M

• Suppose M is constant at some level (denoted M*).

• If there is a steady state, P is constant. Call this P*.

• Then equation (*), $i_t = (1/D)(P_{t+1}/P_t) - 1$, simplifies to $i_t = (1/D) - 1$ for all t, or $i^* = (1 - D)/D$.

• Note that $i^* > 0$. 
The Possibility of a “Liquidity Trap”

- Assume that starting in Period 2, the economy is in steady state.
- So \( P_2 = P^* \), \( i_2 = i^* > 0 \).
- So (*) becomes \( i_1 = (1/D)(P^*/P_1) - 1 \).
The Possibility of a “Liquidity Trap” (cont.)

- Households’ allocation of wealth between money and bonds in period 1:
  - If \( i_1 > 0 \): \( \frac{M_1}{P_1} = y \Rightarrow P_1 = \frac{M_1}{y} \).
  - If \( i_1 = 0 \): \( \frac{M_1}{P_1} \geq y \Rightarrow P_1 \leq \frac{M_1}{y} \).
The Effects of an Increase in $M_1$ when $i_1 > 0$
The Effects of an Increase in $M_1$ when $i_1 = 0$
The Effects of an Increase in $M^*$ when $i_1 = 0$

Recall CC equation: $i_1 = (1/D)(P^*/P_1) - 1$
Some More Experiments (I)

- Suppose the economy is in a liquidity trap in periods 1 and 2, then in steady state with $i = i^* > 0$. Raising $M_1$ or $M_2$ has no effect on aggregate demand in any period. But raising $M^*$ raises aggregate demand in period 2 and in period 1.

- Continue to assume a liquidity trap in period 1 and steady state starting in period 3. Suppose initially $i_2 > 0$. Raising $M_2$ to the point where $i_2 = 0$ raises aggregate demand in period 1. That is, when the economy is in a liquidity trap, promising to stay in the trap longer rises aggregate demand.
Some More Experiments (II)

• Consider raising M by the same proportion in all periods. Then P rises by the same proportion in all periods.

• Suppose the economy is in steady state starting in period 2, and suppose the central bank targets a zero inflation rate from period 1 to period 2. Thus its choice of M* moves one-for-one with movements in $P_1$. Then if something pushes the equilibrium real rate in period 1 below 0, there is no equilibrium: $P_1$ falls without limit. Inflation targeting eliminates any nominal anchor for the economy.
The Committee judges that, on balance, the risk of inflation becoming undesirably low is likely to be the predominant concern for the foreseeable future. In these circumstances, the Committee believes that policy accommodation can be maintained for a considerable period.”
II. Ben Bernanke, “Japanese Monetary Policy: A Case of Self-Induced Paralysis?”
Channels of Monetary Policy Transmission

• Nominal interest rates.
• Expected inflation.
• Asset prices.
• The extent of credit-market imperfections.
• The real exchange rate (and expectations about the real exchange rate).
• Expectations about future output.
• The price level (and expectations about the price level).
Tools of Monetary Policy at the Zero Lower Bound

• Communication about objectives, or the formal adoption of new objectives.
• Communication about future path of safe short-term interest rate (or of supply of high-powered money).
• Communication about the channels of monetary policy (such as the exchange rate or future output).
• Purchases of assets other than short-term government debt.
• Conventional open-market operations?
• Money-financed fiscal expansions (helicopter drops)?
Some Important Questions

• Could some of the tools be counterproductive?

• Could the mix of outcomes (especially, in terms of output and inflation) be different for these tools than for conventional open-market operations in normal times?
The Overnight Call Rate in Japan
The Monetary Base in Japan, 1994–2011

From: Bank of Japan
III. Overview
Figure 2

ACTUAL AND TREND REAL GROSS NATIONAL PRODUCT, 1919–1942
Nominal Interest Rate on 3- to 6-month Treasury Notes
IV. Gauti Eggertsson, “Great Expectations and the End of the Depression”
Industrial Production

Industrial Production (Logarithms)
Producer Price Index, Logarithms

Producer Price Index, All Commodities

(A) Short-term interest rate

(B) Ex post real rate

(C) Ex ante real rate from Cecchetti (1992)

(D) Ex ante real rate from Hamilton (1992)

Figure 2
Logarithms

M1
What are the key elements of the regime?

• Gold standard

• Commitment to a balanced budget

• Belief in small government
What is the mechanism by which the regime change affected inflationary expectations?

- Fiscal expansion gives the government an incentive to inflate.

- So, fiscal expansion leads to monetary expansion.
What is Eggertsson’s evidence of regime change?

- **Narrative**: Roosevelt quotes.

- **Actions**
Fig. 3. The price of cotton and the exchange rate, 1930–1936. Solid line: cotton price; dotted line: value of the dollar in pounds.
Evaluation of Evidence

• Timing of actions

• What happened to spending?
Federal Receipts, Outlays, and Surplus

Outlays

Receipts

Surplus

1930 1931 1932 1933 1934 1935 1936 1937 1938 1939 1940 1941
### Table 1—Measures of the Federal Deficit
(Millions of Dollars)

<table>
<thead>
<tr>
<th></th>
<th>1930</th>
<th>1931</th>
<th>1932</th>
<th>1933</th>
<th>1934</th>
<th>1935</th>
<th>1936</th>
<th>1937</th>
<th>1938</th>
<th>1939</th>
<th>1940</th>
<th>1941</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total GDP</strong></td>
<td>97,400</td>
<td>83,800</td>
<td>67,600</td>
<td>57,600</td>
<td>61,200</td>
<td>69,600</td>
<td>78,500</td>
<td>87,800</td>
<td>89,000</td>
<td>89,100</td>
<td>96,800</td>
<td>114,100</td>
</tr>
<tr>
<td>Federal government consumption(^1) and gross investment</td>
<td>1,830</td>
<td>1,879</td>
<td>1,892</td>
<td>2,286</td>
<td>3,278</td>
<td>3,374</td>
<td>5,565</td>
<td>5,092</td>
<td>5,719</td>
<td>6,018</td>
<td>6,472</td>
<td>17,973</td>
</tr>
<tr>
<td><strong>Total expenditures</strong></td>
<td>3,540</td>
<td>3,917</td>
<td>3,794</td>
<td>4,958</td>
<td>7,521</td>
<td>7,612</td>
<td>9,718</td>
<td>9,260</td>
<td>7,600</td>
<td>12,221</td>
<td>12,998</td>
<td>16,693</td>
</tr>
<tr>
<td>Federal expenditures (excl. gold)</td>
<td>3,320</td>
<td>3,577</td>
<td>4,659</td>
<td>4,598</td>
<td>6,541</td>
<td>6,412</td>
<td>8,228</td>
<td>7,580</td>
<td>6,840</td>
<td>9,141</td>
<td>9,468</td>
<td>13,653</td>
</tr>
<tr>
<td>Gold purchases(^2)</td>
<td>220</td>
<td>340</td>
<td>-910</td>
<td>360</td>
<td>980</td>
<td>1,200</td>
<td>1,490</td>
<td>1,680</td>
<td>760</td>
<td>3,080</td>
<td>3,530</td>
<td>3,040</td>
</tr>
<tr>
<td><strong>Total revenues</strong></td>
<td>4,058</td>
<td>3,116</td>
<td>1,924</td>
<td>1,997</td>
<td>2,955</td>
<td>3,609</td>
<td>3,923</td>
<td>5,387</td>
<td>6,751</td>
<td>6,295</td>
<td>6,548</td>
<td>8,712</td>
</tr>
<tr>
<td>Total liabilities (stocks)</td>
<td>20,727</td>
<td>22,129</td>
<td>23,649</td>
<td>26,954</td>
<td>32,456</td>
<td>37,896</td>
<td>44,555</td>
<td>47,713</td>
<td>48,451</td>
<td>54,009</td>
<td>59,744</td>
<td>66,782</td>
</tr>
<tr>
<td>Monetary base</td>
<td>6,397</td>
<td>6,742</td>
<td>6,873</td>
<td>7,484</td>
<td>9,165</td>
<td>10,552</td>
<td>11,598</td>
<td>13,358</td>
<td>14,364</td>
<td>17,110</td>
<td>21,406</td>
<td>22,701</td>
</tr>
<tr>
<td>Currency in circulation</td>
<td>4,255</td>
<td>4,525</td>
<td>5,305</td>
<td>5,515</td>
<td>5,400</td>
<td>5,580</td>
<td>6,120</td>
<td>6,495</td>
<td>6,495</td>
<td>7,025</td>
<td>7,810</td>
<td>9,500</td>
</tr>
<tr>
<td>Nonborrowed reserves</td>
<td>2,142</td>
<td>2,217</td>
<td>1,568</td>
<td>1,969</td>
<td>3,765</td>
<td>4,972</td>
<td>5,478</td>
<td>6,863</td>
<td>7,869</td>
<td>10,085</td>
<td>13,596</td>
<td>13,201</td>
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<tr>
<td><strong>Public debt(^3)</strong></td>
<td>14,330</td>
<td>15,387</td>
<td>16,776</td>
<td>19,470</td>
<td>23,291</td>
<td>27,344</td>
<td>32,957</td>
<td>34,355</td>
<td>34,087</td>
<td>36,899</td>
<td>38,338</td>
<td>44,081</td>
</tr>
<tr>
<td><strong>Deficit measures (+)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Expenditures excl. gold minus revenues</td>
<td>-738</td>
<td>461</td>
<td>2,735</td>
<td>2,601</td>
<td>3,586</td>
<td>2,803</td>
<td>4,305</td>
<td>2,193</td>
<td>89</td>
<td>2,846</td>
<td>2,920</td>
<td>4,941</td>
</tr>
<tr>
<td>Total expenditures minus revenues</td>
<td>-518</td>
<td>801</td>
<td>1,825</td>
<td>2,961</td>
<td>4,566</td>
<td>4,003</td>
<td>5,795</td>
<td>3,873</td>
<td>849</td>
<td>5,926</td>
<td>6,450</td>
<td>7,981</td>
</tr>
<tr>
<td>Change in total liabilities</td>
<td>1,402</td>
<td>1,520</td>
<td>3,305</td>
<td>5,503</td>
<td>5,440</td>
<td>6,659</td>
<td>3,158</td>
<td>738</td>
<td>5,558</td>
<td>5,735</td>
<td>7,038</td>
<td></td>
</tr>
</tbody>
</table>
Fig. 2. Indexes of investment and consumption spending, 1932–1933. Solid line: investment spending; dotted line: consumer spending.

Source. Moody’s, 1937, pp. a14, a20–21.
### TABLE 2

Monthly Growth Rates, 1933  
(Percent per Month; Seasonally Adjusted)

<table>
<thead>
<tr>
<th>Month</th>
<th>Autos</th>
<th>Steel</th>
<th>Industrial production</th>
<th>Purged industrial production</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>-02</td>
<td>07</td>
<td>00</td>
<td>-00</td>
</tr>
<tr>
<td>February</td>
<td>-29</td>
<td>00</td>
<td>-02</td>
<td>-01</td>
</tr>
<tr>
<td>March</td>
<td>-20</td>
<td>-26</td>
<td>-05</td>
<td>-04</td>
</tr>
<tr>
<td>April</td>
<td>42</td>
<td>46</td>
<td>07</td>
<td>04</td>
</tr>
<tr>
<td>May</td>
<td>18</td>
<td>35</td>
<td>16</td>
<td>14</td>
</tr>
<tr>
<td>June</td>
<td>19</td>
<td>35</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>July</td>
<td>14</td>
<td>29</td>
<td>10</td>
<td>07</td>
</tr>
<tr>
<td>August</td>
<td>06</td>
<td>-20</td>
<td>-05</td>
<td>-03</td>
</tr>
<tr>
<td>September</td>
<td>03</td>
<td>-21</td>
<td>-06</td>
<td>-05</td>
</tr>
<tr>
<td>October</td>
<td>-03</td>
<td>-09</td>
<td>-05</td>
<td>-05</td>
</tr>
<tr>
<td>November</td>
<td>-72</td>
<td>-28</td>
<td>-06</td>
<td>-01</td>
</tr>
<tr>
<td>December</td>
<td>03</td>
<td>24</td>
<td>01</td>
<td>-01</td>
</tr>
</tbody>
</table>

*Source.* Federal Reserve System (1940).

From: Temin and Wigmore, "The End of One Big Deflation"
V. CHRISTINA ROMER, “WHAT ENDED THE GREAT DEPRESSION?”
CHANGES IN SURPLUS-TO-GROSS NATIONAL PRODUCT RATIO, 1923–1942
Figure 6

DEVIATIONS OF MONEY GROWTH RATE FROM NORMAL, 1923–1942
Gold Inflows to the U.S.
Mishkin Method of Estimating Ex Ante Real Rate

**Ex Post Real Rate:**

\[ r_{ep_t} = i_t - \pi_t \]

where \( i_t \) is the nominal rate and \( \pi_t \) is actual inflation.

**Ex Ante Real Rate:**

\[ r_{ea_t} = i_t - \pi^e_t \]

Where \( \pi^e_t \) is expected inflation.
The difference between $r_{ep}$ and $r_{ea}$ is unanticipated inflation ($\varepsilon_t$):

\[ r_{ep}^t = (i_t - \pi_t) + (\pi_e^t - \pi_e^t) \]

\[ r_{ep}^t = (i_t - \pi_e^t) - (\pi_t - \pi_e^t) \]

\[ = r_{ea}^t - \varepsilon_t \]

• Under rational expectations, expectation of unanticipated inflation at a point in time is zero.

• You can’t expect to be surprised.
Think of constructing estimate of $\pi^e$:

$$\pi^e_t = \alpha i_t + \beta'X_t$$

where $X$ is a vector of information known at time $t$.

$$r^{ep}_t = i_t - (\alpha i_t + \beta'X_t) + \epsilon_t$$

$$r^{ep}_t = (1 - \alpha)i_t - \beta'X_t + \epsilon_t$$

Regress $r^{ep}$ on $i$, and other explanatory variables known at time $t$.

Fitted values are estimates of $r^{ea}$. 
### Table 2
REGRESSION USED TO ESTIMATE EX ANTE REAL INTEREST RATES

<table>
<thead>
<tr>
<th>Explanatory Variable</th>
<th>Coefficient</th>
<th>T-Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Monetary Policy Variable</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lag 0</td>
<td>0.044</td>
<td>0.29</td>
</tr>
<tr>
<td>Lag 1</td>
<td>-0.463</td>
<td>-3.02</td>
</tr>
<tr>
<td>Lag 2</td>
<td>0.182</td>
<td>1.09</td>
</tr>
<tr>
<td>Lag 3</td>
<td>-0.196</td>
<td>-1.20</td>
</tr>
<tr>
<td>Lag 4</td>
<td>0.352</td>
<td>2.30</td>
</tr>
<tr>
<td><strong>Nominal Commercial Paper Rate</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lag 0</td>
<td>0.834</td>
<td>0.25</td>
</tr>
<tr>
<td>Lag 1</td>
<td>0.191</td>
<td>0.04</td>
</tr>
<tr>
<td>Lag 2</td>
<td>1.181</td>
<td>0.22</td>
</tr>
<tr>
<td>Lag 3</td>
<td>0.954</td>
<td>0.18</td>
</tr>
<tr>
<td>Lag 4</td>
<td>-1.079</td>
<td>-0.32</td>
</tr>
<tr>
<td><strong>Inflation Rate</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lag 0</td>
<td>-0.396</td>
<td>-2.54</td>
</tr>
<tr>
<td>Lag 1</td>
<td>0.129</td>
<td>0.81</td>
</tr>
<tr>
<td>Lag 2</td>
<td>-0.014</td>
<td>-0.09</td>
</tr>
<tr>
<td>Lag 3</td>
<td>0.111</td>
<td>0.72</td>
</tr>
<tr>
<td>Lag 4</td>
<td>-0.031</td>
<td>-0.21</td>
</tr>
<tr>
<td><strong>Change in Industrial Production</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lag 0</td>
<td>-0.026</td>
<td>-0.47</td>
</tr>
<tr>
<td>Lag 1</td>
<td>0.045</td>
<td>0.78</td>
</tr>
<tr>
<td>Lag 2</td>
<td>-0.120</td>
<td>-2.00</td>
</tr>
<tr>
<td>Lag 3</td>
<td>0.012</td>
<td>0.22</td>
</tr>
<tr>
<td>Lag 4</td>
<td>-0.036</td>
<td>-0.67</td>
</tr>
<tr>
<td><strong>Quarterly Dummy Variables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quarter 2</td>
<td>1.497</td>
<td>0.27</td>
</tr>
<tr>
<td>Quarter 3</td>
<td>-6.961</td>
<td>-1.76</td>
</tr>
<tr>
<td>Quarter 4</td>
<td>5.271</td>
<td>0.97</td>
</tr>
<tr>
<td>Constant</td>
<td>-1.804</td>
<td>-0.44</td>
</tr>
</tbody>
</table>

*Notes:* The dependent variable is the quarterly ex post real interest rate. The sample period used in the estimation is 1923:1 to 1942:2. The $R^2$ of the regression is .52.

*Source:* See the text.
Figure 8

EX ANTE REAL COMMERCIAL PAPER RATES, 1929–1942
Figure 9

Real Fixed Investment and ex Ante Real Rates, 1930–1941
Figure 10

REAL CONSUMER EXPENDITURES ON DURABLE GOODS AND EX ANTE REAL RATES, 1930–1941
Behavior of Different Types of Consumer Spending

- Nondurables
- Services
- Durables