Economics 704a Lecture 11: Liquidity Trap and Unconventional Policy II

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Outline: Questions on the Liquidity Trap

1. What Is the Effect of a Liquidity Trap in the NK Model?
2. What Is Optimal Monetary Policy in a Liquidity Trap?
   2.1 Forward Guidance (Gali 5.4)
   2.2 Other Unconventional Policies
   2.3 Is Zero the Lower Bound?
3. What Is the Role of Fiscal Policy in a Liquidity Trap?

What Is the Effect of a Liquidity Trap in the NK Model?

- Start with standard NK model with no cost-push shocks:

$$\pi_t = \beta E_t \{\pi_{t+1}\} + \kappa x_t$$
$$x_t = E_t \{x_{t+1}\} - \sigma E_t \{i_t - \pi_{t+1} - r^n_{t+1}\}$$

  - Optimal monetary policy is to set $i_t = r^n_{t+1}$ so $x_t = 0$ and $\pi_t = 0$ (divine coincidence).
- Thought experiment we will use repeatedly today:
  - The natural rate is at its steady state of ρ until period $t-1$.
  - At period t, learn r^n_{t+1} will follow deterministic path:

$$r^n_{t+1} = \begin{cases} -\Delta < 0 & \text{from } t \text{ to } t+T \\ \rho & \text{from } t+T+1 \text{ on} \end{cases}$$

- For now, Central Bank pursues optimal discretionary policy
  - Prior to t and from $t+T+1$ onwards, set $x_t = -\frac{\kappa}{\vartheta}\pi_t \Rightarrow i_t = \rho \Rightarrow \pi_t = 0$.
  - From t to $t+T$, lower i_t to ZLB so $i_t = 0$.

What Is the Effect of a Liquidity Trap in the NK Model?

- Iterating forward we have:

$$x_t = -\sigma E_t \left\{ \sum_{s=0}^{\infty} \left[\left(\hat{i}_{t+s} - \hat{\pi}_{t+s+1} - \hat{r}^n_{t+s+1} \right) \right] \right\}$$

$$\pi_t = E_t \left\{ \sum_{s=0}^{\infty} \beta^s \kappa x_{t+s} \right\}$$

- Deterministic path so can drop expectations. Split into two sums, one from o to T and one from $T+1$ to ∞:

$$x_t = -\sigma \sum_{s=0}^{T} \left(\hat{i}_{t+s} - \hat{\pi}_{t+s+1} - \hat{r}^n_{t+s+1} \right) - \underbrace{\sigma \sum_{s=T+1}^{\infty} \left(\hat{i}_{t+s} - \hat{\pi}_{t+s+1} - \hat{r}^n_{t+s+1} \right)}_{\text{Zero By Divine Coincidence}}$$

$$\pi_t = \sum_{s=0}^{T} \beta^s \kappa x_{t+s} + \underbrace{\sum_{s=T+1}^{\infty} \beta^s \kappa x_{t+s}}_{\text{Zero By Divine Coincidence}}$$

What Is the Effect of a Liquidity Trap in the NK Model?

- Plugging in optimal policy in liquidity trap of $i_t = 0$ and $r^n_{t+1} = -\Delta$, we have:

$$x_t = -\sigma \sum_{s=0}^{T} (\Delta - \pi_{t+s+1})$$

$$\pi_t = \sum_{s=0}^{T} \beta^s \kappa x_{t+s}$$

- This implies persistent slump with $x_t < 0$ and $\pi_t < 0$!
  - Start in period $t + T$. Know $\pi_{t+T+1} = 0$ and $\Delta > 0$, so $x_{t+T} < 0$ and $\pi_{t+T} < 0$.
  - In period $t + T - 1$, $\pi_{t+T} < 0$ and $\Delta > 0$, so $x_{t+T-1} < x_{t+T} < 0$ and $\pi_{t+T-1} < \pi_{t+T} < 0$.
  - Working backward, $\pi < 0$ and $\pi < 0$ all the way back to period t, with bigger output gaps and deflation farther back.

What Is the Effect of a Liquidity Trap in the NK Model?

- Why the big slump?
- Even if inflation were zero, consumption would be depressed by

$$x_t = -\sigma \sum_{s=0}^{T} \Delta$$

  - Households are saving "too much" because r_t is "too high."
- Key Idea: Deflation exacerbates the ZLB.
  - Deflation occurs because negative output gaps push down MC.
  - This pushes r_t higher as $r_t = -E_t \{\pi_{t+1}\}$, which makes x_t lower, leading to more deflation....

$$x_t = -\sigma \sum_{s=0}^{T} (\Delta - \pi_{t+s+1})$$

  - Inflation is forward looking, so deflation is worst at the beginning and then gets better.

The Paradox of Flexibility

- Would more flexible prices make things better?
    - NO! Surprisingly, they make things *worse*!
- Output gap with perfectly sticky prices is:

$$x_t = -\sigma \sum_{s=0}^{T} \Delta$$

- Output gap with flexible prices (larger κ) is:

$$x_t = -\sigma \sum_{s=0}^{T} (\Delta - \pi_{t+s+1})$$

with π_{t+s+1} increasing as $\kappa \to \infty$.

- Intuition: Deflation is what turbocharges liquidity trap.
    - More flexibility $\Rightarrow$ more deflation $\Rightarrow$ worse spiral?

What Is Optimal Monetary Policy in a Liquidity Trap?

- What does monetary policy want to do in a liquidity trap?
  - $i_t = 0 \Rightarrow$ It can't do anything!
- But, as with optimal monetary policy, can gain from committing self to non-discretionary solution.
  - This time with respect to policy *after* the liquidity trap.
  - In particular, it wants to *commit to inflating*!

What Is Optimal Monetary Policy in a Liquidity Trap?

- In T period liquidity trap with commitment:

$$
\begin{aligned}
x_t &= -\sigma \sum_{s=0}^{T} \left(\Delta_{t+s+1} - \pi_{t+s+1}\right) - \sigma \sum_{s=T+1}^{\infty} \left(i_{t+s} - \pi_{t+s+1} - \rho\right) \\
\pi_t &= \sum_{s=0}^{\infty} \beta^s \kappa x_{t+s}
\end{aligned}
$$

- Causing an inflationary boom when the liquidity trap is over:
  1. Reduces "over saving" problem causing the trap.
     - Boom in future, so less reason to save.
     - This is the root cause. It would help even with fixed prices.
  2. Reduces deflation ⇒ mitigates deflationary spiral.
     - Inflation today pushes r_t down towards r_t^n.

Central Bank Problem

$$\min_{\{x_{t+s},\pi_{t+s}\}} \frac{1}{2}\sum_{s=0}^{\infty}\beta^s\left(\pi_{t+s}^2+\vartheta x_{t+s}^2\right) \text{ s.t.}$$

$$\pi_t = \beta\pi_{t+1}+\kappa x_t$$

$$x_t \leq x_{t+1}+\sigma\left(\pi_{t+1}+r_{t+1}^n\right)$$

- Second constraint combines IS and ZLB.
  - Recall when ZLB does not bind, we choose $\{x,\pi\}$ subject to NKPC and use DIS to back out i that implements this allocation. So if $i=0$, second constraint is an inequality.
  - If $i=0$, however, we need NKPC to determine agg demand in liquidity trap and $\{x,\pi\}$, so it binds with equality.
- T-period liquidity trap as before:

$$r_{t+1}^n = \begin{cases} -\Delta & \text{from } t \text{ to } t+T \\ \rho & \text{from t+}T+1\text{ on} \end{cases}$$

Central Bank Lagrangian

$$\mathscr{L} = \frac{1}{2}\sum_{s=0}^{\infty}\beta^s \left[\begin{array}{c} \left(\pi_{t+s}^2 + \vartheta x_{t+s}^2\right) + \xi_{1,t+s}\left(\pi_{t+s} - \kappa x_{t+s} - \beta\pi_{t+s+1}\right) \\ +\xi_{2,t+s}\left(x_{t+s} - x_{t+s+1} - \sigma\left(\pi_{t+s+1} + r_{t+s+1}^n\right)\right) \end{array} \right]$$

- FOCs:

$$\begin{aligned} \pi_t + \xi_{1,t} - \xi_{1,t-1} - \frac{\sigma}{\beta}\xi_{2,t-1} &= 0 \\ \vartheta x_t - \kappa\xi_{1,t} + \xi_{2,t} - \frac{1}{\beta}\xi_{2,t-1} &= 0 \end{aligned}$$

- Complementary slackness conditions:

$$\xi_{2,t} \geq 0,\ i_t \geq 0,\ \xi_{2,t} i_t = 0$$

  - Interpretation: $i_t = 0$ and dynamic IS binds or $i > 0$ and off dynamic IS for allocation, as on previous slide.
  - Multiplier is always positive if constraint binds.

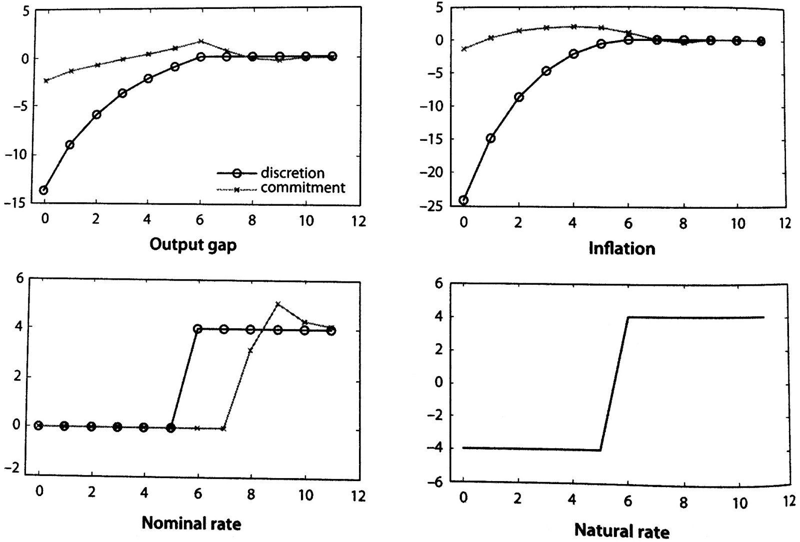
Central Bank Commitment Solution

- Show positive output gap and inflation at $T+1$ by differencing FOCs for between $T+1$ and T and using $\xi_{2,T+1}=0$:

$$x_{T+1}-x_T=-\frac{\kappa}{\vartheta}\pi_{T+1}+\frac{\beta+\sigma\kappa}{\beta\vartheta}\xi_{2,T}+\frac{1}{\beta\vartheta}\left(\xi_{2,T}-\xi_{2,T-1}\right)$$

  - First term is standard leaning against the wind effect. If this alone, $\pi_{T+1}=x_{T+1}=0$.
  - Offset by second two terms with $\xi_{2,T}>0$ which make you want to set $x_{T+1}>0$.
  - Asymptotically returns to $x_t=\pi_t=0$.
- Intuition: Second order inflation and output gap loss in future, first order output gap and deflation gain today.
- Werning (2012) solves full dynamic path using continuous time methods, shows $i_t=0$ for $t\in[t,T_c]$ for $T_c>0$ and then jumps discretely.

Central Bank Commitment Solution



Central Bank Commitment Solution in Practice

- This commitment solution motivates *forward guidance*.
  - Announce you are going to keep your rate low for a long time, unconditional on market conditions.
  - Idea: Get people to believe that you will keep rates low after the ZLB does not bind.
  - Problem: Not a time consistent commitment.
  - Also when do you know you are out? T-period trap is stylized and period of ending is endogenous.
- Fed used forward guidance:
  - In December 2008 says "likely to warrant exceptionally low levels of the federal funds rate for some time."''
  - In August 2011, introduce specific date stating that will be low through mid 2013.
  - Pushed that out twice to late 2014 and mid-2015 in 2012.

Other Unconventional Policies

- Fed also pursued *Large-Scale Asset Purchases* (also known as "quantitative easing").
- There is not just one short term rate.
  - Fed Funds Rate
  - Longer-maturity treasury rates.
  - Checking interest / certificate of deposit rate.
  - Mortgage rates.
  - Business loan rates.
- Other rates are usually spreads over FFR.
- By buying treasuries and GSE mortgage-backed securities, reduce spreads and interest rates for consumers and businesses.
  - And perhaps stimulate the housing market directly by expanding mortgage credit?

Optimal Inflation Rate?

- Many of these policies are controversial.
- Most controversial: raise the inflation target above 2 %.
    - Benefits:
        1. Helps us get out of liquidity trap now.
        2. In future, need $r_t^n < -\pi_t$ to fall in, so fall in less frequently.
    - Olivier Blanchard floated 4%. Nobody has yet adopted.
    - Worry about runaway inflation and that inflation expectations will become "unanchored."
        - But now that we have lost the anchor...

Is Zero the Lower Bound?

- Recently, moved into a world of negative interest rates.
  - Swiss, Swedes, Danish, ECB, and Japanese all have negative rates (for banks, not people).
  - Get banks to lend money by taxing reserves and reducing other rates to zero.
- Money demand has not exploded up yet.
  - Clearly would if you go negative enough.
  - But what is "negative enough"? We really do not know...
- See Rognlie (2016) for model where money demand explodes at negative rate rather than zero, but negative rates cause costly distortions.
- See Eggertsson et al. (2019) for evidence that the pass-through of policy rates to deposit rates breaks down when the policy rate becomes negative.

What Is the Role of Fiscal Policy in a Liquidity Trap?

- In 2009, passed ARRA (e.g., the "Stimulus Act").
- In there a stronger case for fiscal stimulus at the ZLB?
  - Is the multiplier higher?
  - Other justification: $x_t < 0 \Rightarrow$ marginal costs are low, so cheap for government to buy its goods now, and i_t is low so cheap for it to finance with bonds.
- To answer multiplier question, first look at multiplier in normal times in standard NK model, then consider ZLB.

Government Spending in New Keynesian Model

- Assume government consumes G_t and finances with lump sum taxes T_t and bonds B_t:

$$\frac{1}{R_{t+1}} B_{t+1} = B_t + G_t - T_t$$

- With perfect capital markets and no default

$$B_t + \sum_{s=0}^{\infty} \frac{G_{t+s}}{\prod_{j=0}^{s} R_{t+1+j}} = \sum_{s=0}^{\infty} \frac{T_{t+s}}{\prod_{j=0}^{s} R_{t+1+j}}$$

- Assume G_t follows exogenous process.

Ricardian Equivalence

- Household BC:

$$
\begin{aligned}
C_t &= \frac{W_t}{P_t} N_t + TR_t + PR_t - T_t - \frac{B_t - Q_{t-1} B_{t-1}}{P_t} - \frac{M_t - M_{t-1}}{P_t} \\
&= Income_t - T_t - \frac{B_t - Q_{t-1} B_{t-1}}{P_t} - \frac{M_t - M_{t-1}}{P_t}
\end{aligned}
$$

where $Income_t = \frac{W_t}{P_t} N_t + TR_t + PR_t$.

- Then present value BC is:

$$
B_t + M_t + \sum_{s=0}^{\infty} \frac{Income_{t+s} - T_{t+s}}{\prod_{j=0}^{s} R_{t+1+j}} = \sum_{s=0}^{\infty} \frac{C_{t+s}}{\prod_{j=0}^{s} R_{t+1+j}}
$$

and substituting government BC, Ricardian equivalence holds.

  - Timing of taxes does not matter.
  - But changes in G_t matter.

Equilibrium

$$
\begin{aligned}
\frac{W_t}{P_t} &= \frac{\chi N_t^{\varphi}}{C_t^{-\gamma}} \\
1 &= \beta E_t \left\{ Q_t \frac{P_t}{P_{t+1}} \frac{C_{t+1}^{-\gamma}}{C_t^{-\gamma}} \right\} \\
P_t &= \left[\theta P_{t-1}^{1-\varepsilon} + (1-\theta) P_t^{*1-\varepsilon} \right]^{\frac{1}{1-\varepsilon}} \\
P_t^* &= (1+\mu) E_t \left\{ \sum_{s=0}^{\infty} \frac{\theta^s \Lambda_{t,t+s}^n P_{t+s}^{\varepsilon} Y_{t+s}}{\sum_{k=0}^{\infty} \theta^k \Lambda_{t,t+k}^n P_{t+k}^{\varepsilon} Y_{t+k}} \frac{W_{t+s}}{A_{t+s}} \right\} \\
Y_t &= C_t + G_t \\
Y_t &= A_t N_t \left[\int_0^1 \left(\frac{N_t(i)}{N_t} \right)^{\frac{\varepsilon-1}{\varepsilon}} \right]^{\frac{\varepsilon}{\varepsilon-1}}
\end{aligned}
$$

Log Linearized IS and Natural Rate

- Log linearizing resource constraint gives:

$$\hat{y}_t = (1 - s_g)\hat{c}_t + s_g \hat{g}_t$$

- Log linearizing Euler and plugging in:

$$\hat{y}_t = -(1 - s_g)\sigma \left(\hat{i}_t - E_t \{\hat{\pi}_{t+1}\}\right) + E_t \{\hat{y}_{t+1}\} + s_g (\hat{g}_t - E_t \{\hat{g}_{t+1}\})$$

- Consequently in the flex price equilibrium

$$\hat{y}^n_t = -(1 - s_g)\sigma \hat{r}^n_{t+1} + E_t \left\{\hat{y}^n_{t+1}\right\} + s_g (\hat{g}_t - E_t \{\hat{g}_{t+1}\})$$

- Differencing gives modified IS curve:

$$\tilde{y}_t = -(1 - s_g)\sigma E_t \left\{\hat{i}_t - \hat{\pi}_{t+1} - r^n_{t+1}\right\} + E_t \{\tilde{y}_{t+1}\}$$

where:

$$\hat{r}^n_{t+1} = \frac{1}{(1 - s_g)\sigma} \left(E_t \left\{y^n_{t+1}\right\} - \hat{y}^n_t\right) + \frac{s_g}{(1 - s_g)\,\sigma} (\hat{g}_t - E_t \{\hat{g}_{t+1}\})$$

Flex Price Equilibrium

$$
\begin{aligned}
\hat{y}_t^n &= \hat{a}_t + \hat{n}_t^n \\
\hat{y}_t^n - \hat{n}_t^n &= \varphi \hat{n}_t^n + \gamma \hat{c}_t^n \\
\hat{y}_t^n &= (1 - s_g)\hat{c}_t^n + s_g \hat{g}_t
\end{aligned}
$$

- Combining with r_t^n:

$$
\hat{y}_t^n = \left(\frac{1+\varphi}{\varphi + \frac{\gamma}{1-s_g}} \right) \hat{a}_t + \gamma \frac{s_g}{(1-s_g)\varphi + \gamma} \hat{g}_t
$$

- Consequently,

$$
\hat{r}_{t+1}^n = -\psi_a (\hat{a}_t - E_t \{\hat{a}_{t+1}\}) + \psi_g (\hat{g}_t - E_t \{\hat{g}_{t+1}\})
$$

where $\psi_a = \frac{\gamma}{(1-s_g)} \frac{1+\varphi}{\varphi + \frac{\gamma}{1-s_g}}$ and $\psi_g = \frac{\gamma s_g}{(1-s_g)} \frac{\varphi}{\varphi + \frac{\gamma}{1-s_g}}$.

Summary of Model With G

$$
\begin{aligned}
\tilde{y}_t &= -(1-s_g)\sigma E_t\left\{\hat{i}_t - \hat{\pi}_{t+1} - r^n_{t+1}\right\} + E_t\{\tilde{y}_{t+1}\} \\
\hat{\pi}_t &= \kappa\tilde{y}_t + \beta E_t\{\hat{\pi}_{t+1}\} \\
\hat{y}^n_t &= \left(\frac{1+\varphi}{\varphi + \frac{\gamma}{1-s_g}}\right)\hat{a}_t + \gamma\frac{s_g}{(1-s_g)\varphi+\gamma}\hat{g}_t \\
\hat{r}^n_{t+1} &= -\psi_a\left(\hat{a}_t - E_t\{\hat{a}_{t+1}\}\right) + \psi_g\left(\hat{g}_t - E_t\{\hat{g}_{t+1}\}\right) \\
\hat{y}_t &= \tilde{y}_t + \hat{y}^n_t
\end{aligned}
$$

- Government spending affects $\hat{r}^n_t$ and $\hat{y}^n_t$
  - $\uparrow \hat{g}_t \rightarrow \uparrow \hat{y}^n_t$ due to neg wealth effect from taxation increasing aggregate supply.
  - $\uparrow \hat{g}_t \rightarrow \uparrow \hat{r}^n_t \rightarrow \uparrow \tilde{y}_t$ due to aggregate demand effects of government spending.

Government Spending Multiplier

- If Central Bank sets $i_t = r^n_{t+1} + E_t\{\pi_{t+1}\}$, $\tilde{y}_t = 0$ and $\hat{y}_t = \hat{y}^n_t$:

$$\frac{dy_t}{dg_t} = \frac{dy^n_t}{dg_t} = \frac{\gamma s_g}{(1 - s_g)\varphi + \gamma}$$

- The multiplier is then:

$$\frac{dY_t}{dG_t} = \frac{Y}{G}\frac{dy_t}{dg_t} = \frac{\gamma}{(1 - s_g)\varphi + \gamma} < 1$$

- CB completely offsets the agg demand effect of gov't spending.
  - Leaves only aggregate supply (wealth) effect.
- If the CB does nothing, additional effect through $\tilde{y}_t$ rising due to effect of gov't purchases on agg demand.
  - Modestly above one in calibrations (no closed form).

Government Spending Multiplier in a Liquidity Trap

- Return to T-period liquidity trap example with CB setting optimal discretionary policy:

$$
\begin{aligned}
\tilde{y}_t &= \sigma\left(1-s_g\right) E_t\left\{\sum_{s=0}^{T}\left(\pi_{t+s+1}-\hat{r}^n_{t+s+1}\right)\right\} \\
&= -\sigma\left(1-s_g\right) E_t\left\{\sum_{s=0}^{T}\left[\Delta-\pi_{t+s+1}-\psi_g\left(\hat{g}_t-E_t\left\{\hat{g}_{t+1}\right\}\right)\right]\right\}
\end{aligned}
$$

- *Government spending has same stimulative effect as inflation*.
  - Problem is "too much saving" and too little spending.
  - Government spending makes up shortfall, improving output gap through agg demand effect even in absence of inflation effect.
  - Also pushes up wages and marginal costs, creating inflation and mitigating a deflationary spiral.
- Large multipliers at ZLB in calibrated models (well above 1).

Government Spending Multiplier in a Liquidity Trap

- Normal times $\Rightarrow$ use monetary policy (more nimble).
- ZLB $\Rightarrow$ use fiscal policy (monetary policy has hands tied and has to make non-credible commitments).
- However, very large multipliers *depend on inflation responding to fiscal stimulus.*
  - For ZLB episode from Great Recession until pandemic, inflation was fairly anchored.
  - Suggests multiplier may not have risen quite so much.
  - Estimating multiplier in and outside ZLB is source of continued debate.

New Perspectives on the Monetary Transmission Mechanism

- Last two lectures will cover new papers to give you an idea of what frontier research in macro is about.
  - Will feel more like a second year class.
  - Read the papers and be ready to discuss!
- Focus will be on recent papers reevaluating the monetary transmission mechanism.
  - In the New Keynesian model, all about intertemporal substitution by representative consumer.
  - But is this really how monetary policy works?
- Papers will focus on one or more dimensions of heterogeneity.
  - Will build on what you learned with David.

New Perspectives on the Monetary Transmission Mechanism

1. Heterogenous Agents I: Heterogenous Agents and Monetary Transmission
    - Key paper: Kaplan, Moll, and Violante (2018)
    - Secondary Papers: Gali, Lopez-Salido, and Valles (2007), Kaplan and Violante (2014)
2. Household Finance, Housing, and Monetary Policy
    - Key paper: Wong (2021)
    - Secondary Papers: Di Maggio et al. (2017), Beraja et al. (2019)

- Please read key papers!
    - Last "problem set" is brief response assignment on both of the key papers.