A Discussion of Arouba, Cuba-Borda and Schorfheide: "Macroeconomic Dynamics Near the ZLB: A Tale of Two Countries"

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This paper

1. Solves small-scale NK model with ZLB globally with non-linear solver allowing for piece-wise smooth decision rules. Nice.
2. Estimates key structural parameters from pre-liquidity trap samples for US and Japan based on 2nd order pertubation. Nice.
3. Draws inference on shocks using decision rules using global method in step 1 and parameters estimated in step 2. OK.
4. Examines implications for fiscal policy. OK.

Model

- Block 1: Almost standard model with money in the utility function and Rotemberg price adjustment costs:

$$\mathbf{V}_0 = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{\left(\frac{C_t}{A_t}\right)^{1-\tau} - 1}{1-\tau} - \chi_H \frac{H_t^{1+1/\eta}}{1+1/\eta} + \chi_M \mathbf{W}\left(\frac{M_t}{P_t A_t}\right) \right]$$

$$\begin{aligned} \mathbf{Y}_t^{1-v} &= \int_j \mathbf{Y}_t(j)^{1-v} \, dj \\ \mathbf{Y}_t(j) &= A_t H_t(j) \\ \mathbf{AC}_t(j) &= \frac{\phi}{2}\left(\frac{P_t(j)}{P_{t-1}(j)} - \overline{\pi}\right)^2 \end{aligned}$$

Model

- Block 2: Interest rate rule plus demand shocks

$$
\begin{aligned}
R_t &= \max\left(1, \left[r\pi_* \left(\frac{\pi_t}{\pi_*}\right)^{\psi_1} \left(\frac{Y_t}{\gamma Y_{t-1}}\right)^{\psi 2} R_t^{\rho_R} e_t^{\sigma_R \epsilon_{R,t}}\right]\right) \\
G_t &= \left(1 - \frac{1}{g_t}\right) Y_t \\
c_t &= \left[\frac{1}{g_t} - \frac{\phi}{2}\left(\pi_t - \overline{\pi}\right)^2\right] y_t
\end{aligned}
$$

- the "max" operator imposes the ZLB
- G_t (not government spending): An autonomous, non-endogenous component of aggregate demand

Shocks

Model driven by fundamental and possibly non-fundamental shocks:

$$
\begin{aligned}
\varepsilon_t &= \left(\epsilon_{R,t}, \epsilon_{z,t}, \epsilon_{g,t}\right)' \sim iidN\left(0, \mathbf{I}\right) \\
\log A_t &= \log \gamma A_{t-1} + \log z_t \\
\log z_t &= \rho_z \log z_{t-1} + \sigma_z \epsilon_{z,t} \\
\log g_t &= \left(1 - \rho_g\right) \log g_* + \rho_g \log g_{t-1} + \sigma_g \epsilon_{g,t} \\
s_t &\in (0,1) \text{ with transition matrix } P = \begin{pmatrix} p_{00} & 1 - p_{00} \\ 1 - p_{11} & p_{11} \end{pmatrix}
\end{aligned}
$$

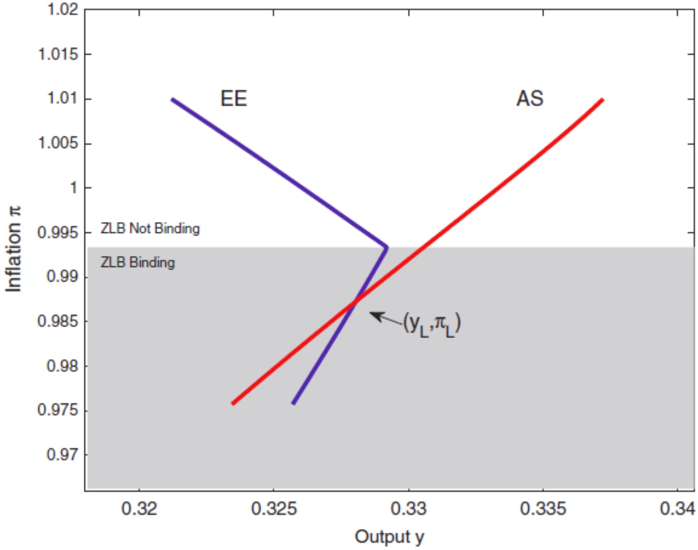
- g_t: exogenous demand shocks. Perhaps it would be good to discipline these.
- s_t is a stochastic variable, no impact on decision rules if there is a unique equilibrium
- If stochastic sunspot exists, s_t impacts on decision rules

ZLB

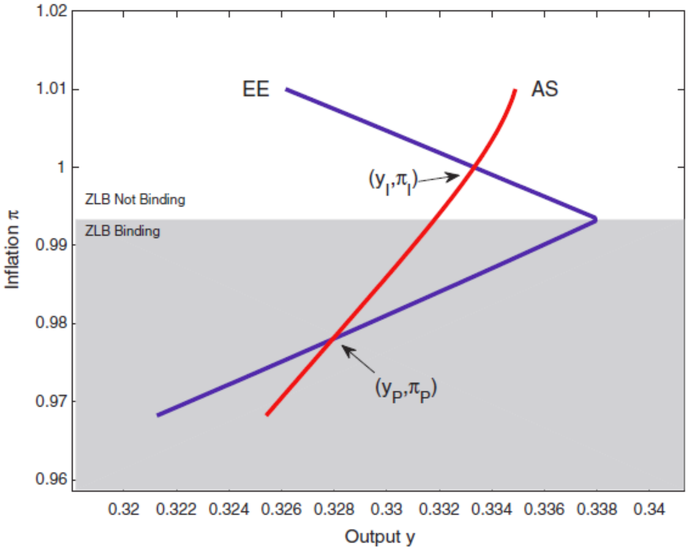
ZLB may be binding for two reasons:

- **A. Fundamental shocks**: Large fall in demand $\Rightarrow$ fall in inflation $\Rightarrow$ fall in nominal interest rate which may go all the way to ZLB $\Rightarrow$ sudden drop in output to restore equilibrium because falling inflation stimulates real interest rate
- **B. Stochastic sunspot equilibria** - sentiment driven self-fulfilling temporary deviations from 'normal' equilibrium: Agents become negative expecting low future real income $\Rightarrow$ fall in inflation $\Rightarrow$ fall in nominal interest rate which may go all the way to ZLB $\Rightarrow$ sudden drop in output to restore equilibrium - expectations therefore self-fulfilling
- A exist if shocks to demand are large (and not too persistent)
- B exist if negative sentiments are sufficiently persistent (LT steady state always exists)

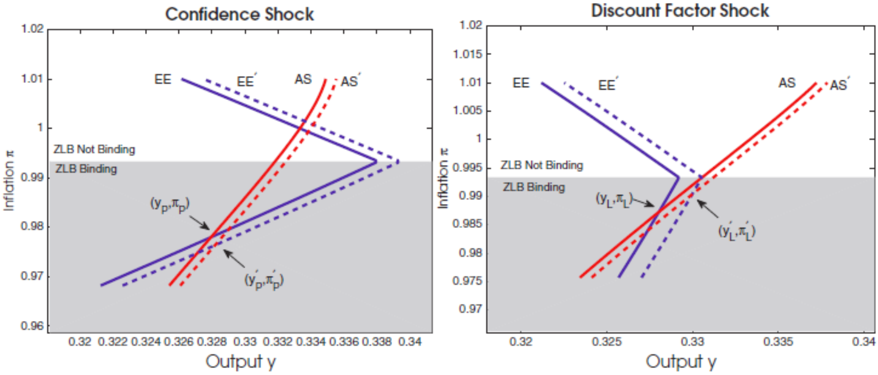
Fundamental LT



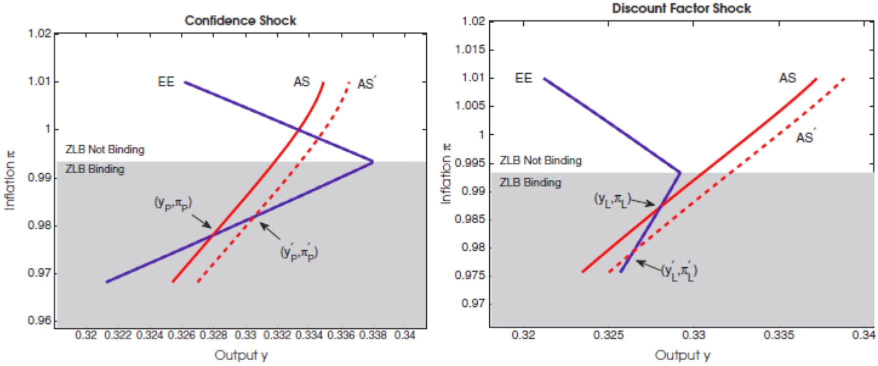
Expectational LT



It Matters: spending



It Matters: taxes



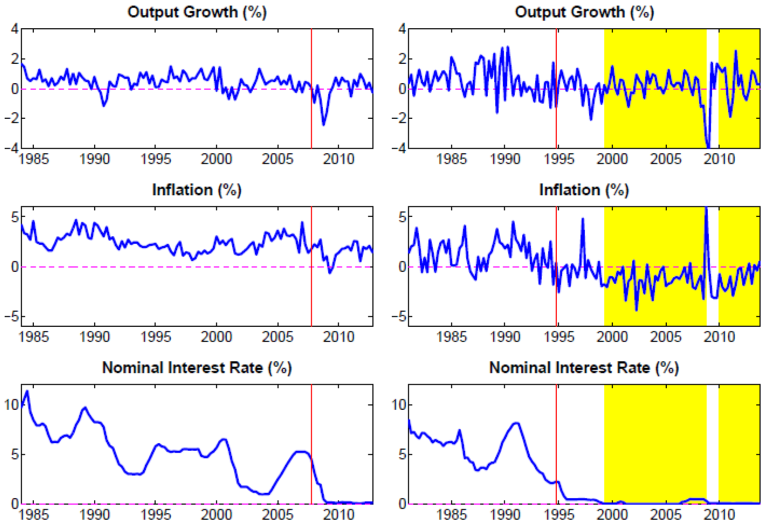
Estimation

Solve model with 2nd order pertubation (around intended steady-state) and calibrate subset

The Following Parameters Were Fixed During Estimation

$100 \ln \gamma$	Quarterly growth rate of technology	0.48	0.56
$400(1 - 1/\beta)$	Annualized discount rate	0.87	1.88
$400 \ln \pi^*$	Annualized inflation rate	2.52	1.28
$(G/Y)_*$	SS consumption/output ratio	0.15	0.16
η	Frisch elasticity	0.85	0.72
ψ_2	Taylor rule: weight on output growth	0.80	0.30
ν	EOS intermediate inputs	0.10	0.10
p_{00}	Prob of staying in deflation regime	0.95	0.95
p_{11}	Prob of staying in targeted-inflation regime	0.99	0.99

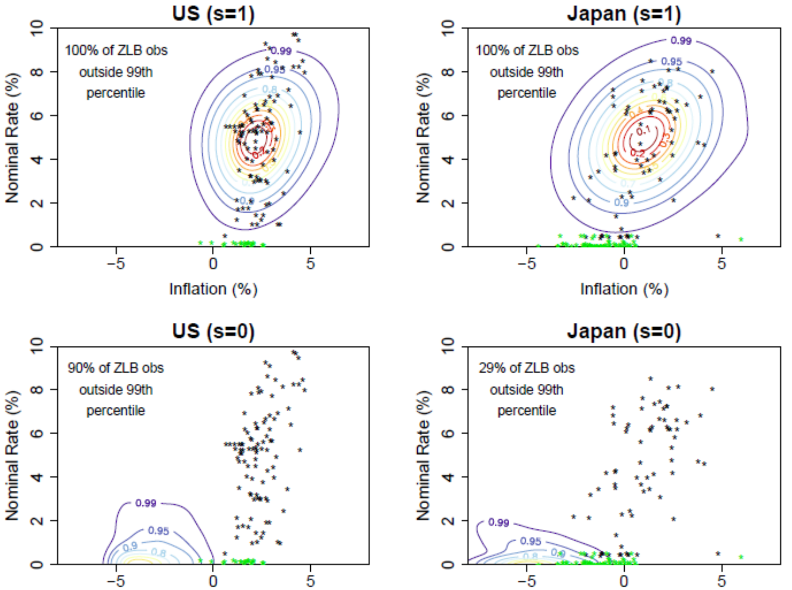
Observables



Parameter estimates

		1984:Q1-2007:Q4		1981:Q1-1994:Q4	
Parameters	Description	U.S.		Japan	
τ	Inverse IES	2.23	(1.85, 2.66)	1.14	(0.72, 1.70)
κ	Slope (linearized) Phillips curve	0.26	(0.16, 0.39)	0.55	(0.36, 0.77)
ψ_1	Taylor rule: weight on inflation	1.52	(1.45, 1.60)	1.49	(1.41, 1.58)
ρ_R	Interest rate smoothing	0.59	(0.51, 0.68)	0.6	(0.47, 0.71)
ρ_g	Persistence: demand shock	0.92	(0.88, 0.94)	0.88	(0.82, 0.94)
ρ_z	Persistence: technology shock	0.16	(0.05, 0.30)	0.04	(0.01, 0.09)
$100\sigma_R$	Std dev: monetary policy shock	0.23	(0.18, 0.30)	0.23	(0.17, 0.30)
$100\sigma_g$	Std dev: demand shock	0.54	(0.41, 0.70)	1.02	(0.71, 1.51)
$100\sigma_z$	Std dev: technology shock	0.54	(0.44, 0.66)	1.02	(0.82, 1.26)

Ergodic distributions



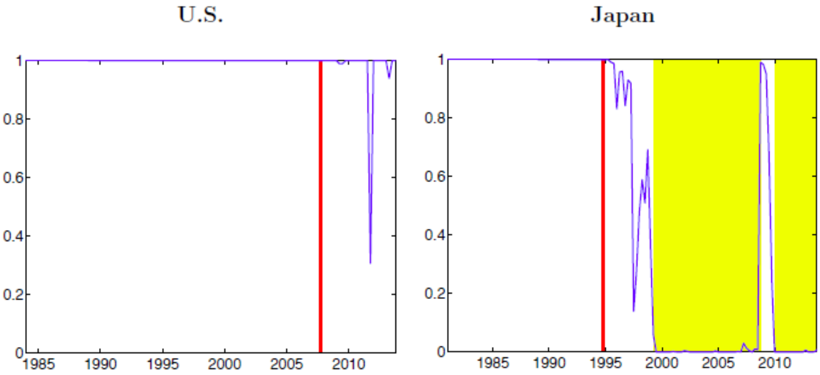
Sources of the Liquidity Trap

Draw inference on the probability of $s_t = 0$

$$
\begin{aligned}
u_t &= \mathbf{F}_1 \left(x_t \right) + v_t \\
x_t &= \mathbf{F}_{2,s_t} \left(x_{t-1}, \varepsilon_t \right) \\
\mathbb{P} \left(s_t = 1 \right) &= \begin{cases} 1 - p_{00} \text{ if } s_t = 0 \\ p_{11} \text{ if } s_t = 1 \end{cases}
\end{aligned}
$$

- $\mathbf{F}_1$ and $\mathbf{F}_{2,s_t}$ are determined by the estimated parameters
- Use particle filter to extract estimates of latent states and filtered probabilities

Sources of the Liquidity Trap



Summary and Implications

- Japanese LT most likely due to expectations
- US LT most likely due to fundamental "demand" shock
- Implies that

1. US monetary policy successful in stabilizing expecations and Obama right to provide fiscal stimulus
2. Japan unsuccessful in stabilizing expectations and wrong to attempt fiscal stimuli

Discussion

1. **Inflation and Inference on Equilibria**
2. **Estimation**: Peso problems - an estimation problem?
3. **Usefulness for policy**: Limited?

Inference on Equilibria

The Inference on the sources of the liquidity traps rest on the inflation dynamics

- **In the expectations driven LT steady-state**: Deflation at the rate of the discount factor ($\pi = \beta < 1$)
- **In the sunspot limit**: $\pi < \beta$
- **In the fundamental LT**: $\pi \lesseqgtr 1$ depending on parameters
- **In the US**: Essentially no deflation - this implies $\mathbb{P}(s_t = 0) = 0$

Inference on Equilibria

Problems:

1. There may be near-observational equivalence between fundamental and non-fundamental equilibria in the absence of intervention.
    - The degree of similarity between the regimes depend on parameters some of which Frank and coauthors calibrate.
2. There may be inflation even in non-fundamental liquidity traps
    - Transitional dynamics - the argument about deflation relates to the sunspot limit, this may take a long time to occur. See Mertens and Ravn, ReStud, 2014.
    - More complicated sunspot processes (3 states) may imply inflation in non-fundamental equilibria.

Inference on Equilibria

Possibilities:

1. Interventions help identify: Higher g spur inflation (deflation) in the fundamental (expectational) liquidity trap: Problem is that interventions are endogenous. Regional variation in Japan is helpful though.
2. Duration of LT is informative.
    1. Non-fundamental LT's need to be sufficiently long in expected duration to exist. Consistent both with Japan and US.
    2. Fundamental LT's need to be short in expected duration to exist. Probability of long LT's goes to zero as duration increases since it requires a long sequence of surprise shocks.
3. Financial shocks also informative.

Estimation and Peso-type Problems

- **ZLB never binds during the sample that is used for estimation**
- **But non-fundamental equilibrium still affects observed equilibrium**: Inflation and activity in fundamental equilibrium depends on inflation and output in non-fundamental equilibrium none of which are observed in the estimation sample:

$$\Theta = \Theta\,(\text{state not observed in sample})$$

- Here this relates to p_{00} and p_{11} which are calibrated: Can only be estimated if estimation sample includes ZLB episodes
- In general, problem much worse because dynamics in non-fundamental equilibrium can impact on sample paths in very non-linear manner - intrinsic sunspots

Usefulness for policy

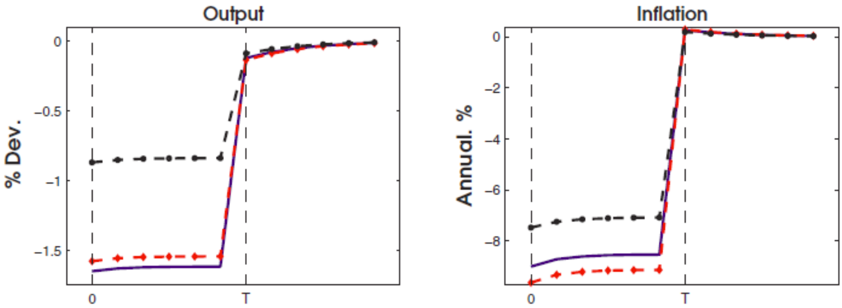
Two problems:

1. Near observational equivalence: In the absence of interventions, the paths of output and inflation may be near identical in the two equilibria - it is the intervention that helps identify.

2. When would policy maker have known?

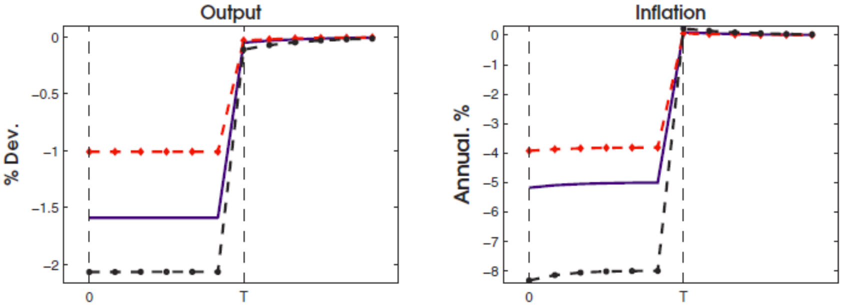
- At the beginning of the crisis, how would you have known if it was a fundamental or non-fundamental LT?
- Interventions much more powerful early on
- But "wrong treatment" would only have made things worse
- Perhaps need for experimentation?

Expectational LT



Blue = constant policy, red = government spending increase, black = tax cut

Fundamental LT



Blue = constant policy, red = government spending increase, black = tax cut

More Policy Implications:

1. **Make ZLB irrelevant**: Can be done with sufficiently rich set of fiscal instruments.
2. **Ruling out Non-Fundamental Equilibria**: Can be done with monetary or fiscal policies (Benhabib, Schmitt-Grohe and Uribe) but policies are sort of crazy (threaten with default, pure monetary targeting forever)
3. **Making Liquidity Trap Less Likely**:
    1. **Increase inflation target**: Larger fundamental shock required to take economy to ZLB. But makes non-fundamental liquidity trap more dramatic.
    2. **Respond more aggressively to inflation**: Stabilizes expectations
4. **Unconventional policies**?

Conclusions

It is a great paper!!!

Solving the model

Impose a minimum state variable assumption

$$
\begin{aligned}
u_t &= \mathbf{F}(S_t, \Theta) \\
S_t &= (R_{t-1}, y_{t-1}; g_t, z_t, \epsilon_{R\,t}) \\
(R_{t-1}, y_{t-1}, c_t) &= \mathbf{G}(S_t, \Theta)
\end{aligned}
$$

- solve for **F** and **G** given Θ using global solver specifying piece-wise smooth decision rules
- Judd, Maliar and Maliar, Mertens and Ravn

This paper

- Solves a small-scale DSGE model that can move between target inflation equilibrium and deflationary equilibrium
- Two reasons why it might be at the ZLB
  - successive exogenous shocks in first equilibrium
  - switch to second equilibrium
- Estimate structural parameters and draw inference
  - US: ZLB due to shocks, Fed was aggressive
  - Japan: ZLB due to switch to second equilibrium, Bank of Japan unable to coordinate expectations (too weak response to shocks)
- Fiscal multipliers small in Japan's ZLB but large in US

Steady-states

Model has “two” steady-states

- **A: Intended steady-state** where $R = r\pi_* > 1$ and inflation rate is on target $\pi = \pi_*$
- **B. Unintended liquidity trap steady-state** where $R = 1$ and $\pi = 1/r$

Solving the model

Impose a minimum state variable assumption

$$
\begin{aligned}
u_t &= \mathbf{F}\left(S_t, \Theta\right) \\
S_{t+1} &= \left(S_t, \Theta\right) \\
S_t &= \left(R_{t-1}, y_{t-1}; g_t, z_t, \epsilon_{R\,t}\right)
\end{aligned}
$$

- solve for **F** and **G** given Θ using global solver specifying piece-wise smooth decision rules
- Judd, Maliar and Maliar, Mertens and Ravn