Fiscal Policy in an Expectations Driven Liquidity Trap

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Introduction

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  This paper: Fiscal policy

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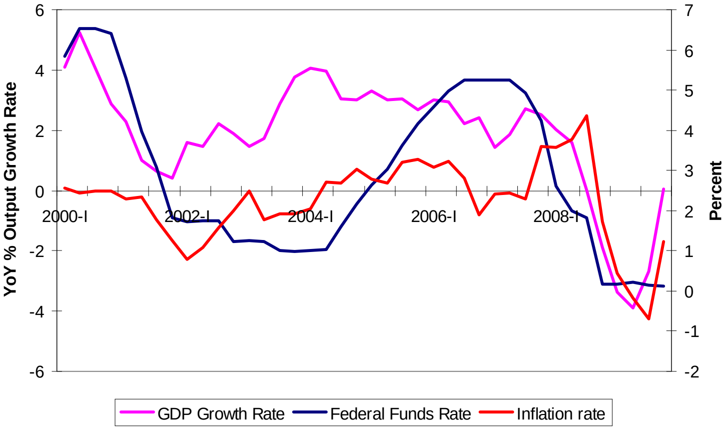

Should we expect fiscal multipliers to be large?

1. **Normal times** (positive short-term interest rates):
   - Multipliers most likely *moderate* and smaller than one (Hall, 2009, Woodford, 2010) due to crowding-out unless allowance for non-standard features (Ravn, Schmitt-Grohe and Uribe, 2006, 2008, Monacelli and Perotti, 2009)
2. **In a liquidity trap** (constant short term interest rates):
   - Multipliers may be *very large* (Eggertsson, 2009, Christiano, Eichenbaum and Rebelo, 2009, Woodford, 2010)
3. **Which instrument**?
   - *Demand management* rather than supply-side policies (Eggertsson, 2009, Woodford, 2010)

Table 1

	Labor Tax Multiplier	**Government Spending Multiplier**
Positive interest rate	0.19	0.3
Zero interest rate	-1.65	2.45

This paper

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2. **Global approach**: We do not rely on local approximations

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4. Higher inflation targets could be a really bad idea

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- **Agents**: Households, intermediate goods producers, final goods producers, a government

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- **Zero lower bound**: Equilibrium short-term interest rates must be non-negative in order to prevent an arbitrage.
- **Fiscal policy**: Government has choice of fiscal instruments (spending, labor income taxes, sales taxes). Must observe government budget constraint (Ricardian policies). We do look also at threats of being irresponsible.

The Model: Households

Preferences

$$V_0 = \mathbb{E}_0 \sum_{t=0}^{\infty} (\omega_t \beta)^t \, u(c_t, l_t, m_t)$$

Budget constraints

$$\begin{aligned}(1+\tau_{c,t}) P_t c_t + M_t + \frac{B_t}{1+i_t} &\leq (1-\tau_{n,t}) W_t (1-l_t) \\ &+ B_{t-1} + M_{t-1} + T_t + \Pi_t\end{aligned}$$

Bounded budget sets:

$$i_t \geq 0$$

Final Goods Producers

Technology

$$y_t = \left(\int_0^1 y_{it}^{1-1/\eta} di \right)^{1/(1-1/\eta)}$$

implying demand functions

$$y_{it} = \left(\frac{P_{it}}{P_t} \right)^{-\eta} y_t$$

P_t is the price of the final good defined as

$$P_t = \left(\int_0^1 P_{it}^{1-\eta} di \right)^{1/(1-\eta)}$$

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- **Profit maximization**

$$\max \mathbb{E}_t \sum_{s=t}^{\infty} \xi^{s-t} Q_{t,s} \left(P_{it}^* - (1-\tau_r) W_s\right) \left(\frac{P_{it}^*}{P_s}\right)^{-\eta} y_s$$

Monetary policy

$$1 + i_t = \phi\left(\frac{\pi_t}{\tilde{\pi}}\right)$$

- $\tilde{\pi} \geq 1$ is the inflation target
- $\phi(1) = \beta^{-1}\tilde{\pi}$, $\phi(\cdot) \geq 1$ for all π_t ,
- $\phi'(\cdot)$ is sufficiently large when $i_t > 0$

Fiscal policy

$$\frac{B_t}{1+i_t} = B_{t-1} - M_t + M_{t-1} + D_t$$

$$D_t = P_t g_t + T_t + \frac{1}{\eta} W_t n_t - \left(\tau_{c,t} P_t c_t + \tau_{n,t} W_t (1 - l_t)\right)$$

Fiscal policies are Ricardian

Price Dispersion

- In equilibrium, aggregation implies that:

$$y_t = \frac{1}{v_t} n_t = c_t + g_t$$

$$v_t = \int_0^1 \left(\frac{P_{it}}{P_t} \right)^{-\eta} di \geq 1$$

- v_t is a price dispersion term: An **inefficiency wedge** that arises due to sticky prices
- it follows a law of motion:

$$v_t = \xi \pi_t^{\eta} v_{t-1} + (1 - \xi) \, p_t^{*-\eta}$$

Equilibrium

- Putting all together, the equilibrium allocation and relevant prices are the solutions to the following set of stochastic difference equations:

$$
\begin{aligned}
1 &= \beta\phi\left(\frac{\pi_t}{\tilde{\pi}}\right)\mathbb{E}_t\left[\frac{\frac{\omega_{t+1}}{(1+\tau_{c,t+1})\pi_{t+1}}}{\frac{\omega_t}{(1+\tau_{c,t})}}\frac{U_c\left(y_{t+1}-g_{t+1},1-v_{t+1}y_{t+1}\right)}{U_c\left(y_t-g_t,1-v_t y_t\right)}\right] \\
p_t^*\pi_t &= \frac{\mathbb{E}_t\sum_{s=t}^{\infty}\left(\beta\xi\right)^{s-t}\omega_s\frac{U_l(y_s-g_s,1-v_s y_s)}{1-\tau_{n,s}}\left(\prod_{j=0}^{s-t}\pi_{t+j}\right)^{\eta}y_s}{\mathbb{E}_t\sum_{s=t}^{\infty}\left(\beta\xi\right)^{s-t}\omega_s\frac{U_c(y_s-g_s,1-v_s y_s)}{1+\tau_{c,s}}\left(\prod_{j=0}^{s-t}\pi_{t+j}\right)^{\eta-1}y_s} \\
v_t &= \xi\pi_t^{\eta}v_{t-1}+\left(1-\xi\right)p_t^{*-\eta} \\
1 &= \xi\pi_t^{\eta-1}+\left(1-\xi\right)p_t^{*1-\eta}
\end{aligned}
$$

- for a given initial condition v_{-1} and (Ricardian) fiscal policies and law of motion for the preference shock ω_t

Markovian Equilibria and Computation

- We focus on Markov equilibria that can be generated from

$$\begin{aligned} u_t &= f(s_t) \\ s_{t+1} &= h(s_t) + \varepsilon_t, \ s_0 \text{ given} \end{aligned}$$

  s_t vector of state variables, u_t inflation/output vector, random innovation ε_t

- Equilibrium allocations and prices are then computed by using a polynomial approximation and time iteration

Multiple Equilibria

- **Sargent and Wallace, 1975**: Interest rate rules can lead to multiple equilibria
- **Local indeterminacy and Taylor rules**: Local determinacy of the intended equilibrium usually obtained by imposing the Taylor principle on the policy rule
- **Global indeterminacy**: With a lower bound on the interest rate, Taylor type rules leads to global indeterminacy (Benhabib, Schmitt-Grohe and Uribe, 2001 AER & JET, 2002, JPE)
- The global indeterminacy opens the door for **sunspots** (Shell, 1977, Cass and Shell, 1983) and this will be our focus

Steady-States

- The steady-states are the fixed points of the system of equations above assuming $\omega_t = 1$ and all policy instruments time-invariant
- Assume that $\widetilde{\pi} = 1$ so that the inflation target is price stability and for simplicity set $\tau_c = \tau_l = g = 0$
- Constancy of consumption in the steady state requires that real interest rate equals $1/\beta$
- But this can hold when either
  - $\pi = \widetilde{\pi}$ and $i = \phi(1) - 1$
  - or $\pi = \beta$ and $i = 0$

The Intended and the Unintended Steady-States

The intended steady-state: Inflation is on target and output is efficient:

$$\begin{aligned}
\pi^I &= \widetilde{\pi}, \text{ and } \phi(1) = 1/\beta \\
y^I &= n^I = y^E \\
v^I &= 1 \\
U_l\left(y^E, 1 - y^E\right) &= U_c\left(y^E, 1 - y^E\right)
\end{aligned}$$

The unintended steady-state: Interest rate at lower bound and inefficiently low output:

$$\begin{aligned}
\pi^U &= \beta \text{ and } \phi(1/\beta) = 1 \\
y^U &< y^E \\
v^U &> 1 \text{ and } p^* < 1 \\
U_l\left(y^U, 1 - y^U v^U\right) &> U_c\left(y^U, 1 - y^U v^U\right)
\end{aligned}$$

- Price dispersion gives rise to inefficiently low output

Stochastic Sunspot Equilibria

- We look at **temporary liquidity traps** modelled as sunspot equilibria: Sunspot variable, ψ_t follows discrete Markov chain $\psi_t \in [\psi_1, ..., \psi_n]$ with transition matrix R.

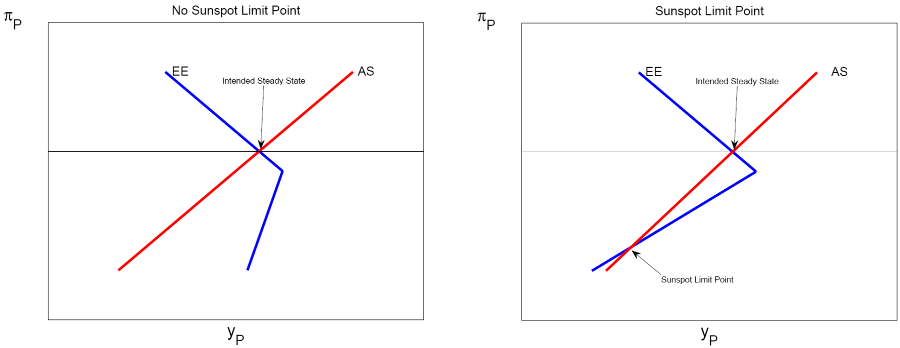
Definition

A Markov sunspot equilibrium is defined by a pair of functions $f(s_t)$ and $h(s_t)$ for which $f([v_{t-1}, \omega_t, \psi_t = \psi_i]) \neq f([v_{t-1}, \omega_t, \psi_t = \psi_j])$ and $h([v_{t-1}, \omega_t, \psi_t = \psi_i]) \neq h([v_{t-1}, \omega_t, \psi_t = \psi_j])$ for $i \neq j$, $i, j = 1, ..., n$.

Two state exaple:ψ_t follows a Markov process with transition matrix R

$$\psi_t \in [\psi_O, \psi_P] \quad , \quad R = \begin{bmatrix} 1 & 0 \\ 1-q & q \end{bmatrix} \quad , \quad 0 < q < 1$$

Existence of an Expectations Driven Liquidity Trap



- **In the left picture**: Kink is moderate because of too low persistence of low confidence state - only the intended steady-state prevails

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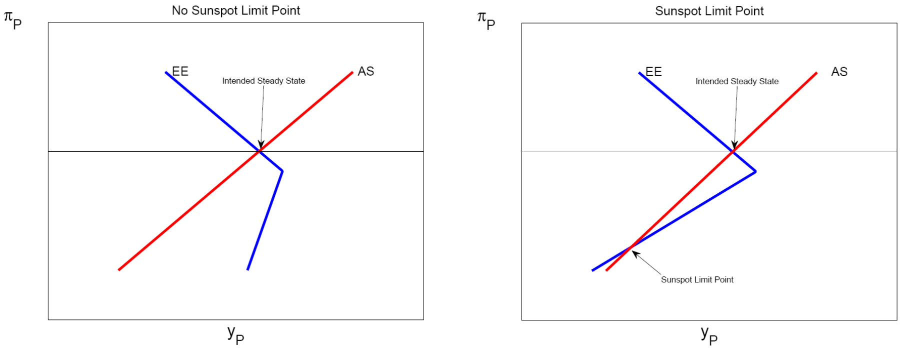
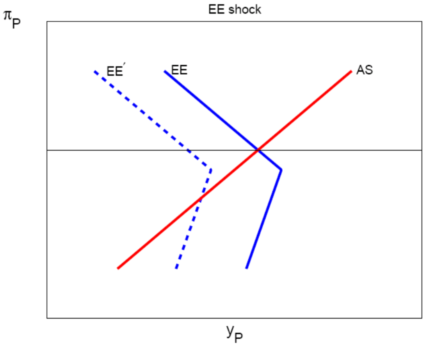
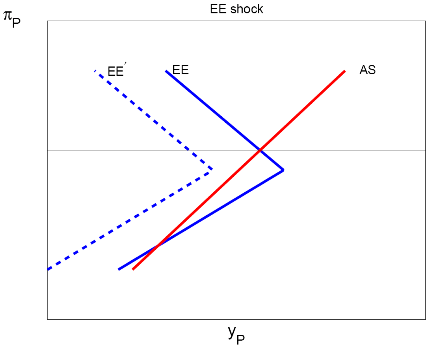


- **In the left picture**: Kink is moderate because of too low persistence of low confidence state - only the intended steady-state prevails
- **In the right picture**: More persistent low confidence state - we can end up in unintended equilibria

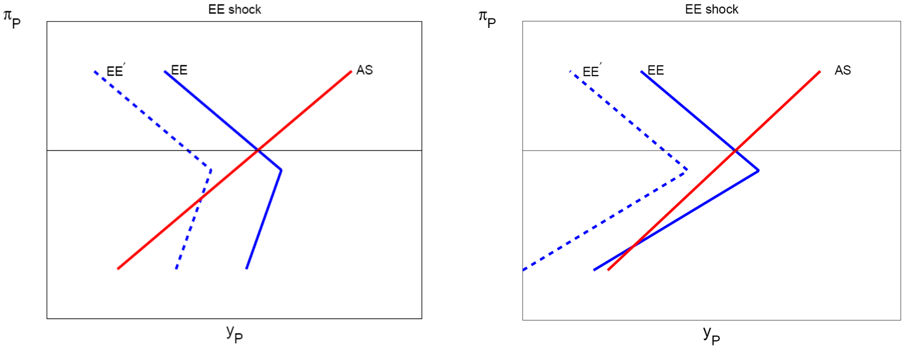
Existence of a "Fundamental" Liquidity Trap





- **In the left picture**: A not too persistent shock to the discount rate leads the economy into a liquidity trap

Existence of a "Fundamental" Liquidity Trap



- **In the left picture**: A not too persistent shock to the discount rate leads the economy into a liquidity trap
- **In the right picture**: No equilibrium when the shock is too persistent

Numerical Evaluation

- Functional forms:

$$U(c_t, l_t) = \frac{c_t^{1-\sigma} - 1}{1-\sigma} - \frac{\theta}{1+\kappa}(1-l_t)^{1+\kappa}, \ \sigma, \theta, \kappa > 0$$

$$\phi\left(\frac{\pi_t}{\tilde{\pi}}\right) = \max\left(\frac{\pi_t^{\phi_\pi}}{\beta}, 1\right), \ \phi_\pi > 1$$

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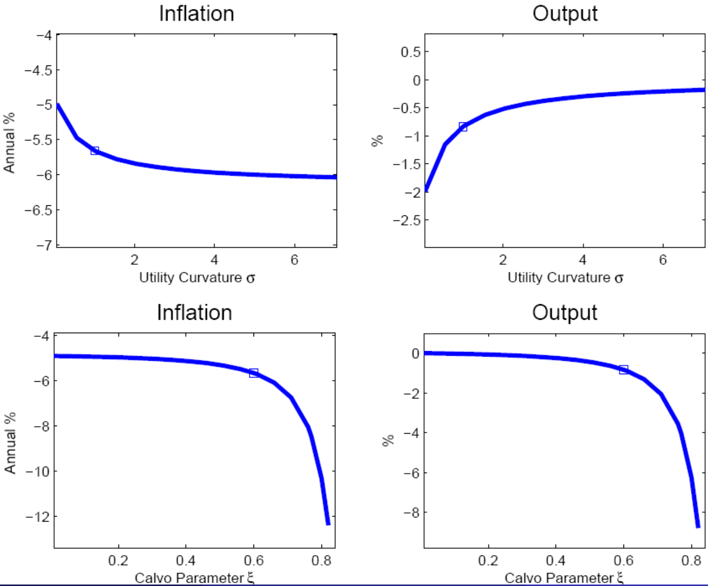
- Calibration

parameter	Mertens-Ravn	CER
β	0.99	0.99
Frisch Elasticity	2/3	1.4
σ	1	2
ξ	0.6	0.85
ϕ_π	1.5	1.5
q^ψ	0.8	-
q^ω	-	0.8

Liquidity Traps and Parameters



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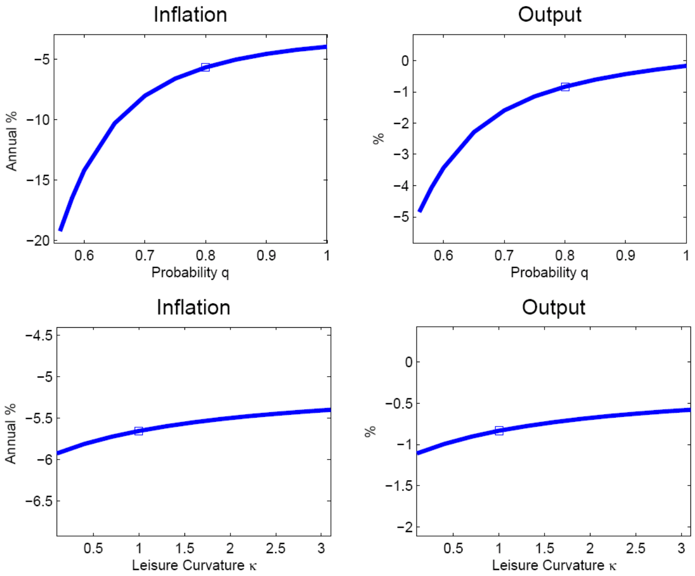
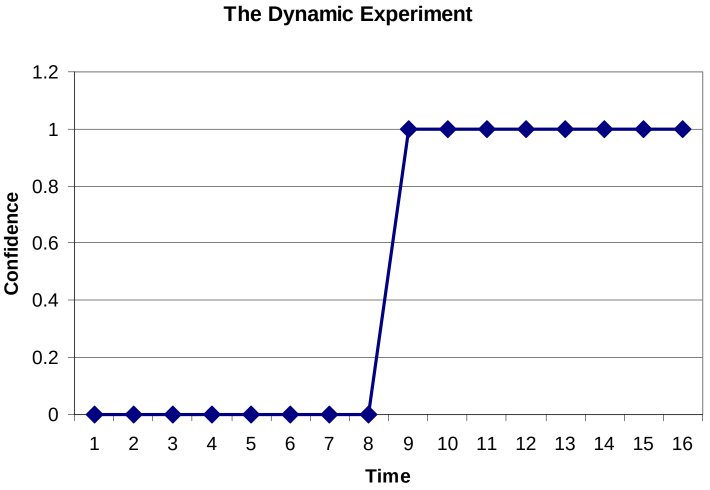


Dynamics of a Liquidity Trap

We assume that the economy starts in a low confidence state and then makes a permanent transition to the optimistic state in period T



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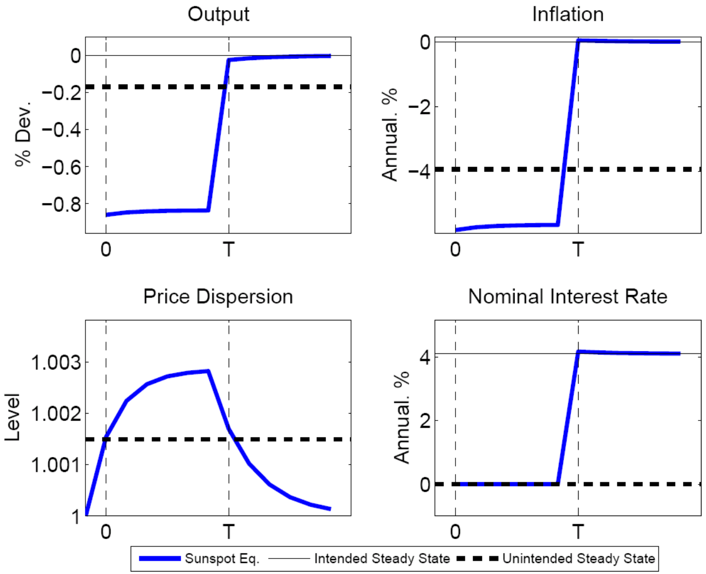
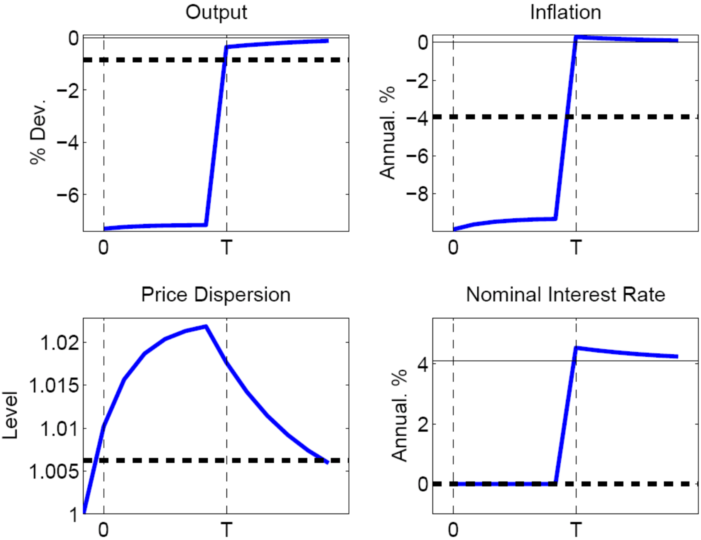


Dynamics of a Liquidity Trap:

$\xi = 0.8, \ \sigma = 0.7$



Policy

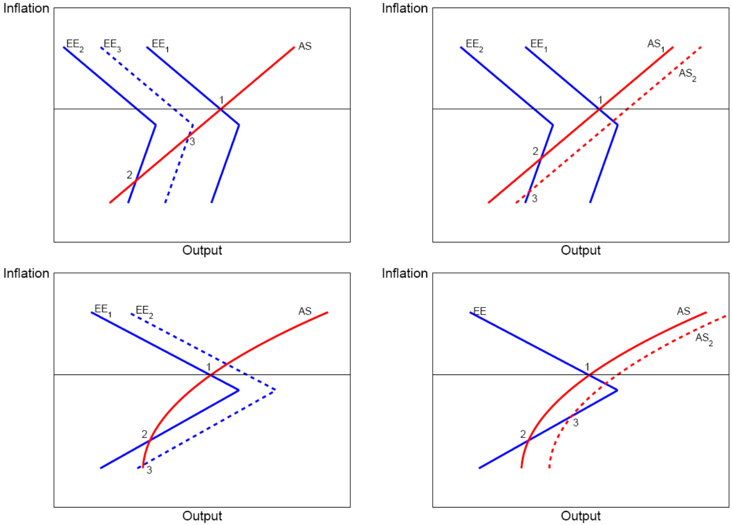
Ex-Ante: Prevention

- Benhabib, Schmitt-Grohe and Uribe: Promise to be fiscally irresponsible in case agents coordinate on deflationary expectations - agents realize that transversality condition does not hold so this cannot be an equilibrium
- Benhabib, Schmitt-Grohe and Uribe: Switch to money growth target if agents coordinate on deflationary expectations
- Atkeson, Chari and Kehoe (QJE, 2010): Sophisticated equilibrium - stochastic switches to money growth rule
- BUT: We ARE in a LT

Ex-Post: **What to do in case a LT occurs**

- Eggertsson and Woodford: Commit to a higher inflation target for an extended period (also after LT ends) - but serious credibility problems
- Eggertsson, 2009, Christiano, Eichenbaum and Rebelo, 2009, Woodford, 2010: Fiscal policy expansion

Graphically



Fiscal Policy Evaluation

Fiscal Instruments:

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- **Government Spending**: Marginal increase from 20% of GDP
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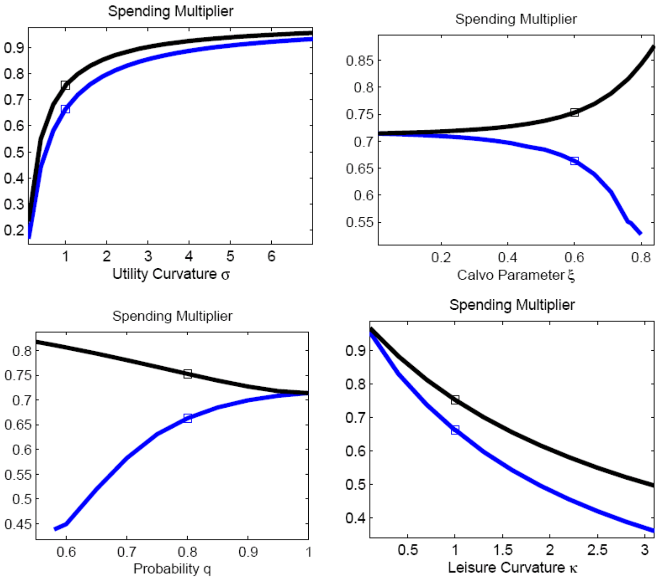
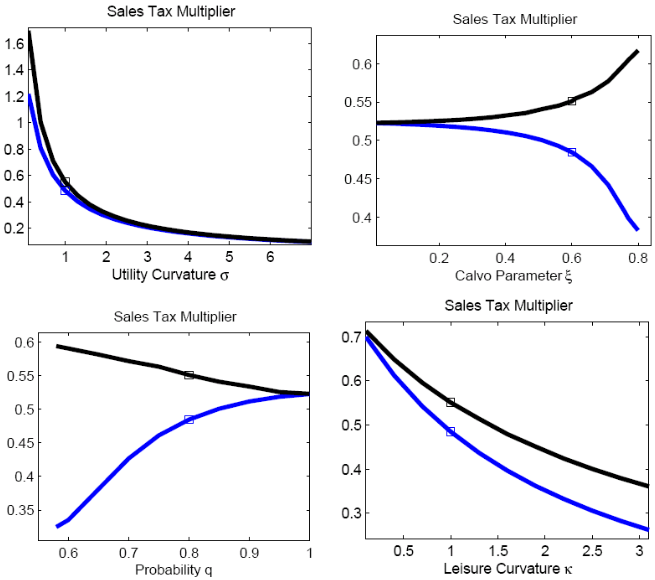
- **Labor Income Tax Rate**: Marginal decrease from 20%
- In all cases: Fiscal instrument perfectly coordinated with the sunspot

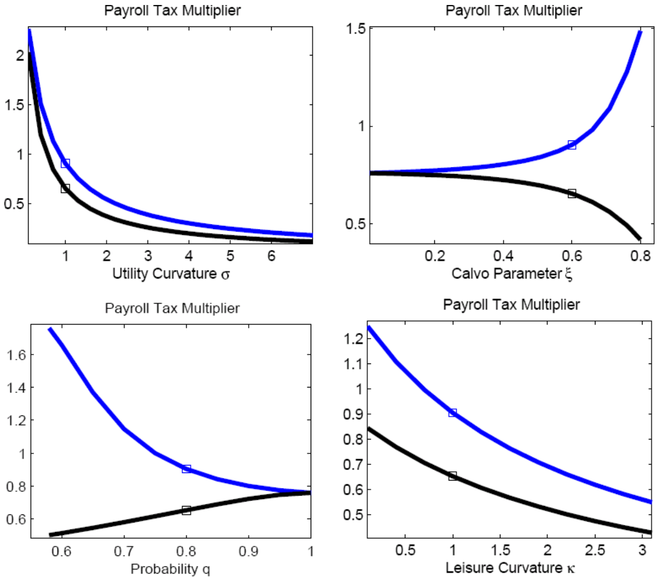
Spending Multipliers



Sales Tax Multipliers



Labor Income Tax Rate Multipliers



Ruling Out Liquidity Traps Ex Ante

Can fiscal policy be applied to eliminate expectations driven liquidity traps ex-ante?

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- The appropriate transversality condition is:

$$\begin{aligned} \lim_{s\to\infty} \mathbb{E}_t \left[a_{t+s} \frac{\pi_t}{1+i_t} \cdots \frac{\pi_{t+s}}{1+i_{t+s}} \right] &= 0 \\ a_t &= \left(B_t + M_t\right)/P_t \end{aligned}$$

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$$a_t = (B_t + M_t) / P_t$$

- Outcomes that violate this condition cannot be equilibria
- They propose fiscal rules of the type:

$$\tilde{d}_t = \varkappa(\pi_t)\, a_{t-1} \quad (1)$$
$$x(\beta) > 1/\beta \quad (2)$$
$$x(\tilde{\pi}) < 1/\beta \quad (3)$$

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In a sunspot, the equivalent rule for the LT will require that:

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  - Transversality condition violated for expectational LT
  - Transversality condition holds for fundamentals driven LT

Ruling Out Liquidity Traps Ex Ante

In a sunspot, the equivalent rule for the LT will require that:

$$\varkappa(\pi_L) > \frac{1}{q\pi_L} > 1/\beta$$

- Thus, the government must threaten to be potentially extremely irresponsible in a LT
- **Problem:**
- If LT can occur for both fundamental and expectational reasons, then the rule has to be such that:
  - Transversality condition violated for expectational LT
  - Transversality condition holds for fundamentals driven LT
- This might not always be possible

Conclusions

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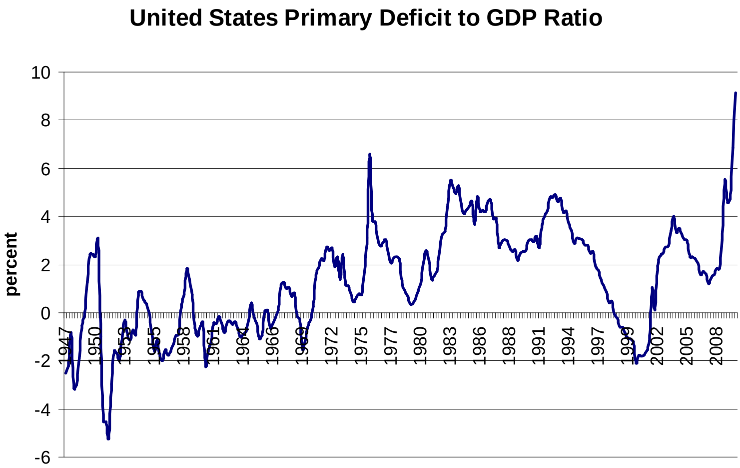
4. Multipliers quite similar in LT and in normal times for standard parameter values
5. Increases in inflation target to prevent expectations driven LT could be very counterproductive
6. Policy recommendations consistent with Bils and Klenow (2008), Hall and Woodward (2008) and Feldstein (2009) but differ from Christiano et al (2009) and Woodford (2010)

Introduction



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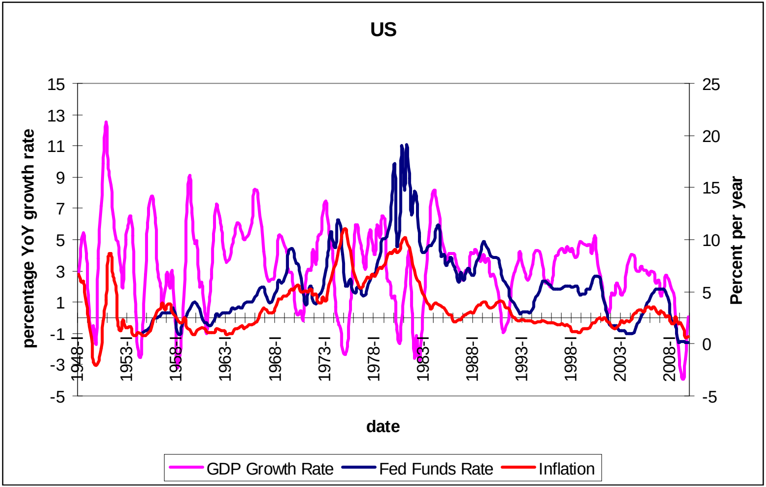

Fiscal Policies in a Liquidity Trap

Eggertsson, 2009, Christiano, Eichenbaum and Rebelo, 2009, Woodford, 2010:

- New Keynesian sticky price models
- Monetary policy described by an interest rate rule
- Large shock leads the economy to a liquidity trap where the short-term interest rate is at its lower floor
  - Christiano, Eichenbaum and Rebelo: Huge temporary positive productivity shock or a very large decrease in the rate of time discount
  - Woodford: Very large temporary increase in spread (Eggertsson: Equivalent to large decrease in the rate of time discount)

Table 1

	Labor Tax Multiplier	Government Spending Multiplier
Positive interest rate	0.19	0.3
Zero interest rate	-1.65	2.45

Households: Assumptions

We impose the following restrictions:

$$
\begin{aligned}
u(c_t, l_t, m_t) &= U(c_t, l_t) + V(m_t) \text{ (superneutrality)} \\
U_{c,l} &\geq 0 \text{ (complementarity)}
\end{aligned}
$$

- and to guarantee an interior solution for consumption and output:

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\lim_{c \to 0+} U_c &= \infty, \ \lim_{c \to \infty} U_c = 0 \\
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- and to have finite real money demand:

$$\lim_{m \to \infty} V_m < 0$$

- which can be replaced by allowance for a satiation point

Households: First-Order Conditions

The households' problem implies that:

$$
\begin{aligned}
\frac{U_l\left(c_t, l_t\right)}{U_c\left(c_t, l_t\right)} &= \frac{\left(1-\tau_{n,t}\right) W_t}{\left(1+\tau_{c,t}\right) P_t} \\
U_c\left(c_t, l_t\right) &= \beta(1+i_t)\mathbb{E}_t\left[\frac{\omega_{t+1}}{\omega_t}\frac{\left(1+\tau_{c,t}\right) P_t}{\left(1+\tau_{c,t+1}\right) P_{t+1}} U_c\left(c_{t+1}, l_{t+1}\right)\right] \\
\frac{V_m\left(m_t\right)}{U_c\left(c_t, l_t\right)} &= \frac{i_t}{1+i_t}\frac{1}{\left(1+\tau_{c,t}\right)} \\
0 &= \lim_{s\to\infty}\mathbb{E}_t\left[\frac{B_{t+s}+M_{t+s}}{(1+i_t)\cdots(1+i_{t+s})}\right]
\end{aligned}
$$

Equilibrium

Definition

A competitive rational expectations equilibrium is a sequence of allocations $(c_t, n_t, l_t, y_t)_{t=0}^{\infty}$, a price system $(\pi_t, w_t, p_t^*, v_t)_{t=0}^{\infty}$, monetary policies $(i_t, m_t)_{t=0}^{\infty}$, and fiscal policies $(b_t, d_t, g_t, \tau_{c,t}, \tau_{n,t}, t_t)_{t=0}^{\infty}$ such that

1. Households maximize utility subject to all constraints

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given initial conditions b_{-1}, $m_{-1} \geq 0$, $\upsilon_{-1} \geq 0$, a law of motion for ω_t and a specification of monetary and fiscal policies

Two State Sunspot Example

- Suppose ψ_t follows a Markov process with transition matrix R

$$\psi_t \in [\psi_O, \psi_P] \quad , \quad R = \begin{bmatrix} 1 & 0 \\ 1-q & q \end{bmatrix} \quad , \quad 0 < q < 1$$

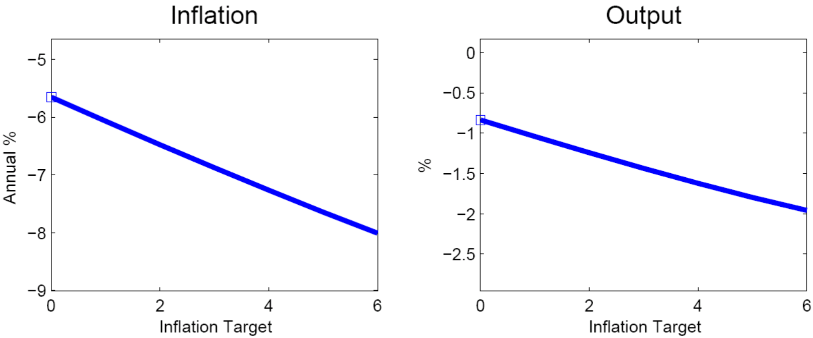
- Let π_P, y_P and v_P denote the fixed points of the system:

$$U_c(y_P, 1 - v_P y_P) = \beta\phi\left(\frac{\pi_P}{\tilde{\pi}}\right)[\frac{q}{\pi_P} U_c(y_P, 1 - v_P y_P) + \frac{1-q}{\pi'_O} U_c(y'_O, 1 - v'_O y'_O)] \quad \text{(EE)}$$

$$p^*_P = \frac{(1 - \beta\xi q \pi_P^{\eta-1})}{(1 - \beta\xi q \pi_P^{\eta})}(\Lambda_P \frac{U_l(y_P, 1 - v_P y_P)}{U_c(y_P, 1 - v_P y_P)} + (1 - \Lambda_P) p^{*\prime}_O \pi'_O) \quad \text{(SS)}$$

- where $0 < \Lambda_P < 1$ and π'_O, y'_O and v'_O are obtained from $f([v_P, \psi_O])$ and $h([v_P, \psi_O])$

Higher Inflation Target



- contrary to e.g. Blanchard's recommendations, higher inflation target makes a LT even worse