Fiscal Policy in an Expectations Driven Liquidity Trap

Karel Mertens\textsuperscript{1} and Morten O. Ravn\textsuperscript{2,3}
Cornell University\textsuperscript{1}, University College London\textsuperscript{2}, and the CEPR\textsuperscript{3}

May 2010
Some famous economist: “You see computers everywhere except in the productivity statistics”
Some famous economist: “You see computers everywhere except in the productivity statistics”

Giuseppe Bertola: “You see multiple equilibria everywhere .....”
Some famous economist: “You see computers everywhere except in the productivity statistics”

Giuseppe Bertola: “You see multiple equilibria everywhere ….”

“…………….. except at ESSIM”
Introduction

Much of the world economy has witnessed a sharp recession during 2008-2010:

- Relative large output losses and very low inflation
Much of the world economy has witnessed a sharp recession during 2008-2010:

- Relative large output losses and very low inflation
- Short term interest rates at or close to their lower floor - i.e. a \textit{liquidity trap}
Much of the world economy has witnessed a sharp recession during 2008-2010:

- Relative large output losses and very low inflation
- Short term interest rates at or close to their lower floor - i.e. a *liquidity trap*

**Policy responses** have included
Introduction

Much of the world economy has witnessed a sharp recession during 2008-2010:

- Relative large output losses and very low inflation
- Short term interest rates at or close to their lower floor - i.e. a *liquidity trap*

**Policy responses** have included

- Unorthodox monetary policy interventions
Much of the world economy has witnessed a sharp recession during 2008-2010:

- Relative large output losses and very low inflation
- Short term interest rates at or close to their lower floor - i.e. a *liquidity trap*

**Policy responses** have included

- Unorthodox monetary policy interventions
- Expansionary fiscal policies
Much of the world economy has witnessed a sharp recession during 2008-2010:

- Relative large output losses and very low inflation
- Short term interest rates at or close to their lower floor - i.e. a *liquidity trap*

**Policy responses** have included

- Unorthodox monetary policy interventions
- Expansionary fiscal policies
- Important to understand whether either of these have been / should be effective
Introduction

Much of the world economy has witnessed a sharp recession during 2008-2010:

- Relative large output losses and very low inflation
- Short term interest rates at or close to their lower floor - i.e. a liquidity trap

Policy responses have included

- Unorthodox monetary policy interventions
- Expansionary fiscal policies
- Important to understand whether either of these have been / should be effective

This paper: Fiscal policy
Should we expect fiscal multipliers to be large?

1. **Normal times** (positive short-term interest rates):

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>
<thead>
<tr>
<th></th>
<th>Labor Tax Multiplier</th>
<th>Government Spending Multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Positive interest rate</strong></td>
<td>0.19</td>
<td>0.3</td>
</tr>
<tr>
<td><strong>Zero interest rate</strong></td>
<td>-1.65</td>
<td>2.45</td>
</tr>
</tbody>
</table>
1. **The shock**: A temporary loss of confidence - *an expectations driven liquidity trap.*

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

**Main Findings**

1. Expectations driven liquidity trap associated with large drops in output and welfare
1. The shock: A temporary loss of confidence - an expectations driven liquidity trap.
2. Global approach: We do not rely on local approximations

Main Findings

1. Expectations driven liquidity trap associated with large drops in output and welfare
2. Demand management become less effective than in normal times
1. **The shock**: A temporary loss of confidence - *an expectations driven liquidity trap.*

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

### Main Findings

1. Expectations driven liquidity trap associated with large drops in output and welfare
2. Demand management become less effective than in normal times
3. Supply side policies become more effective
1. **The shock**: A temporary loss of confidence - *an expectations driven liquidity trap.*

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

**Main Findings**

1. Expectations driven liquidity trap associated with large drops in output and welfare

2. Demand management become less effective than in normal times

3. Supply side policies become more effective

4. Higher inflation targets could be a really bad idea
Agents: Households, intermediate goods producers, final goods producers, a government
The Model: Building Blocks

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

- **Intermediate goods producers**: Monopolistically competitive, staggered prices à la Calvo

Monetary policy: Described by an interest rate rule. We do not allow for non-standard policies neither ex-ante nor ex-post.

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

**Intermediate goods producers:** Monopolistically competitive, staggered prices a’ la Calvo

**Monetary policy:** Described by an interest rate rule. We do not allow for non-standard policies neither ex-ante nor ex-post.
The Model: Building Blocks

- **Agents**: Households, intermediate goods producers, final goods producers, a government
- **Intermediate goods producers**: Monopolistically competitive, staggered prices a’ la Calvo
- **Monetary policy**: Described by an interest rate rule. We do not allow for non-standard policies neither ex-ante nor ex-post.
- **Zero lower bound**: Equilibrium short-term interest rates must be non-negative in order to prevent an arbitrage.
The Model: Building Blocks

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

- **Intermediate goods producers**: Monopolistically competitive, staggered prices a’ la Calvo

- **Monetary policy**: Described by an interest rate rule. We do not allow for non-standard policies neither ex-ante nor ex-post.

- **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

\[
(1 + \tau_{c,t}) P_t c_t + M_t + \frac{B_t}{1 + i_t} \leq (1 - \tau_{n,t}) W_t (1 - l_t) \\
+ B_{t-1} + M_{t-1} + T_t + \Pi_t
\]

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

\[ P_t = \left( \int_0^1 P_{it}^{1-\eta} \, di \right)^{1/(1-\eta)} \]
Intermediate Goods Producers

Intermediate goods producers:

- Produce a differentiated good with labor sold at price $P_{it}$
Intermediate goods producers:

- Produce a differentiated good with labor sold at price $P_{it}$
- Each period they receive the opportunity to reoptimize prices with probability $(1 - \zeta) \in (0, 1]$. The arrival of this event is Poisson
Intermediate Goods Producers

Intermediate goods producers:

- Produce a differentiated good with labor sold at price $P_{it}$
- Each period they receive the opportunity to reoptimize prices with probability $(1 - \zeta) \in (0, 1]$. The arrival of this event is Poisson
- Government pays intermediate goods producers a labor cost subsidy
Intermediate goods producers:

- Produce a differentiated good with labor sold at price $P_{it}$
- Each period they receive the opportunity to reoptimize prices with probability $(1 - \xi) \in (0, 1]$. The arrival of this event is Poisson
- Government pays intermediate goods producers a labor cost subsidy
- Technology

$$y_{it} = n_{it}$$
Intermediate goods producers:

- Produce a differentiated good with labor sold at price $P_{it}$
- Each period they receive the opportunity to reoptimize prices with probability $(1 - \xi) \in (0, 1]$. The arrival of this event is Poisson
- Government pays intermediate goods producers a labor cost subsidy
- Technology

$$y_{it} = n_{it}$$

- Profit maximization

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

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 \( \pi_t \),
- \( \phi'(\cdot) \) is sufficiently large when \( i_t > 0 \)

Fiscal policy

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

\[ D_t = P_t g_t + T_t + \frac{1}{\eta} W_t n_t - (\tau_{c,t} P_t c_t + \tau_{n,t} W_t (1 - I_t)) \]

Fiscal policies are Ricardian
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:

\[ v_t = \bar{\zeta} \pi_t^\eta v_{t-1} + (1 - \bar{\zeta}) p_t^{*-\eta} \]
Putting all together, the equilibrium allocation and relevant prices are the solutions to the following set of stochastic difference equations:

\[ 1 = \beta \phi \left( \frac{\pi_t}{\bar{\pi}} \right) \mathbb{E}_t \left[ \frac{\omega_{t+1}}{(1+\tau_{c,t+1})\pi_{t+1}} \frac{U_c(y_{t+1} - g_{t+1}, 1 - v_{t+1}y_{t+1})}{U_c(y_t - g_t, 1 - v_ty_t)} \right] \]

\[ p^* \pi_t = \mathbb{E}_t \sum_{s=t}^{\infty} (\beta \xi)^{s-t} \omega_s \frac{U_l(y_s - g_s, 1 - v_s y_s)}{1 - \tau_{n,s}} \left( \prod_{j=0}^{s-t} \pi_{t+j} \right)^{\eta} y_s \]

\[ \mathbb{E}_t \sum_{s=t}^{\infty} (\beta \xi)^{s-t} \omega_s \frac{U_c(y_s - g_s, 1 - v_s y_s)}{1 + \tau_{c,s}} \left( \prod_{j=0}^{s-t} \pi_{t+j} \right)^{\eta-1} y_s \]

\[ v_t = \xi \pi^\eta_t v_{t-1} + (1 - \xi) p^*_{t-\eta} \]

\[ 1 = \xi \pi^\eta_t + (1 - \xi) p^*_{t-\eta} \]

for a given initial condition \( v_{-1} \) and (Ricardian) fiscal policies and law of motion for the preference shock \( \omega_t \)
We focus on Markov equilibria that can be generated from

\[ u_t = f(s_t) \]
\[ s_{t+1} = h(s_t) + \varepsilon_t, \quad s_0 \text{ given} \]

- $s_t$ vector of state variables, $u_t$ inflation/output vector, random innovation $\varepsilon_t$

- 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.


- The global indeterminacy opens the door for sunspots (Shell, 1977, Cass and Shell, 1983) and this will be our focus.
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 \( \pi = 1 \) 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

- \( \pi = \pi \) 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:

\[ \pi^I = \tilde{\pi}, \text{ and } \phi(1) = 1/\beta \]
\[ y^I = n^I = y^E \]
\[ \nu^I = 1 \]
\[ U_l \left( y^E, 1 - y^E \right) = U_c \left( y^E, 1 - y^E \right) \]

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

\[ \pi^U = \beta \text{ and } \phi(1/\beta) = 1 \]
\[ y^U < y^E \]
\[ \nu^U > 1 \text{ and } p^* < 1 \]
\[ U_l \left( y^U, 1 - y^U \nu^U \right) > U_c \left( y^U, 1 - y^U \nu^U \right) \]

- Price dispersion gives rise to inefficiently low output
We look at temporary liquidity traps modelled as sunspot equilibria: Sunspot variable, $\psi_t$ 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 $f([\nu_{t-1}, \omega_t, \psi_t = \psi_i]) \neq f([\nu_{t-1}, \omega_t, \psi_t = \psi_j])$ and $h([\nu_{t-1}, \omega_t, \psi_t = \psi_i]) \neq h([\nu_{t-1}, \omega_t, \psi_t = \psi_j])$ for $i \neq j, i, j = 1, ..., n$.

**Two state example:** $\psi_t$ follows a Markov process with transition matrix $R$

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

- In the right picture: More persistent low confidence state - we can end up in unintended equilibria.
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:

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

\[
\phi\left(\frac{\pi_t}{\tilde{\pi}}\right) = \max\left(\frac{\pi_t^{\phi_t}}{\beta}, 1\right), \quad \phi_t > 1
\]
Functional forms:

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

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

Calibration
Numerical Evaluation

- **Functional forms:**

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

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

- **Calibration**

<table>
<thead>
<tr>
<th>parameter</th>
<th>Mertens-Ravn</th>
<th>CER</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \beta )</td>
<td>0.99</td>
<td>0.99</td>
</tr>
<tr>
<td>Frisch Elasticity</td>
<td>2/3</td>
<td>1.4</td>
</tr>
<tr>
<td>( \sigma )</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>( \zeta )</td>
<td>0.6</td>
<td>0.85</td>
</tr>
<tr>
<td>( \phi_{\pi} )</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>( q^{\psi} )</td>
<td>0.8</td>
<td>-</td>
</tr>
<tr>
<td>( q^{\omega} )</td>
<td>-</td>
<td>0.8</td>
</tr>
</tbody>
</table>
Liquidity Traps and Parameters

Inflation

Output

Inflation

Output

Leisure Curvature $\kappa$

Leisure Curvature $\kappa$
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 $T$.
Dynamics of a Liquidity Trap:

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

![Graphs showing output, inflation, price dispersion, and nominal interest rate dynamics in the context of a liquidity trap.](image-url)
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
Graphically
Fiscal Policy Evaluation

Fiscal Instruments:

- **Government Spending**: Marginal increase from 20% of GDP
Fiscal Instruments:

- **Government Spending**: Marginal increase from 20% of GDP
- **Consumption Tax**: Marginal decrease from 10%
Fiscal Policy Evaluation

Fiscal Instruments:

- **Government Spending**: Marginal increase from 20% of GDP
- **Consumption Tax**: Marginal decrease from 10%
- **Labor Income Tax Rate**: Marginal decrease from 20%
Fiscal Policy Evaluation

Fiscal Instruments:

- **Government Spending**: Marginal increase from 20% of GDP
- **Consumption Tax**: Marginal decrease from 10%
- **Labor Income Tax Rate**: Marginal decrease from 20%
- In all cases: Fiscal instrument perfectly coordinated with the sunspot
Sales Tax Multipliers
Can fiscal policy be applied to eliminate expectations driven liquidity traps ex-ante?

- **Benhabib, Schmitt-Grohe and Uribe** (2002, JPE): Commit to being irresponsible if agents coordinate on pessimism

\[
\lim_{s \to \infty} E_t \left( \pi_{t+1} + i_{t+1} + \pi_{t+2} + i_{t+2} + \ldots \right) = 0
\]

Outcomes that violate this condition cannot be equilibria.
Ruling Out Liquidity Traps Ex Ante

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

- **Benhabib, Schmitt-Grohe and Uribe** (2002, JPE): Commit to being irresponsible if agents coordinate on pessimism.
- The appropriate transversality condition is:

\[
\lim_{s \to \infty} \mathbb{E}_t \left[ a_{t+s} \frac{\pi_t}{1 + i_t} \ldots \frac{\pi_{t+s}}{1 + i_{t+s}} \right] = 0
\]

\[
a_t = \frac{(B_t + M_t)}{P_t}
\]
Ruling Out Liquidity Traps Ex Ante

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

- **Benhabib, Schmitt-Grohe and Uribe** (2002, JPE): Commit to being irresponsible if agents coordinate on pessimism

The appropriate transversality condition is:

\[
\lim_{s \to \infty} E_t \left[ a_{t+s} \frac{\pi_t}{1 + i_t} \cdots \frac{\pi_{t+s}}{1 + i_{t+s}} \right] = 0
\]

\[
a_t = \frac{(B_t + M_t)}{P_t}
\]

Outcomes that violate this condition cannot be equilibria
Can fiscal policy be applied to eliminate expectations driven liquidity traps ex-ante?

- **Benhabib, Schmitt-Grohe and Uribe** (2002, JPE): Commit to being irresponsible if agents coordinate on pessimism
- The appropriate transversality condition is:

\[
\lim_{s \to \infty} E_t \left[ a_{t+s} \frac{\pi_t}{1+i_t} \ldots \frac{\pi_{t+s}}{1+i_{t+s}} \right] = 0
\]

\[
a_t = \frac{(B_t + M_t)}{P_t}
\]

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

\[
\tilde{d}_t = \pi(\pi_t) a_{t-1}
\]

\[
x(\beta) > 1/\beta
\]

\[
x(\tilde{\pi}) < 1/\beta
\]
In a sunspot, the equivalent rule for the LT will require that:

\[ \pi(\pi_L) > \frac{1}{q\pi_L} > 1/\beta \]

Thus, the government must threaten to be potentially extremely irresponsible in a LT.
Ruling Out Liquidity Traps Ex Ante

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

\[ \pi (\pi_L) > \frac{1}{q\pi_L} > \frac{1}{\beta} \]

Thus, the government must threaten to be potentially extremely irresponsible in a LT

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

\[ \pi'(\pi_L) > \frac{1}{q\pi_L} > 1/\beta \]

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

\[ \pi_L > \frac{1}{q \pi_L} > 1/\beta \]

- 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
Ruling Out Liquidity Traps Ex Ante

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

\[ \pi_L \left( \frac{1}{q\pi_L} > \frac{1}{1/\beta} \right) \]

- 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
Ruling Out Liquidity Traps Ex Ante

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

\[ \kappa(\pi_L) > \frac{1}{\eta \pi_L} > \frac{1}{\beta} \]

- 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

1. An expectations driven LT can be associated with large output and welfare losses

In contrast to fundamentals driven LT, increases in government spending lose potency in an expectations driven LT. Supply side policies are effective when expectations drive the economy into a LT (consistent with Akerlof and Shiller but for different reasons). Multipliers are quite similar in LT and in normal times for standard parameter values. Increases in inflation target to prevent expectations driven LT could be very counterproductive.

Conclusions

1. An expectations driven LT can be associated with large output and welfare losses.

2. In contrast to fundamentals driven LT, increases in government spending lose potency in an expectations driven LT.
Conclusions

1. An expectations driven LT can be associated with large output and welfare losses.
2. In contrast to fundamentals driven LT, increases in government spending lose potency in an expectations driven LT.
3. Supply side policies effective when expectations drive the economy into a LT (consistent with Akerlof and Shiller but for different reasons).

Increases in inflation target to prevent expectations driven LT could be very counterproductive.

Conclusions

1. An expectations driven LT can be associated with large output and welfare losses.
2. In contrast to fundamentals driven LT, increases in government spending lose potency in an expectations driven LT.
3. Supply side policies effective when expectations drive the economy into a LT (consistent with Akerlof and Shiller but for different reasons).
4. Multipliers quite similar in LT and in normal times for standard parameter values.
Conclusions

1. An expectations driven LT can be associated with large output and welfare losses.

2. In contrast to fundamentals driven LT, increases in government spending lose potency in an expectations driven LT.

3. Supply side policies effective when expectations drive the economy into a LT (consistent with Akerlof and Shiller but for different reasons).

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.
Conclusions

1. An expectations driven LT can be associated with large output and welfare losses
2. In contrast to fundamentals driven LT, increases in government spending lose potency in an expectations driven LT
3. Supply side policies effective when expectations drive the economy into a LT (consistent with Akerlof and Shiller but for different reasons)
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
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>
<thead>
<tr>
<th></th>
<th>Labor Tax Multiplier</th>
<th>Government Spending Multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive interest rate</td>
<td>0.19</td>
<td>0.3</td>
</tr>
<tr>
<td>Zero interest rate</td>
<td>-1.65</td>
<td>2.45</td>
</tr>
</tbody>
</table>
We impose the following restrictions:

\[ u(c_t, l_t, m_t) = U(c_t, l_t) + V(m_t) \] (superneutrality)
\[ U_{c,l} \geq 0 \] (complementarity)

and to guarantee an interior solution for consumption and output:

\[ \lim_{c \to 0^+} U_c = \infty, \quad \lim_{c \to \infty} U_c = 0 \]
\[ \lim_{l \to 0^+} U_l = \infty, \quad \lim_{l \to \infty} U_l = \infty \]
Households: Assumptions

We impose the following restrictions:

\[ u(c_t, l_t, m_t) = U(c_t, l_t) + V(m_t) \] (superneutrality)

\[ U_{c,l} \geq 0 \] (complementarity)

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

\[ \lim_{c \to 0^+} U_c = \infty, \quad \lim_{c \to \infty} U_c = 0 \]

\[ \lim_{l \to 0^+} U_l = \infty, \quad \lim_{l \to \infty} U_l = \infty \]

- and to have finite real money demand:

\[ \lim_{m \to \infty} V_m < 0 \]
Households: Assumptions

We impose the following restrictions:

\[ u(c_t, l_t, m_t) = U(c_t, l_t) + V(m_t) \] (superneutrality)

\[ U_{c,l} \geq 0 \] (complementarity)

- and to guarantee an interior solution for consumption and output:
  \[
  \lim_{c \to 0^+} U_c = \infty, \quad \lim_{c \to \infty} U_c = 0
  \]
  \[
  \lim_{l \to 0^+} U_l = \infty, \quad \lim_{l \to \infty} U_l = \infty
  \]

- and to have finite real money demand:
  \[
  \lim_{m \to \infty} V_m < 0
  \]

- which can be replaced by allowance for a satiation point
The households’ problem implies that:

\[
\frac{U_l(c_t, l_t)}{U_c(c_t, l_t)} = \frac{(1 - \tau_{n,t}) W_t}{(1 + \tau_{c,t}) P_t}
\]

\[
U_c(c_t, l_t) = \beta (1 + i_t) \mathbb{E}_t \left[ \frac{\omega_{t+1}}{\omega_t} \frac{(1 + \tau_{c,t}) P_t}{(1 + \tau_{c,t+1}) P_{t+1}} U_c(c_{t+1}, l_{t+1}) \right]
\]

\[
\frac{V_m(m_t)}{U_c(c_t, l_t)} = \frac{i_t}{1 + i_t} \frac{1}{(1 + \tau_{c,t})}
\]

\[
0 = \lim_{s \to \infty} \mathbb{E}_t \left[ \frac{B_{t+s} + M_{t+s}}{(1 + i_t) \cdots (1 + i_{t+s})} \right]
\]
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
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.
2. Intermediate and final goods producers maximize profits.
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 $(\pi_t, w_t, p_t^*, \nu_t)_{t=0}^\infty$, 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
2. Intermediate and final goods producers maximize profits
3. Monetary policy is determined by the interest rate rule and fiscal policies are consistent with the government budget constraint
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
2. Intermediate and final goods producers maximize profits
3. Monetary policy is determined by the interest rate rule and fiscal policies are consistent with the government budget constraint
4. Goods and asset markets clear
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
2. Intermediate and final goods producers maximize profits
3. Monetary policy is determined by the interest rate rule and fiscal policies are consistent with the government budget constraint
4. Goods and asset markets clear

given initial conditions \(b_{-1}, \ m_{-1} \geq 0, \ v_{-1} \geq 0\), a law of motion for \(\omega_t\) and a specification of monetary and fiscal policies.
Two State Sunspot Example

- Suppose $\psi_t$ follows a Markov process with transition matrix $R$

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

- Let $\pi_P, y_P$ and $\nu_P$ denote the fixed points of the system:

  $$U_c(y_P, 1 - \nu_P y_P) = \beta \phi \left( \frac{\pi_P}{\bar{\pi}} \right) \left[ \frac{q}{\pi_P} U_c(y_P, 1 - \nu_P y_P) \right.\left. + \frac{1 - q}{\pi'_O} U_c(y'_O, 1 - \nu'_O y'_O) \right]$$

  (EE)

  $$p^*_P = \frac{(1 - \beta \xi q \pi_P^{\eta - 1})}{(1 - \beta \xi q \pi_P^\eta)} \left( \Lambda_P \frac{U_l(y_P, 1 - \nu_P y_P)}{U_c(y_P, 1 - \nu_P y_P)} \right.\left. + (1 - \Lambda_P) p^*_O \pi'_O \right)$$

  (SS)

- where $0 < \Lambda_P < 1$ and $\pi'_O, y'_O$ and $\nu'_O$ are obtained from $f([\nu_P, \psi_O])$ and $h([\nu_P, \psi_O])$
contrary to e.g. Blanchard’s recommendations, higher inflation target makes a LT even worse