Liquidity Traps in a World Economy

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Liquidity traps in a world economy

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A B S T R A C T

This paper studies a New Keynesian model of a two-country world with a zero lower bound (ZLB) constraint for nominal interest rates. A floating exchange rate regime is assumed. The presence of the ZLB generates multiple equilibria. The two countries can experience recurrent liquidity traps induced by the self-fulfilling expectation that future inflation will be low. These "expectations-driven" liquidity traps can be synchronized or unsynchronized across countries. In an expectations-driven liquidity trap, the domestic and international transmission of persistent shocks to productivity and government purchases differs markedly from shock transmission in a "fundamentals-driven" liquidity trap.

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Euro Area Core inflation % p.a. (YoY)

Source: Eurostat (From Croitorov, Ratto, Pfeiffer, Roeger, 2020)

ECB deposit facility rate (% p.a.)

● Understanding "low rates" environment: key challenge for economic analysis

●This paper: analyzes low-rates environment in two-country sticky-prices model (NK) with ZLB, FLOATING EXCHANGE RATE

● Compare two leading LT theories

"fundamentals-driven" liquidity traps caused by adverse aggregate demand shocks (Krugman (1998); Eggertsson & Woodford (2003), Holden (2016))

vs.

"beliefs-driven" liquidity traps due to self-fulfilling deflationary expectations (Benhabib, Schmitt-Grohé & Uribe (2001))

- **RESULT:** Cause of liquidity trap matters for dynamics of world economy

- **RESULT:** Model with expectations-driven liquidity trap is better suited for generating PERSISTENT liquidity traps than theory of fundamental liquidity traps

- RESULT: cross-country correlation of BELIEFS-DRIVEN liquidity traps is indeterminate

Intuition: floating exchange rate regime insulates Home inflation from changes in Foreign inflation.

By contrast, cross-country correlation of fundamental liquidity traps equals correlation of shocks triggering those traps

- **RESULT: The cause of the liquidity trap matters for domestic and <u>international</u> transmission of business cycle shocks (persistent)**

<u>Beliefs-driven LT: shock transmission to Domestic & Foreign GDP and RER switches sign, compared to fundamental liquidity trap</u>

<u>Sensitivity of Domestic GDP response to cause of trap is known from literature; this paper highlights sensitivity of RER & Foreign transmission to cause of LT</u>

• **Fundamental liquidity trap:**

Inflation responds more strongly to aggregate supply & demand shocks than when ZLB is slack

► positive TFP shock at ZLB: sharper fall in inflation

⇒ *consumption & GDP can fall* (topsy-turvy world)

► positive Government purchases shock at ZLB: stronger rise in inflation ⇒ larger fiscal multipliers

E.g. Eggertsson (2011), Erceg & Lindé (2011), Eggertsson, Ferrero & Raffo (2014)

This paper highlights further topsy-turvy features of "fundamental" liquidity traps, in open economies

► TFP ↑ ⇒ RER appreciation, Foreign GDP ↑

► G ↑ ⇒ RER depreciation, Foreign GDP ↓

• <u>“Beliefs-driven” liquidity trap:</u>

■’NORMAL’ RESPONSES OF <u>REAL</u> VARIABLES:

TFP $\uparrow \Rightarrow$ Y $\uparrow$ C $\uparrow$ RER depreciation $Y^* \downarrow$

G $\uparrow \Rightarrow$ Y $\uparrow$ C $\downarrow$ RER appreciation $Y^* \uparrow$

►SIMILARITY BETWEEN RESPONSES OF REAL VARIABLES AT ZLB AND AWAY FROM ZLB

● In Fundamental liquidity trap a rise in Government purchases has a ‘beggar-thy-neighbor’ effect

● In Beliefs-driven liquidity trap, a rise in Home government purchases raises Foreign output

SUMMARY OF DOMESTIC & INTERNATIONAL SHOCK TRANSMISSION

(LT: liquidity trap)

“Fundamental LT” $\neq$ “Beliefs-driven LT” $\approx$ Away from ZLB

BELIEFS-DRIVEN LIQUIDITY TRAPS:

■ **Benhabib et al. (2001): ZLB + active Taylor rule: induces multiple equilibria.**
Liquidity trap can be due to self-fulfilling pessimism about future inflation if monetary policy follows ‘active’ Taylor rule

$$E_t\{\beta u'(C_{t+1})/u'(C_t))(1+i_{t+1})/\Pi_{t+1}=1$$

Under risk neutrality, certainty equivalent approximation:
$E_t\Pi_{t+1}=\beta\cdot(1+i_{t+1})$ **[Fisher equation]**

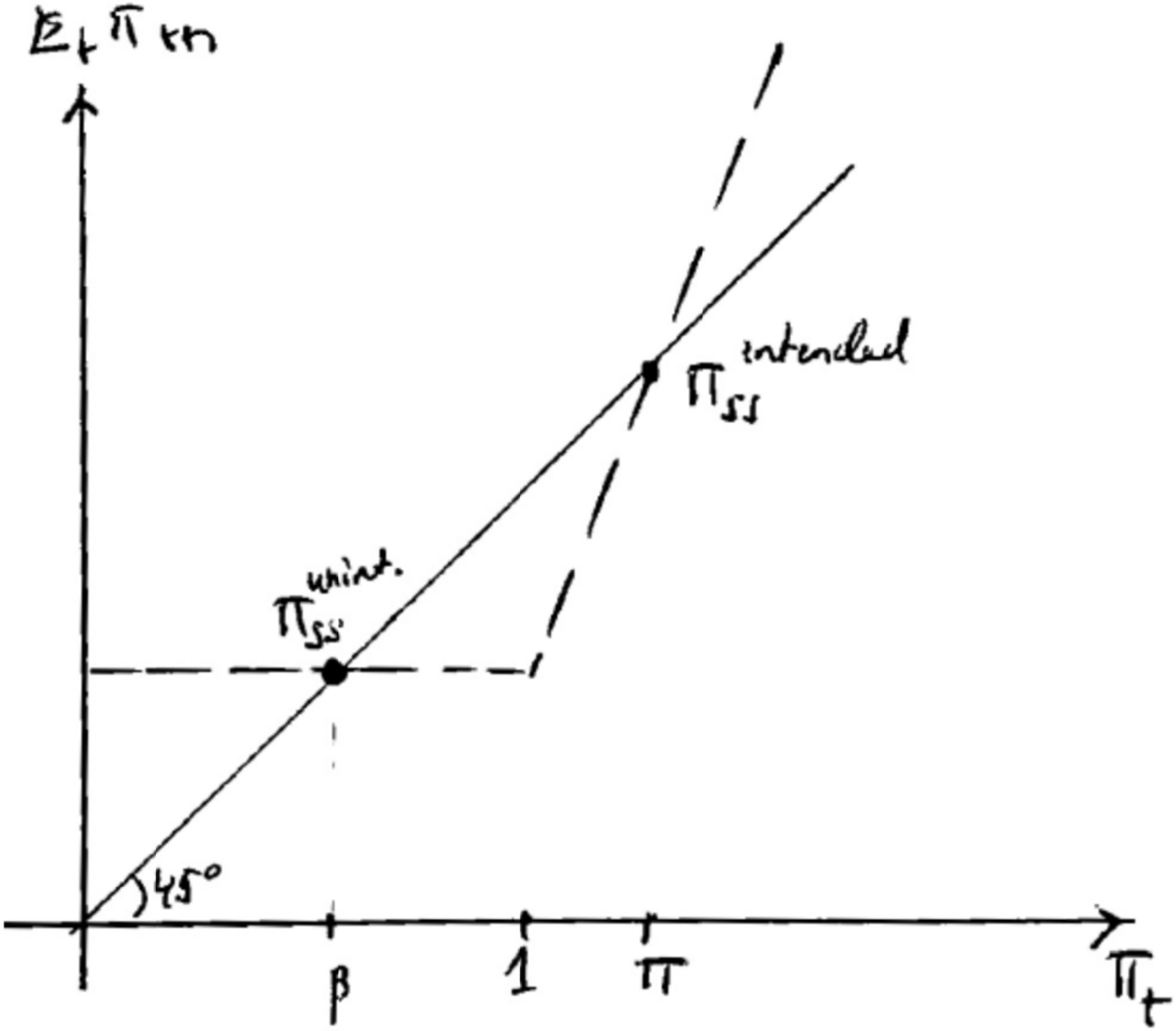
Taylor rule, with ZLB: $1+i_{t+1}=Max[1,\Pi/\beta+(\gamma_\pi/\beta)(\Pi_t-\Pi)]$

$\Pi>1$: **Central Bank (gross) inflation target**

$\gamma_\pi>1$ **(Taylor rule)**

$$E_t\Pi_{t+1}=Max[\beta,\Pi+\gamma_\pi(\Pi_t-\Pi)]$$

Two steady states: $\Pi_{SS}^{\text{intended}}=\Pi>1$ **and** $\Pi_{SS}^{\text{unintended}}=\beta<1$



$$E_t\Pi_{t+1} = Max[\beta, \Pi + \gamma_\pi(\Pi_t - \Pi)]$$

- **There exist sunspot equilibria in which inflation rate randomly switches between values in neighborhood of the ‘intended’ and ‘unintended’ steady states**

- **With random supply and demand (TFP,G) shocks: economy can fluctuate in the neighborhoods of the ‘intended’ and ‘unintended’ steady states**

● **This paper applies Benhabib et al. logic to two-country model**

● **Focus on equilibria with expectations-driven LTs in which inflation, output etc. depend on the ZLB regime and on current fundamental shocks:**
<u>Minimum State Variable (MSV) solutions</u>

● Large applied (policy) literature focuses on "fundamental" liquidity traps.

Can be analyzed with easy-to-use computer code (Guerrieri & Iacoviello (2015), Holden (2016))

Influential work that informs key policy debates

Andrade, Galí, Le Bihan & Matheron (2020)
Coenen, Montes-Galdon & Schmidt (2020)
Erceg, Jakab & Lindé (2020)

Thus: important to assess robustness of this class of models to source of liquidity trap & other model assumptions

● Few papers have considered business cycle models with "expectations-driven" liquidity traps: <u>closed economy models</u>

Mertens & Ravn (2014): compare beliefs-driven vs. fundamental liquidity trap. Focus on comparison of Gov't purchases vs. tax changes; special shock structure

Arifovic, Schmitt-Grohé & Uribe (2018) and **Aruoba, Cuba-Borda & Schorfheide (2018):** beliefs-driven liquidity traps, no comparison vs. fundamental traps

Value added of present paper:

● Expectations-driven LTs in OPEN economies

● Open econ macro literature with liquidity traps focuses entirely on "fundamental" liquidity traps driven by exogenous negative demand shock (e.g. rise in subjective discount factor)

E.g.: Jeanne (2009), Erceg & Lindé (2010), Cook Devereux (2013), Fujiwara & Ueda (2013), Gomez et al. (2015), Farhi & Werning (2016), Blanchard, Erceg & Lindé (2016), Acharya & Bengui (2018), Badarau & Sangaré (2019) [+ many others]

Beliefs-driven LT:

Inflation is function of the natural real interest rate (rules depending on the ZLB state) [MSV solution]

PERSISTENT TFP, G shocks have little effect on natural real rate $\Rightarrow$ little effect on inflation

$\Rightarrow$ output response resembles response away from ZLB (under inflation targeting)!

Why the difference Fundam. LT vs Expect-driven LT ?

- **Fundamental LT**: triggered by big one-time negative demand shock that induces negative value of unconstrained nominal interest rate (need big shock for long LiqTrap)
- Once shock has subsided, the liquidity trap ends, and agents believe that the economy will NEVER enter liquidity trap again
- Small shocks to baseline trajectory have big effects
- Inflation during liquidity trap determined using backward iteration, from trap exit date
- The backward iteration is explosive
- Small shocks around that baseline trajectory have big effects: e.g., TFP shock during liquidity trap lowers inflation after exit from liquidity trap $\Rightarrow$ massive front-loaded fall in inflation $\Rightarrow$ GDP $\downarrow$

Beliefs-driven liquidity trap with

TRANSITORY SHOCKS

■ **with transitory shocks, ZLB constraint bites more – away from ZLB the interest rate would adjust strongly to adjust to sharp natural rate changes**

TFP $\uparrow \Rightarrow \Pi \downarrow$ **Y** $\downarrow$ **C** $\downarrow$ **RER** $\uparrow$ **(appreciation)**

G $\uparrow \Rightarrow \Pi \uparrow$ **Y** $\uparrow$ **C** $\downarrow$ **RER** $\downarrow$ **(depreciation)**

Transmission of transitory shocks:

"Fundamental LT" $\approx$ "Beliefs-driven LT" $\neq$ Away from ZLB

Numerical illustration:

- **Unit risk aversion, unit labor supply elast.**
- **Substitution elast. domestic vs. foreign goods: 1.5**
- **Price stickiness = 4 quarters (slope of Phillips curve: 0.08)**
- **Producer currency pricing**
- **Taylor rule inflation coefficient: 1.5**
- **No capital: purely forward looking model (inflation & other endogenous variables are all jump variables)**

■ Model variant with beliefs-driven liquidity trap:
ZLB regime (slack or binding ZLB) is driven by sunspot
Probability of remaining in same ZLB regime next period: 0.95
ZLB regime uncorrelated across countries.

■ Model variant with "fundamental" liquidity trap:
Assume a baseline liquidity trap lasting 12 quarters, induced by big negative (autocorr. 0.95) shock to household subjective discount rate. Negative discount rate shock makes the unconstrained nominal interest rate (without ZLB) negative. Once unconstrained rate becomes positive, the liquidity trap ends. Solve for inflation during liquidity trap by "backward" iteration of Euler & Phillips equations
E.g.: Blanchard, Erceg & Lindé (2016)

IMPACT RESPONSES TO HOME TFP SHOCK

	...............Home...............					.......Foreign......		
	i	π	GDP	TB/Y	RER	i	π	GDP
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
• 1% Home TFP shock, persistent (ρ=0.95)								
Beliefs-driven Liq.Trap	**0.00**	**0.26**	**1.11**	**0.10**	**-0.70**	**0.00**	**0.02**	**-0.05**
Fundamental Liquid.Trap	**0.00**	**-34.59**	**-17.63**	**-1.90**	**12.44**	**0.00**	**3.26**	**2.98**
Away from ZLB	**-0.37**	**-0.25**	**0.99**	**0.09**	**-0.79**	**-0.02**	**-0.01**	**-0.05**
RBC world	**--**	**--**	**1.05**	**0.10**	**-0.76**	**--**	**--**	**-0.05**

Rise in RER: appreciation of Home real exchange rate

Fundamental liquidity trap: 12 quarters, triggered by shock to Home & Foreign household discount

Simulations assume that both countries are in the same ZLB regime.

i: nominal interest rate, % p.a.; π: PPI inflation, % p.a.

GDP, TB/Y & RER responses shown in %.

IMPACT RESPONSES TO HOME GOVERNMENT PURCHASES SHOCK

	……………Home……………					……Foreign……		
	i	π	GDP	TB/Y	RER	i	π	GDP
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
• 1% Home G shock, persistent (ρ=0.95)								
Beliefs-driven Liq.Trap	**0.00**	**-0.13**	**0.44**	**-0.05**	**0.35**	**0.00**	**-0.01**	**0.02**
Fundamental Liq.Trap	**0.00**	**9.93**	**5.85**	**0.51**	**-3.36**	**0.00**	**-0.71**	**-0.72**
Away from ZLB	**0.19**	**0.12**	**0.50**	**-0.05**	**0.31**	**0.01**	**0.01**	**0.02**
RBC world	**--**	**--**	**0.47**	**-0.05**	**0.33**	**--**	**--**	**0.02**

i: nominal interest rate, % p.a.; π: PPI inflation, % p.a.
GDP, TB/Y & RER responses shown in %. Rise in RER: appreciation of Home real exchange rate
Fundamental liquidity trap: 12 quarters, triggered by shock to Home & Foreign household discount
Liquidity trap regime: both countries; “Away from ZLB”: both countries.

THE MODEL

Stylized model two-country NK model

- **Floating exchange rate**
- **Each country is specialized in production of a distinct tradable good, but consumes domestic & imported tradables (with home bias),**
- **Government purchases local output only**
- **Complete financial markets**
- **Sticky prices (price adjustment costs)**
- **Central bank targets inflation (Taylor principle)**

Study beliefs-driven sunspot equilibria with occasionally binding ZLB constraint

• Preferences [Home = H; Foreign = F]

$E_0 \sum_{t=0}^{\infty} \beta^t \Psi_{H,t} U(C_{H,t}, L_{H,t})$, $\Psi_{H,t}$: preference shock

$$U(C_{H,t}, L_{H,t}) = \ln(C_{H,t}) - \frac{1}{1+1/\eta}(L_{H,t})^{1+1/\eta}$$

• Risk sharing

$$C_{H,t}/C_{F,t} = (\Psi_{H,t}/\Psi_{F,t})/RER_t$$

• Euler equation

$$(1+i_{H,t+1})E_t \beta(\Psi_{H,t+1}/\Psi_{H,t})(C_{H,t}/C_{H,t+1})/\Pi^{CPI}_{H,t+1} = 1$$

• Price setting (Phillips equation)

$\widehat{\Pi_{H,t}} = \kappa_w \cdot \widehat{mc_{H,t}} + \beta E_t \widehat{\Pi_{H,t+1}}$; $\Pi_{H,t}$: PPI inflation; $mc_{H,t}$: real marg.cost

Producer currency pricing (PCP) assumed

• Monetary policy rule

$1+i_{H,t+1} = Max\{1, \Pi/\beta + (\gamma_\pi/\beta)\cdot(\Pi_{H,t} - \Pi)\}$, Π: target inflation (gross)

Assume PPI inflation targeting

Linearize around target inflation rate "Euler-Phillips-MP" equation:

$$Max\{-(\Pi-\beta)/\Pi, \gamma_\pi \cdot \widehat{\Pi_{H,t}}\} + \tfrac{1}{\kappa}\widehat{\Pi_{H,t}} = (1+\tfrac{1+\beta}{\kappa})E_t\widehat{\Pi_{H,t+1}} - \tfrac{\beta}{\kappa}E_t\widehat{\Pi_{H,t+2}} + \widehat{r_{H,t}}$$

[This holds when substitution elasticity domestic vs. foreign goods = 1]

$r_{H,t}$: **natural real interest rate (flex-prices)**

$$\widehat{r_{H,t}} \equiv E_t\widehat{\theta_{H,t+1}} - \widehat{\theta_{H,t}} - \tfrac{1}{1+\eta}(E_t\widehat{g_{H,t+1}} - \widehat{g_{H,t}}) - [\xi + \tfrac{\eta}{1+\eta}(1-\xi)]E_t(\widehat{\Psi_{H,t+1}} - \widehat{\Psi_{H,t}}) - \tfrac{1}{1+\eta}(1-\xi)E_t(\widehat{\Psi_{F,t+1}} - \widehat{\Psi_{F,t}}),$$

$$\widehat{r_{H,t}} = (1-\rho)\{-\widehat{\theta_{H,t}} + \tfrac{1}{1+\eta}\widehat{g_{H,t}} + [\xi + \tfrac{\eta}{1+\eta}(1-\xi)]\widehat{\Psi_{H,t}} + \tfrac{1}{1+\eta}(1-\xi)\widehat{\Psi_{F,t}}\}$$

ρ: **autocorrelation of exogenous variables**

Aggregate TFP $\uparrow \;\Rightarrow\; r_t \downarrow$

Aggregate G $\uparrow \;\Rightarrow\; r_t \uparrow$

Sunspot equilibria:

Focus on equilibria in which inflation is a function of natural real interest rate:

$\widehat{\Pi_{H,t}} = \mu^B + \lambda^B \widehat{r_{H,t}}$ if country H ZLB constraint binds at t

$\widehat{\Pi_{H,t}} = \mu^S + \lambda^S \widehat{r_{H,t}}$ if country H ZLB constraint is slack at t

Assume constant transition probabilities between ZLB regimes (driven by sunspot)

In liquidity trap:
For persistent shock:

$$\theta_t \uparrow \; \Rightarrow \; r_t \downarrow \; \Rightarrow \widehat{\Pi_t} \uparrow, \quad E_t \widehat{\Pi_{t+1}} \uparrow$$

Intuition:

$$(1+i_{t+1}) E_t \beta \frac{C_t}{C_{t+1}} \frac{1}{\Pi_{t+1}} = 1$$

- With persistent shock ρ<1,

$$\theta_t \uparrow \; \Rightarrow \; \frac{C_t}{C_{t+1}} \uparrow$$

At ZLB: $i_{t+1}=0 \; \Rightarrow \Pi_{t+1} \uparrow \Rightarrow \; \Pi_t \uparrow$

But when ρ close to 1, then $\frac{C_t}{C_{t+1}}$ rises very little

$\Rightarrow$ **muted effect on inflation**

Conclusions

● Shock transmission in liquidity trap depends on the cause of the liquidity trap

● ZLB may matter much less for response of real variables to business cycle shocks than what you think (based on popular "fundamental" liquidity trap models)

● Global dimension of liquidity traps:

► International correlation of beliefs-driven liquidity traps is indeterminate

► In "beliefs-driven" liquidity trap TFP & G shocks have similar effects on RER and foreign output as away from the ZLB.

By contrast, in "fundamental" liquidity trap the RER response is "topsy-turvy"

► In Beliefs-driven liquidity trap, a rise in Home government purchases raises Foreign output

● In Fundamental liquidity trap a rise in Government purchases has a ‘beggar-thy-neighbor’ effect

Avenues for future research:

►Analysis of beliefs-driven liquidity traps in richer models. Welfare effects of liquidity traps?

► Implications for monetary policy strategy ?