The Expansionary Lower Bound: Contractionary Monetary Easing and the Trilemma*

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*The views expressed in this presentation are those of the authors and do not necessarily represent the views of the IMF, its Executive Board, or IMF management.

Introduction

- Can financially integrated economies retain monetary independence?
- Under Mundell's trilemma
  - yes, as long as the exchange rate is flexible
  - capital flows do not pose problems
- However, growing concerns by both academics and policy makers
  - Global financial conditions prevail over MP in EMs (Rey 2015, 2016; Rajan, 2015; IMF 2012)
  - MP in EMs undermined by carry-trade flows (Blanchard et al., 2016)

Empirical evidence

VARIABLES	(1) Quarterly	(2) Quarterly	(3) Quarterly	(4) Monthly
Expected inflation	1.13***	1.07***	1.02***	0.93***
	(0.07)	(0.07)	(0.06)	(0.04)
Output gap	0.14**	0.20***	-0.00	
	(0.07)	(0.07)	(0.05)	
VIX		0.06***	0.05***	0.05***
		(0.01)	(0.01)	(0.01)
U.S. policy rate			0.66***	0.64***
			(0.04)	(0.02)
Constant	2.48***	1.70***	1.46***	1.96***
	(0.44)	(0.48)	(0.38)	(0.23)
Observations	543	543	543	1,555
R-squared	0.311	0.330	0.570	0.502
Number of countries	8	8	8	8

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Our contribution

- Theory of interaction between

  monetary policy $\longleftrightarrow$ capital flows $\longleftrightarrow$ collateral constraints

- Key implication is existence of Expansionary Lower Bound (ELB)

  $\Rightarrow$ Interest rate below which further easing becomes contractionary

- ELB can be positive

  $\Rightarrow$ tighter constraint for MP than ZLB

- ELB determines major departures from Trilemma

  $\Rightarrow$ Global liquidity and monetary shocks can destabilize EMs...

  $\Rightarrow$ ... even with flexible exchange rates

Outline

- Two small-open-economy models in which ELB may arise due to
  - Carry-trade capital flows
  - Currency mismatches
- Three period analysis
  - Steady state from period 2 onward
  - Period 1 to characterize conditions under which ELB arises
  - Period 0 to analyze ex-ante implications
- Alternative policy tools to relax ELB
  - Fiscal policy
  - Balance-sheet operations by the central bank
  - Forward guidance
  - Capital controls, macroprudential policy

Literature Review

- Global financial cycle and monetary spillovers: Rey (2015, 2016); Rajan (2015); Bernanke (2015); Obstfeld (2015); Blanchard et a. (2016); Bruno and Shin (2015, 2017); Baskaya et al. (2017); Avdjiev and Hale (2017)
- Currency mismatches and crises: Krugman (1999); Aghion, Bacchetta and Banerjee (2000, 2001); Cespedes, Chang and Velasco (2004); Christiano, Gust and Roldos (2004)
- Monetary policy and borrowing constraints: Ottonello (2015); Farhi and Werning (2016); Brunnermeier and Koby (2017); Eggertsson et al. (2017)
- Monetary policy with incomplete markets and heterogeneous agents: Werning (2015); Auclert (2016); Gornemann, Kuester and Nakajima (2016); Kaplan, Moll and Violante (2016); McKay, Nakamura and Steinsson (2016); Guerrieri and Lorenzoni (2016)

Model with carry-trader capital flows

- Household sector includes borrowers and savers that maximize

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \ln C_t^i$$

with $C_t = C_{H,t}^{1-\alpha} C_{F,t}^{\alpha}$ subject to the following budget constraints

$$\begin{aligned} P_t C_t^B + L_{t-1} I_{t-1}^L &= \Pi_t^B + L_t \\ P_t C_t^S + D_t &= \Pi_t^S + D_{t-1} I_{t-1}^D \end{aligned}$$

- Firms hire workers to produce domestic goods subject to sticky prices

$$P_{H,t} = P_{H,t}^* = 1 \text{ for } t < 2$$

Domestic banks

- Banks collect deposits to provide loans and buy government bonds

$$\underbrace{N_t}_{\text{Networth}} + \underbrace{D_t}_{\text{Deposits}} = \underbrace{L_t}_{\text{Loans}} + \underbrace{B_t}_{\text{Gov Bonds}} + \underbrace{R_t}_{\text{Reserves}}$$

- They act competitively to maximize networth

$$N_{t+1} = L_t I_t^L + B_t I_t^B + R_t I_t - D_t I_t^D$$

subject to the leverage constraint

$$L_t + \lambda B_t \leq \phi N_t$$

with $\phi > 1$ and $\lambda \in (0, 1)$

Interest rates

- No arbitrage between reserves and deposits implies

$$I_t^D = I_t$$

- Lending and bond rates increase above policy rate if constraint binds

$$\begin{aligned} I_t^L &\geq I_t \\ I_t^B &= \lambda I_t^L + (1-\lambda) I_t \end{aligned}$$

Foreign investors

- Foreign intermediaries borrow internationally to buy domestic bonds
  - They are subject to an agency friction à la Gabaix Maggiori (2015)
  - Foreign demand for government bonds is proportional to excess return

$$B_t^F = \frac{1}{\gamma_t}\mathbb{E}_t\left[\frac{e_t}{e_{t+1}}\frac{I_t^B}{I_t^*} - 1\right]$$

- The parameter γ_t captures tightness of global financial conditions
- In equilibrium, the model generates carry trade capital flows
  $\Rightarrow$ domestic monetary easing triggers capital outflows

Public sector and market clearing

- Ruling out fiscal policy, government simply rolls over public debt

$$B_t^G = B_{t-1}^G I_{t-1}^B$$

- We also rule out balance-sheet operations by the central bank

$$R_t \downarrow 0$$

- Market clearing requires

$$\begin{aligned} Y_{H,t} &= C_{H,t} + C_{H,t}^* \\ B_t^G &= B_t + B_t^F \end{aligned}$$

Steady-state equilibrium

- From $t \geq 2$, model is in steady state
  - flexible prices, no domestic or international financial frictions
  - $I_t \beta = 1$
  - assume $\beta = 1 \Rightarrow P_2 C_2^i = \Pi_2^i$
- Nominal spending equal to money supply

$$P_2 C_2^i = M_2^i$$

- Using market clearing, exchange rate is

$$e_2 = M_2 / M_2^*$$

normalize $M_2 = M_2^* = 1$

Time 1 equilibrium

- Time-1 output is determined by

$$Y_{H,1} = (1-\alpha)\left(\frac{\omega_2}{I_1^L} + \frac{1-\omega_2}{I_1}\right) + \frac{\alpha}{I_1^*}$$

- If leverage constraint does not bind, $I_1^L = I_1$

  $\Rightarrow$ monetary easing is expansionary

- However, monetary easing triggers capital outflows if $\gamma_1 > 0$

$$\begin{aligned} e_1 &= \frac{I_1^*}{I_1}\frac{1+\gamma_1\left(\mathbb{B}_1^F + \alpha/I_1\right)}{1+\gamma_1\alpha/I_1} \\ B_1^F &= \frac{\mathbb{B}_1^F}{1+\gamma_1\alpha/I_1} \end{aligned}$$

where $\mathbb{B}_1^F = B_0^F I_0^B$

The Expansionary Lower Bound

- By triggering outflows, MP easing moves banks towards constraint
- This effect is possibly compounded by stronger loan demand

$$L_1 = \mathbb{L}_1 + \frac{\omega_2}{I_1^L} - \Pi_1^B$$

$\rightarrow$ we turn off loan demand by setting $\Pi_1^B = \omega_2 / I_1$

- Leverage constraint binds once policy rate reaches ELB

$$I_1^{ELB} = \frac{\gamma_1 \alpha}{\mathbb{B}_1^F / \underline{B}_1^F - 1}$$

where $\underline{B}_1^F = \mathbb{B}_1^G - (\phi N_1 - \mathbb{L}_1) / \lambda$ is capital shortfall

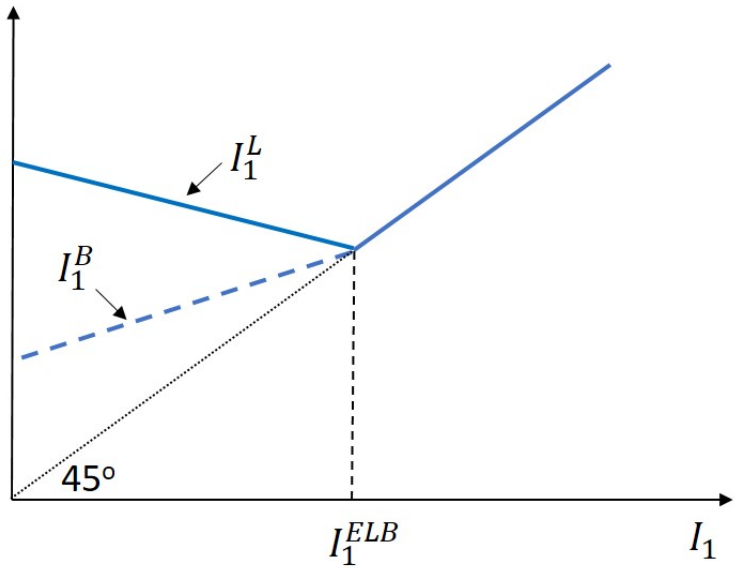
Constrained equilibrium

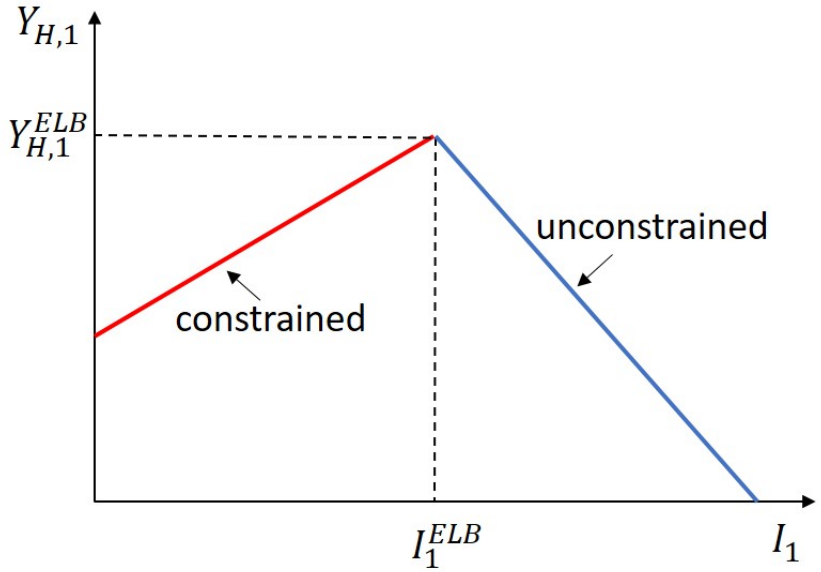
- Once constraint binds, I_1^L increases as outflows crowd out lending
- If carry-trade flows are strong enough, i.e. γ_1 is high

  $\Rightarrow$ Decline in borrowers' demand $>$ increase in savers' demand

  $\Rightarrow$ Monetary easing becomes contractionary

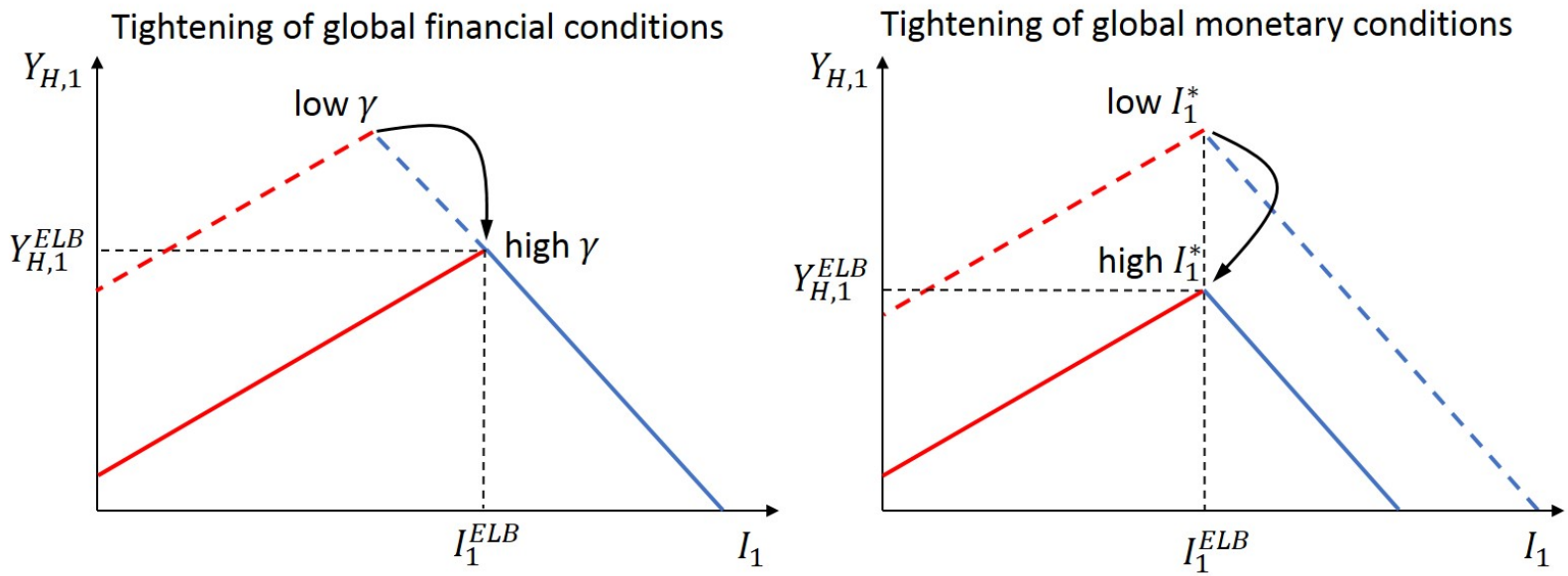
  $\Rightarrow$ ELB places upper bound on output achievable through MP





Global liquidity and monetary shocks

- A tightening of global financial conditions worsens the ELB
  - Lower global liquidity raises the ELB
  - Higher foreign policy rates reduce output at the ELB



- Despite flexible exchange rate, MP unable to stabilize output
  $\rightarrow$ Trilemma is violated

Time 0 equilibrium

- How should MP behave in good times if ELB may bind in the future?
- ELB gives rise to novel intertemporal trade-off for MP
  $\rightarrow$ ELB is affected by ex-ante MP through impact of I_0 on

$$\frac{\mathbb{B}_1^F}{\underline{B}_1^F} = \frac{B_0^F}{B_0^G - (\phi N_0 - L_0)/\lambda}$$

- Higher I_0 reduces I_1^{ELB}
  $\Rightarrow$ keep economy below potential to gain future monetary space
  $\Rightarrow$ MP becomes less effective at time 0

$$Y_{H,0} = \frac{1-\alpha}{I_0 \mathbb{E}_0 [I_1]} + \frac{\alpha}{I_0^* I_1^*}$$

Policy tools against the ELB - fiscal policy

- Fiscal consolidation with lump-sum taxes T_1 has mixed effects on ELB
  $\rightarrow$ It relaxes bank constraints...
  $\rightarrow$ ...but increases loan demand by taxed borrowers
  $\Rightarrow$ It lowers ELB only if $\lambda > T_1^B/T_1$
- A recapitalization of the banking sector lowers the ELB
  $\rightarrow$ even if financed with T_1^B since banks are leveraged $\phi > 1$
- Subsidies on capital inflows lower the ELB
  $\rightarrow$ despite increasing public debt

Policy tools against the ELB - central bank operations

- Balance sheet of the central bank is

$$N_t^{CB} + R_t = B_t^{CB} + e_t X_t$$

- Quantitative easing relaxes the ELB despite strengthening outflows
  $\rightarrow$ Central bank acts as financial intermediary
- Unsterilized FX intervention by buying FX relaxes ELB
  $\rightarrow$ It reduces outflows by depreciating exchange rate
- Sterilized FX intervention by selling FX to buy bonds relaxes ELB
  $\rightarrow$ Positive effect of QE prevails over exchange rate appreciation
- Forward guidance ineffective against ELB ($\neq$ ZLB)
  $\rightarrow$ Higher M_2 increases outflows and raises ELB

Model with currency mismatches

- Homogeneous households, only borrowers
- Export prices are sticky in domestic currency
- UIP holds
- Banks borrow abroad in foreign currency
  - Exchange rate depreciation reduces networth

$$N_t = L_{t-1} I^L_{t-1} - e_t D^*_{t-1} I^*_{t-1}$$

  - Leverage constraint requires

$$L_1 \leq \phi N_1$$

$$\Rightarrow I^L_{t+1} \geq I_t$$

Time 1 equilibrium

- Time-1 output is determined by

$$Y_{H,1} = \frac{1-\alpha}{I_1^L} + \frac{\alpha e_1}{I_1^*}$$

- If leverage constraint does not bind $\Rightarrow$ expansionary effects
  - Banks increase leverage to expand credit $\Rightarrow$ I_1^L declines
  - Exchange rate depreciation stimulates foreign demand
- Once constraint binds $\Rightarrow$ contractionary effects if D_1^* high enough
  - Exchange rate depreciation tightens leverage constraint
  - Banks have to reduce lending $\Rightarrow$ I_1^L increases

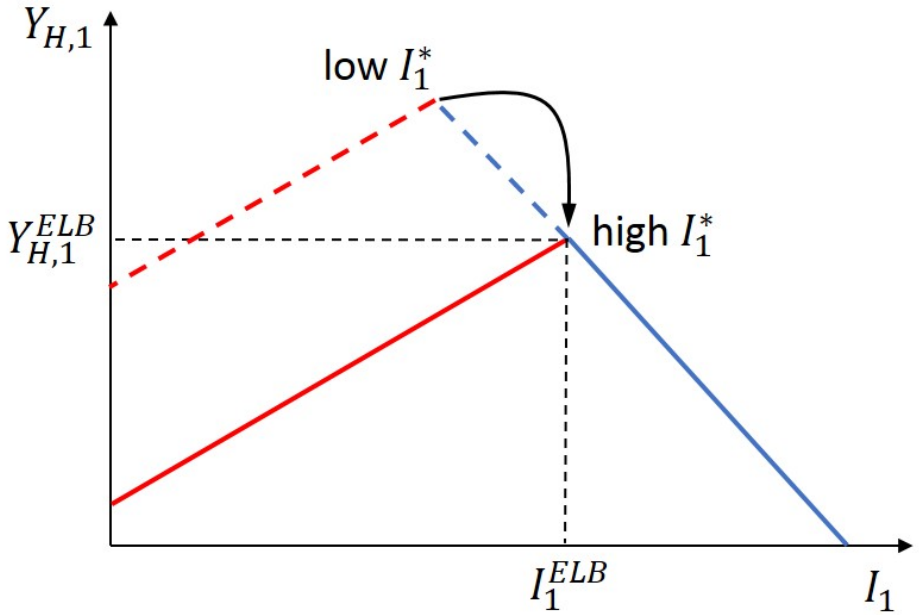
Global monetary shock

- Under currency mismatches, the ELB is

$$I_1^{ELB} = I_1^* \frac{\phi \mathbb{D}_1^*}{(\phi - 1)\mathbb{L}_1}$$

- A foreign monetary tightening raises the ELB

  $\Rightarrow$ possibly pushing EMs into recession, despite flexible exchange rates



Time-0 equilibrium

- Domestic loans and foreign debt are equal to

$$\mathbb{L}_1 = \mathbb{L}_0 I_0 + \frac{\delta\alpha}{\mathbb{E}_0\left[I_1\right]}$$

$$\mathbb{D}_1^* = \mathbb{D}_0^* I_0^* + \frac{\delta\alpha}{\mathbb{E}_0\left[I_1^*\right]}$$

- As with carry traders, higher I_0 reduces I_1^{ELB}
  - Intertemporal trade-off for MP
  - Time-0 MP becomes less effective
- Novel aspect about US monetary policy
  - Ex-post, optimal to reduce I_1^* if ELB binds
  - Ex-ante, expectation of lower I_1^* raises FX debt and increases ELB

Policy tools against the ELB

- Recapitalization of banking sector lowers ELB
  $\rightarrow$ They relax leverage constraint
- Subsidies to capital inflows effective to delink exchange rate from I_1
  $\rightarrow$ They appreciate e_1
- Forward guidance ineffective
  $\rightarrow$ Future monetary easing depreciates e_1, raising ELB
- FX intervention by the central bank is ineffective
  $\rightarrow$ UIP holds
- Time-0 "prudential" capital controls lower time-1 ELB
  $\rightarrow$ They reduce foreign currency borrowing

Conclusions

- Theory rationalizes concerns about loss of monetary independence
- Existence of Expansionary Lower Bound (ELB)
  - $\Rightarrow$ Interest rate below which further easing becomes contractionary
- Despite flexible exchange rates, MP unable to stabilize output
  - $\Rightarrow$ Departures from trilemma
- ELB generates novel intertemporal trade-off for MP...
- ...and calls for alternative policy tools