Exchange Rate Policies at the Zero Lower Bound

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Motivation

- After 2008 some developed economies have experienced:
 - Sustained appreciations
 - Large accumulation of reserves
 - Low/zero nominal rates

Switzerland



Basic question

• What are the consequences of these sustained appreciations and associated reserve accumulation?

What we do

- Simple model of exchange rate policy under:
 - Limited international arbitrage
 - Gabaix-Maggiori(15), Cavallino(16), Fanelli-Straub(15)
 - Zero lower bound (ZLB) constraint for nominal rates
- Characterize consequences of policy on and off ZLB

Results

- Away from the ZLB:
 - Interest parity $1 + i = (1 + i^*)\frac{s_2}{s_1}$ holds: 1 + i adjusts to $\frac{s_2}{s_1}$ policy, no capital flows nor reserve accumulation
 - Cost of setting $\frac{s_2}{s_1}$ is loss of monetary independence: Mundellian Trilemma

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- \bullet Welfare losses of Swiss policy: up to 1% of GDP

Environment

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- Three agents
 - 1. Households:
 - Endowments, standard consumption/saving problem, hold money
 - 2. Foreign investors:
 - $\bullet\,$ Buy domestic/for eign assets, have limited wealth \bar{w}
 - 3. Central Bank:
 - Issues money (M), buys domestic/foreign assets (A, F)
 - Implements exchange rate policy (s_1, s_2) , with $s_1 > s_2$
 - i.e. keeps exchange rate depreciated for a while.

Notation

- Price of good abroad constant and normalized at 1
- Exchange rate:

• $s_t = \#$ of domestic currency per foreign currency

- Law of one price holds: $P_t = s_t$
- Nominal interest rate on domestic currency assets: 1 + i
- Real interest rate on domestic currency assets: $(1+i)\frac{s_1}{s_2}$
- Real interest rate on foreign currency assets, $1 + i^{\star}$
- Money does not pay interest

Households

$$U(c_1, c_2, m) = \max_{c_1, c_2, f \ge 0, a, m} u(c_1) + h\left(\frac{m}{s_1}\right) + \beta u(c_2)$$

$$y_1 + T_1 = c_1 + \frac{m+a}{s_1} + f$$

$$y_2 + T_2 = c_2 - \frac{(1+i)a + m}{s_2} - (1+i^*)f$$

Borrow/save in domestic assets a. Foreign assets f ≥ 0
h' ≥ 0, h'' ≤ 0 and satiation level

Households: domestic and foreign bonds

• Domestic bonds FOC

$$u'(c_1) = \beta(1+i)\frac{s_1}{s_2}u'(c_2)$$

• Foreign bonds FOC

$$u'(c_1) \ge \beta(1+i^*)u'(c_2)$$

 \rightarrow In equilibrium

$$(1+i) \geq (1+i^*)\frac{s_2}{s_1}$$

• Equality \Rightarrow standard interest rate parity condition

$$(1+i) = (1+i^*)\frac{s_2}{s_1}$$
 (IP)

• Inequality strict, domestic rate is high $\rightarrow f = 0$

Foreigners

- Have limited initial wealth \overline{w} and can't go short limits to international arbitrage.
- Invest at home in either assets or money, a^*, m^* or internationally in foreign assets f^*
- Linear. Maximize their return:

$$\begin{aligned} \max_{\substack{f^{\star} \ge 0, a^{\star} \ge 0, m^{\star} \ge 0}} c^{\star} \\ \text{s.t.:} \\ \bar{w} &= f^{\star} + \frac{a^{\star} + m^{\star}}{s_1} \\ c^{\star} &= (1 + i^{\star})f^{\star} + (1 + i)\frac{a^{\star}}{s_2} + \frac{m^{\star}}{s_2} \end{aligned}$$

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$$\max_{\substack{f^* \ge 0, a^* \ge 0, m^* \ge 0}} c^*$$

s.t.:
$$\bar{w} = f^* + \frac{a^* + m^*}{s_1}$$

$$c^* = (1 + i^*)f^* + (1 + i)\frac{a^*}{s_2} + \frac{m^*}{s_2}$$

• If (IP) violated, for eigners invest all \bar{w} at home

Central Bank

- Issues money, M, redeemed at exchange rate in period 2
- Implements given exchange rate policy, s_1 , s_2
- Buys for eign reserves, ${\cal F}$
- Buys domestic assets, A
- Makes transfers to households, T_1, T_2

$$\frac{M}{s_1} + T_1 = F + \frac{A}{s_1}$$
$$(1+i^*)F + (1+i)\frac{A}{s_2} = \frac{M}{s_2} + T_2$$
$$M \ge 0; F \ge 0$$

Equilibrium

- 1. HH max. utility
- 2. Foreign lenders maximize return
- 3. CB budget constraint holds
- 4. Market clearing for money and domestic assets

$$m + m^{\star} = M$$
$$a + a^{\star} + A = 0$$

A Real Economy

- Forget exchange rates and money
- Let r and r^* be domestic and foreign real rates
- Let $\tilde{y}_1 = y_1 F$ and $\tilde{y}_2 = y_2 + F(1 + r^*)$ (central bank interventions intertemporally shift the endowments)

Household IBC



- If $r = r^*$ interventions/gross positions are irrelevant
- If $r > r^*$ interventions/gross positions involve a loss
- r is endogenous (depends on F)









- CB interventions either neutral or damaging
- If \bar{w} large enough: neutral, as households undo them by borrowing
- If \bar{w} not large enough, CB forces private agents to compete to borrow scarce foreign resources, driving up borrowing rates (rent for foreigners, Costinot et al. 2014), while saving at low foreign rate
 - Raises r away from r^{\star} distorting consumption

• Generates arbitrage losses:
$$\left|1 - \frac{1+r^*}{1+r}\right| F$$

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- Let \underline{r} be domestic real rate in best non monetary equilibrium (F = 0)
- Is \underline{r} consistent with $\frac{s_2}{s_1}$?

Monetary Equilibria away from ZLB

- If $(1 + \underline{r})_{s_1}^{s_2} \ge 1$ then the best non monetary allocation can be achieved in monetary equilibrium
- When CB does not intervene, domestic nominal interest above 0, IP holds
- Best non monetary allocation compatible with exchange rate policy!

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- hence i = 0, and i = 0 is above parity: both foreigners and domestic agents want to save in domestic assets (or money), NOT an equilibrium in domestic asset markets
- Equilibrium restored by costly CB interventions described above
- Interventions (achieved simply by maintaining peg) make domestic agents poorer, curb their saving



Relation to Closed Economy ZLB

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- In closed economy (e.g. Christiano, Eichenbaum and Rebelo, 2011) saving induced by discount factor shocks, equilibrium restored by current recession that reduces desired saving
- Here saving induced by exchange rate policy, CB intervention mops up the saving, creating losses and lowering current consumption until equilibrium is restored
- Notice that no deliberate action by the CB is required, just maintaining the peg in face of increasing demand for domestic assets!

Fragilities and Policies at the ZLB

- Fragilities
 - More financial integration (high \bar{w}): damaging at ZLB (desirable with i > 0)
 - Lower international rates: damaging at ZLB (desirable with i > 0)
 - Irrational speculators: damaging at ZLB (desirable with i > 0)
- Policies
 - Capital Controls
 - Negative Interest rates

The role of foreign wealth at the ZLB



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- Away from ZLB, more \bar{w} always good, as it reduces rate received by foreigners and allows larger net positions
- At the ZLB, rate is fixed (at $\frac{s_1}{s_2}$ because of pegging) hence more wcapital inflows simply increase gross position and increase losses
- Natural role for capital controls

Negative Interest Rates

• Overcoming ZLB with tax on money

$$y_2 + T_2 + \frac{(1 - \tau^m)m + (1 + i)a}{s_2} + (1 + i^*)f = c_2$$

• Optimality:

$$h'\left(\frac{m}{s_1}\right) = \frac{\beta u'(c_2)}{s_2}(i+\tau^m)$$

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- \Rightarrow Effective lower bound $i \ge \tau^m$ (Goodfriend, McCallum, Buiter)
- Setting $\tau^m = 1 (1 + i^*)s_2/s_1$ eliminates [IP] deviations
 - Negative rates avoid capital inflows and intervention losses

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• Sufficient statistic:



- We construct empirical counterparts to both terms
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• Sufficient statistic:



• We construct empirical counterparts to both terms

- Measure daily deviations from covered interest rate parity (CIP) as a proxy to arbitrage profits
- Key empirical issues:
 - 1. Do we observe deviations from CIP (Du, Tepper and Verdelhan, 2016)?
 - 2. Are deviations from CIP associated to strong demand for assets denominated in Swiss franc?

Switzerland and Denmark



Zooming in on Switzerland



CIP Deviations and **SNB** Interventions



Measuring the Losses



• Monthly losses increase significantly towards the end of the floor episode reaching 0.8 - 1.0% of monthly GDP

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- In progress:
 - A theory of why a CB wants to follow a particular exchange policy, and how it interacts with the costs (simple model with nominal rigidities)
 - A theory of timing of peg abandonment (Reverse Speculative Attacks, ABBP, 2016)
 - Uncertainty