# Macroeconomics B, EI060

## Class 7

## Currency crises, foreign exchange interventions

Cédric Tille

April 2, 2025

# What you will get from today class

- Current account crises.
  - First generation: unsustainable policy (Harms X.3.2, Obstfeld and Rogoff (secondary) 8.4).
  - Second generation: multiple equilibra (Harms X.3.3).
  - Third generation: linkage with banks (Harms X.3.4, Vegh (brief, secondary) 17.7).
- Foreign exchange interventions.
  - Impact when interest parity does not hold (Harms VIII.6).
  - Empirical evidence (Fratzscher, Gloede, Menkhoff, Sarno, and Stöhr 2019).

# A question to start

EXPECTATIONS → BASED ON FUND.

BANK RUN ; AGGREGATE

*Currency crises (failure of an exchange rate peg) often occur as a surprise. This points to multiple equilibria, with a limited role for fundamentals.*

Do you agree? Why or why not?

# FIRST GENERATION CRISES

- Monetary policy cannot both follow a domestic objective and maintain an exchange rate peg.
  - Insight: the break ends in a sudden and perfectly predictable manner.
- Building blocks are UIP, money demand, and PPP:

$e\uparrow$ DEPREC

$$\begin{aligned} i^H_{t+1} &= i^F_{t+1} + \mathbb{E}_t\left(e_{t+1}\right) - e_t \\ m_t - p_t &= \phi y_t - \lambda i^H_{t+1} \\ p_t &= e_t + p^F_t \end{aligned}$$

- Exchange rate solution (assume $p^F_t + \phi y_t - \lambda i^F_{t+1} = 0$ for simplicity):

$i^H = i^F$

$$m_t - e_t = -\lambda\left(\mathbb{E}_t\left(e_{t+1}\right) - e_t\right)$$

- A peg requires $\mathbb{E}_t\left(e_{t+1}\right) - e_t = 0$ and constant money supply:

$$e_t = e_{t+1} = \overline{m}$$

# Central bank balance sheet

$D_t$ | $M_t$    CB
$R_t$ |

- Liabilities: money, $M_t$. Assets: domestic currency bonds, $D_t$, and foreign currency bonds (reserves), $R_t$:

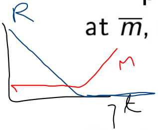
$$M_t = D_t + R_t \qquad ; \qquad m_t = \ln(D_t + R_t)$$

- Domestic policy: the central bank steadily acquires domestic currency bonds at a rate $\mu$ (usual reason: finance the government deficit):

$$\ln(D_{t+1}) = \ln(D_t) + \mu$$

- Keeping the money constant requires that domestic bond purchases are offset by sales of foreign currency bonds. $R \searrow$
  - At some points reserves will run out. $R > 0$
  - Everything is fully expected.

# Exchange rate dynamics




- The peg breaks at time $T$ (endogenous). Money is constant until then at $\overline{m}$, and after that money grows at the rate $\mu$.

m ↑ RATE μ

PEG

$$e_{T-1} = \overline{m} \qquad ; \qquad e_T = \underbrace{\ln(D_T)}_{m_T} + \lambda\mu$$

- Can it be that reserves smoothly run out: $\overline{m} = m_{T-1} = m_T = \ln(D_T)$?

  $R_t$ → PEG

  - No. This would imply a discrete and fully expected depreciation jump: $e_T - e_{T-1} = \lambda\mu > 0$.
  - Incompatible with interest parity (monetary model implies that the exchange rate can jump, but only unexpectedly).
- Parity requires $e_T = e_{T-1}$, hence:

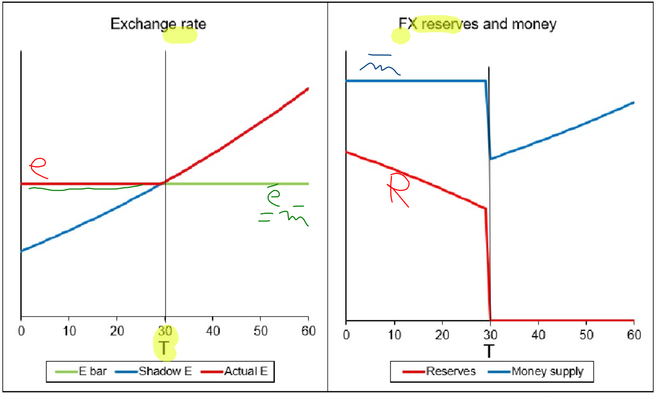

$$\underset{e_{T-1}}{\tilde{\overline{m}}} = \overbrace{\ln(D_T) + \lambda\mu}^{e_T} \qquad m_T$$

$$m_{T-1} = m_T + \lambda\mu > m_T$$

- The money supply drops down. This requires reserve to jump down from $R_{T-1}$ to zero. A run on reserves that is fully predicted.

# Paths of exchange rate and reserves

- Shadow exchange rate: value that would prevail under a float with only domestic bonds (at the value of the period). Trend depreciation as domestic bonds increase.
- Exchange rate breaks when the the shadow rate reaches the pegged value.



# Timing of the break

- Floating exchange rate = pegged value at the time of break:

PtC —

$$\overline{m} = \ln(D_T) + \lambda\mu$$

— $e_T$

- Initial money equal to its value at the starting period 0:

$$\overline{m} = \ln(D_0 + R_0)$$

- As $\ln(D_T) = \ln(D_0) + T\mu$, we get the period of break:

$$T = \frac{1}{\mu}\ln\left(1 + \frac{R_0}{D_0}\right) - \lambda$$

- Longer lasting peg ($T$ higher) with limited purchases of domestic bonds $\mu$, impact impact of interest on money demand (low $\lambda$), and higher initial reserves (high $R_0/D_0$).
- The run on reserves just reflects an unsustainable policy mix.
    - But many countries experienced crises with a policy mix that was not clearly unsustainable, and crises were unexpected.
    - Note that the only role of reserves is to be an asset that can be sold. There is nothing particular about it being in foreign currency.

# SECOND GENERATION CRISES

# Domestic - foreign tension

- Central bank minimizes a loss function:

$$L = \frac{1}{2}\left\{\phi\left(x_t - \overline{x}\right)^2 + \left(\Delta e_t\right)^2\right\} + c_{\Delta e_t > 0}$$

    - Volatility of the output gap $x_t$ around a reference level $\overline{x}$.
    - Volatility of the exchange rate $\Delta e_t$, which is zero is the peg is maintained.
    - FIX Discrete cost $c$ if the peg is abandoned (we focus on depreciation).
- The output gap reflects an aggregate supply, with higher output when the exchange rate depreciates more than expected (unexpected inflation as we have PPP):

$$x_t = \theta\left(\Delta e_t - \Delta e_t^{\text{expected}}\right)$$

- Tension between keeping the peg and accepting a depreciation to raise output.

# Loss under discretion

- If the central bank decides to abandon the peg, it sets $\Delta e_t$ to minimize the loss given $\Delta e_t^{\text{expected}}$:

REACTION

$$\Delta e_t = \frac{\phi\theta}{1+\phi\theta^2}\left(\theta \Delta e_t^{\text{expected}} + \overline{x}\right)$$

  - Higher depreciation if the reference gap is high, and if the market expects a high depreciation.
  - If the exchange rate matches expectations (conditional on abandoning the peg): $\Delta e_t = \Delta e_t^{\text{expected}} = \phi\theta\overline{x}$.
- The loss function reflects the discrete cost of abandoning the peg:

$$L^{\text{float}} = \frac{\phi}{2\left(1+\phi\theta^2\right)}\left(\overline{x} + \theta \Delta e_t^{\text{expected}}\right)^2 + c$$

- If the peg is maintained, , the loss is $\Delta e_t = 0$:

$$L^{\text{peg}} = \frac{\phi}{2}\left(\overline{x} + \theta \Delta e_t^{\text{expected}}\right)^2$$

# To peg or not?

- Abandon the peg if the loss is reduced under a float $L^{\text{peg}} > L^{\text{float}}$:

$$\frac{\phi}{2}\left(\overline{x} + \theta \Delta e_t^{\text{expected}}\right)^2 > \frac{1}{1+\phi\theta^2}\frac{\phi}{2}\left(\overline{x} + \theta \Delta e_t^{\text{expected}}\right)^2 + c$$

- Trade-off reduced loss from $\left(\overline{x} + \theta \Delta e_t^{\text{expected}}\right)^2$ vs. fixed cost (always float in the absence of a fixed cost).
- The peg is abandoned if the cost is below a critical value:

$$c \quad < \quad c^{\text{critical}} = \frac{(\phi\theta)^2}{2\left(1+\phi\theta^2\right)}\left(\overline{x} + \theta \Delta e_t^{\text{expected}}\right)^2$$

  - The critical value is higher (peg less sustainable) if the reference gap $\overline{x}$ is high, if the market expects a high depreciation, if the central bank care about output ($\phi$ high) and if the exchange rate impacts output ($\theta$ high).

# Threshold exchange rate

- The critical cost $c = c^{\text{critical}}$ translates into a critical value of the exchange rate:

$$\Delta \overline{e}_t^{\text{expected}} = \frac{\sqrt{2\left(1+\phi\theta^2\right)c}}{\phi\left(\theta\right)^2} - \frac{\overline{x}}{\theta}$$

- If $\Delta e_t^{\text{expected}} < \Delta \overline{e}_t^{\text{expected}}$, the peg is abandoned.
  - More likely if the reference gap $\overline{x}$ is high, or if the fixed cost $c$ is low.

# Equilibria

BAD FUND

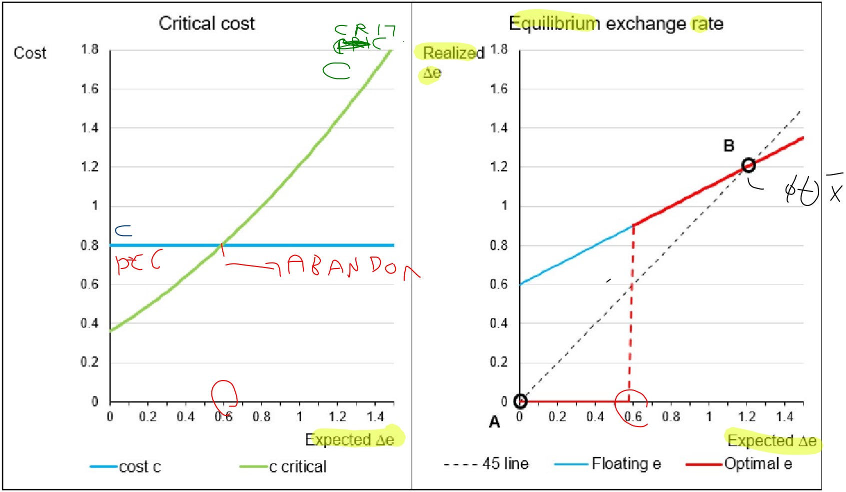
- Consider that $\Delta \overline{e}_t^{\text{expected}} < 0$
  - Even when markets do not expect a depreciation ($\Delta e_t^{\text{expected}} = 0$) the central bank abandons the peg: $\Delta e_t^{\text{expected}} > \Delta \overline{e}_t^{\text{expected}}$.
  - $\Delta e_t^{\text{expected}} = 0$ is not an equilibrium. The only equilibrium is a depreciation $\Delta e_t = \Delta e_t^{\text{expected}} = \phi\theta\overline{x}$, and the peg is abandoned.

SOLID FUND

- Consider that $\Delta \overline{e}_t^{\text{expected}} > \phi\theta\overline{x}$.
  - A depreciation is not an equilibrium: if it is chosen and expected, the exchange rate, $\phi\theta\overline{x}$, remains below $\Delta \overline{e}_t^{\text{expected}}$. The peg is kept.
- Consider that $0 < \Delta \overline{e}_t^{\text{expected}} < \phi\theta\overline{x}$, there are two equilibria:
  - One where the peg is kept.
  - One where the peg is abandoned and $\Delta e_t = \Delta e_t^{\text{expected}} = \phi\theta\overline{x}$.

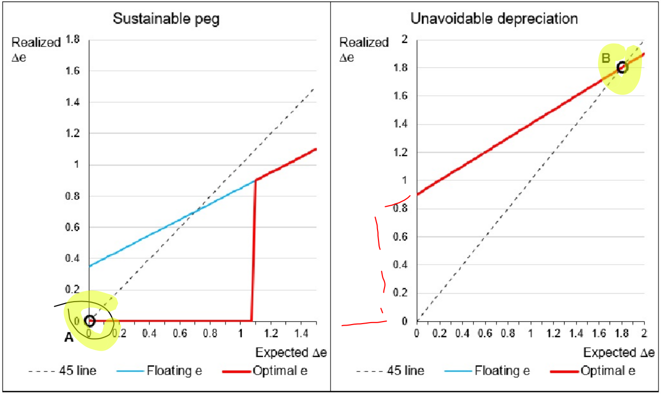
# Multiple equilibria

- Parameters: $\phi = \theta = 1$, $c = 0.8$, $\overline{x} = 1.2$. This implies $\Delta \overline{e}_t^{\text{expected}} = 0.59$, and there are two equilibria.



# Unique equilibrium

- Left panel: $\overline{x} = 0.7$, which implies $\Delta\overline{e}_t^{\text{expected}} = 1.09 > \phi\theta\overline{x}$ and the peg is the only equilibrium.
- Right panel: $\overline{x} = 1.87$, which implies $\Delta\overline{e}_t^{\text{expected}} = -0.01 < 0$ and the peg cannot be kept.



# Insights from the model

- Countries may not be so committed to keeping a peg.
- If markets expect them to abandon the peg, they may chose to do so.
  - But they would have kept the peg of markets had expected them to do so.
  - Multiple equilibria.
- Fundamentals matter. VULNERABILITY
  - Very bad fundamentals (high $\overline{x}$, could reflect an adverse shock) imply the peg will be abandoned for sure.
  - Good fundamentals (low $\overline{x}$) imply the peg will survive for sure.
  - Intermediate fundamentals put the country is a risky zone of multiple equilibria.
- Example: crisis of the European Monetary System in 1992 following the German reunification.

# THIRD GENERATION CRISES

# Leveraged financial intermediaries

- Asian crisis of 1997-1998: fiscal fundamentals were good, but financial intermediaries had foreign exchange exposure.
  - Bank run in a multiple currencies context.
- Illustration with a two-period model where banks are active in domestic and foreign currency.
  - Bank $i$ has domestic currency earnings in the second period: $Y_2^{H,i}$.
  - In both periods, it has foreign currency earnings, $Y_1^{F,i}$ and $Y_2^{F,i}$, and payments, $D_1^{F,i}$ and $D_2^{F,i}$ .
  - Maturity mismatch, as first period foreign currency net earnings are negative: $Y_1^{F,i} - D_1^{F,i} < 0$.
  - Currency mismatch. It needs the domestic currency earnings to cover the fact that the present value of its foreign currency activity is negative ($i_1^H$ is the domestic interest rate and $E_2^{\text{expected}}$ the expected exchange rate):

$$0 > E_1 \left( Y_1^{F,i} - D_1^{F,i} \right) + \frac{1}{1 + i_1^H} E_2^{\text{expected}} \left( Y_2^{F,i} - D_2^{F,i} \right)$$

# Bank net worth

- Domestic currency net worth is the present value of net earnings (using the expected future exchange rate):

$$V_1^{H,i} = E_1\left(Y_1^{F,i} - D_1^{F,i}\right) + \frac{1}{1+i_1^H}\left[Y_2^{H,i} + E_2^{\text{expected}}\left(Y_2^{F,i} - D_2^{F,i}\right)\right]$$

- Using the interest rate parity, $1 + i_1^H = \left(1+i_1^F\right)\left(E_2^{\text{expected}}/E_1\right)$, the net worth in foreign currency reflects the foreign exchange rate:

$< 0$

$$\widetilde{V}_1^{H,i} = \frac{Y_2^{H,i}}{\left(1+i_1^F\right)E_2^{\text{expected}}} + \left(Y_1^{F,i} - D_1^{F,i}\right) + \frac{1}{1+i_1^F}\left(Y_2^{F,i} - D_2^{F,i}\right)$$

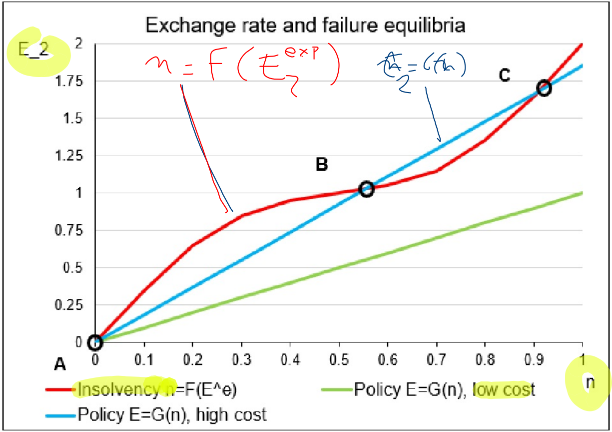
- We start at a situation where $E_1 = E_2^{\text{expected}} = 1$ and $\widetilde{V}_1^{H,i} > 0$.
- If expectations shifts towards a domestic depreciation, $E_2^{\text{expected}} > 1$, this lowers the foreign currency value $\widetilde{V}_1^{H,i}$.
  - Insolvency, from the point of view of foreign lenders, when $\widetilde{V}_1^{H,i} < 0$.

# Equilibrium

- There are many banks in the country, with different values of $E_2^{\text{expected}} > 1$ that put them in bankruptcy.
  - Cumulative distribution $F$ of the threshold expected exchange rate.
- Positive relation between the expected exchange rate and the share $n$ of banks that are insolvent: $n = F\left(E_2^{\text{expected}}\right)$.
- The government can bail out the banks.
  - Use reserves, and if not enough needs to resort to lender of last resort operations in domestic currency, leading the peg to fail.
  - Positive relation between the realized exchange rate $E_2$ and the share $n$ of banks which need a rescue: $E_2 = G(n)$.
- Equilibrium at the intersection of the lines, $E_2^{\text{expected}} = E_2$. As both relations have a positive slope, multiple equilibria are possible.
  - The peg survives if $E_2 = G(n)$ keeps $E_2$ low, for instance thank to abundant reserves.
  - It also survives if $n = F\left(E_2^{\text{expected}}\right)$ shows high values of $E_2^{\text{expected}}$, for instance thanks to macroprudential policies.

# Multiple equilibria

- The two lines can cross in several instances. If $n = F\left(E_2^{\text{expected}}\right)$ is above $E_2 = G(n)$, the peg survives.



# A fuller model (Vegh)

- Twin crises, with a banking crisis leading to a currency crisis.
  - The cost of bailing out the bank behaves as the unsustainable fundamental in the first generation model.
  - Cost can be big even if the government's finances are initially fine.
- Small open economy, initially under a peg.
- Bad shock at time 0 weakens the bank (permanent drop of constant endowment).
  - Earnings on endowment insufficient to pay the return on deposits, banks borrow (unsustainably) from foreign investors.
- Banking crisis at time $T_1$: foreign investors unwilling to lend more.
  - The government takes over the bank.
  - Support from abroad (IMF) makes the bank solvent on a forward looking flow basis.
- Debt to foreign investors remains.
  - If the government reserves can cover this, the peg is sustainable.
  - Otherwise, currency crisis at time $T_2$ with abandonment of the peg.

# FOREIGN EXCHANGE INTERVENTIONS

# Balance of payments

- Exchange rate models indicate that changing money supply affect the exchange rate.
  - Do reserves matter in addition (i.e. for an unchanged monetary policy)?
- Current account equal to (non-reserve) financial account and reserves accumulation ($\Delta R_{t+1}$):

$$CA_t = FA_t^{NR} + \Delta R_{t+1}$$

- Monetary policy: interest rate rule: follows the foreign rate, reacts to the exchange rate, and shifts $\xi_t$:

$$i_t^H = i_t^F + \delta e_t + \xi_t$$

MP

- Policy maker also change reserves $\Delta R_{t+1}$.

policy

- Current account higher when the currency is weak:

$$CA_t = \gamma e_t$$

- Non-reserve financial account reflects deviations from uncovered interest parity:

UIP HOLDS = 0

0 < ← OUTFLOWS

$$FA_t^{NR} = \alpha \left( i_t^F - i_t^H + \mathbb{E}_t e_{t+1} - e_t \right)$$

  - Higher foreign interest rate / lower domestic interest rate / expectation of domestic depreciation raise capital outflows and limit capital inflows.
  - $\alpha \to \infty$ is the case of UIP always holdings.

# Equilibrium exchange rate

- Substitute the various elements in the balance of payments:

$$\begin{aligned} CA_t &= FA_t^{NR} + \Delta R_{t+1} \\ \gamma e_t &= \alpha\left(-\delta e_t - \xi_t + \mathbb{E}_t e_{t+1} - e_t\right) + \Delta R_{t+1} \end{aligned}$$

- Exchange rate solution (we consider that $\Delta R_{t+1}$ and $\xi_t$ are on-off changes, so $\mathbb{E}_t e_{t+1} = 0$):

"$-m_t$"

$$e_t = \frac{-\xi_t + \frac{\Delta R_{t+1}}{\alpha}}{1 + \delta + \frac{\gamma}{\alpha}}$$

- An interest increase ($\xi_t > 0$) appreciates the currency (tighter policy, similar to a reduction of money supply).
- An increase in reserves ($\Delta R_{t+1} > 0$) depreciates the currency.
  - It requires a positive current account, or a negative financial account, both achieved by a weaker currency (expectation of appreciation draws in foreign capital).
  - The effect is present only with a finite $\alpha$, i.e. there can be deviations from UIP.

# Introducing shocks

- Enrich the setting with autoregressive shocks to capital flows, the current account, and interest rates:

$z \uparrow$ K INFLOW

$$\begin{aligned} FA_t^{NR} &= \alpha\left(i_t^F - i_t^H + \mathbb{E}_t e_{t+1} - e_t\right) - z_t \\ CA_t &= \gamma e_t + \zeta_t \\ i_t^H &= i_t^F + \delta e_t + \xi_t \end{aligned}$$

where: $z_t = \phi z_{t-1} + \varepsilon_t$, $\zeta_t = \varphi \zeta_{t-1} + \nu_t$, $\xi_t = \psi \xi_{t-1} + \iota_t$, and $0 < \phi, \varphi, \psi < 1$, and $\mathbb{E}_{t-1}\varepsilon_t = \mathbb{E}_{t-1}\nu_t = \mathbb{E}_{t-1}\iota_t = 0$.

- Reserves lean against shocks to capital inflows:

$$\Delta R_{t+1} = \theta z_t$$

- Combining the balance of payments elements, and iterating forward (with the transversality condition):

MP ΔR = Z θ = 1 K FLOWS

$$e_t = -\frac{1}{1+\delta-\psi+\frac{\gamma}{\alpha}}\xi_t - \frac{1}{1+\delta-\varphi+\frac{\gamma}{\alpha}}\frac{\zeta_t}{\alpha} - \frac{1-\theta}{1+\delta-\phi+\frac{\gamma}{\alpha}}\frac{z_t}{\alpha}$$

- The reserve policy limits the impact of capital flows shocks.
- Under UIP ($\alpha \to \infty$), shocks to the current account or capital flows do not impact the nominal exchange rate.

# SOME EMPIRICAL EVIDENCE

# Do interventions work?

- Focus on sterilized interventions are quite common (Fratzscher, et al. 2019).
  - The central bank sells / buys foreign currency assets, offsets with domestic currency assets, no change in money supply.
- Theoretical channels for effectiveness.
  - Porfolio balance: private investors are willing to take the mirror position of the central bank only with different asset prices.
  - Signalling: the intervention conveys information about future policy.
- New database of daily observations for 33 countries from 1995 to 2011.
- Challenge: we never know how the exchange rate would have moved without interventions.

# How do we define success?

- An intervention can have different objectives.
- “Event“ criterion: impact the level of the exchange rate.
  - Does the exchange rate move in the intended direction (depreciation of the domestic currency after a foreign currency purchase)?
- “Smoothing“ criterion: limit volatility.
  - Is exchange rate volatility lower after the intervention than before (5 days windows)?
- “Stabilization“ criterion: keep the exchange rate in a given range.
  - Does the exchange rate remain within a 2 percent band over the next two weeks?
- To assess effectiveness, test whether the criteria is met more often after an intervention than in other times.

# Evidence of effectiveness

- Distinguish between exchange rate regime: floats, broad bands, narrow bands.
- Floaters are successful according to the event and smoothing criteria.
- Broad and narrow bands are successful according to the smoothing criterion.
    - Narrow bands are successful according to the stabilization criteria, but not to a large extent.
- Large interventions are more successful.
- "Oral" interventions (communications by the central banks) help, especially in turbulent markets.
    - Communication occurs in 52 % of the interventions.

# Evidence

- Floaters succeed in moving and smoothing the exchange rate.
- Managed regimes succeed in smoothing.

TABLE 4—UNCONDITIONAL SUCCESS RATES OF INTERVENTION EPISODES BY REGIME

| Regime | Free floater | | Broad band | | Narrow band | |
|---|---|---|---|---|---|---|
| Criterion | Event (1) | Smooth (2) | Smooth (3) | Stabilize (4) | Smooth (5) | Stabilize (6) |
| Intervention episodes | 0.611 | 0.883 | 0.791 | 0.348 | 0.781 | 0.840 |
| Placebo rates | 0.481 | 0.401 | 0.396 | 0.495 | 0.342 | 0.768 |
| $p$-value ($H_0$: equal effectiveness) | 0.012 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| $p$-value ($H_0$: actual $\leq$ placebo) | 0.006 | 0.000 | 0.000 | 1.000 | 0.000 | 0.000 |
| Actual events | 95 | 77 | 561 | 1,062 | 1,010 | 2,893 |

Fratzscher, Marcel, Oliver Gloede, Lukas Menkhoff, Lucio Sarno, and Tobias Stöhr (2019). "When is foreign exchange intervention effective? Evidence from 33 countries", *American Economic Journal: Macroeconomics* 11(1), pp. 132-156.