Exchange rates and monetary spillovers

Guillaume Plantin\textsuperscript{1} \quad Hyun Song Shin\textsuperscript{2}

\textsuperscript{1}\textit{Sciences Po}

\textsuperscript{2}\textit{Bank for International Settlements}
Mundell’s “trilemma”: Flexible exchange rates allow for independent monetary policies in the presence of free capital flows

Post crisis discussions of monetary spillovers have revisited it (Agrippino and Rey, 2014; Rey, 2013; Bruno and Shin, 2015)

- Monetary policy and financial conditions spill over from a center country to the periphery despite flexible exchange rates

- An important channel for this spillover seems to be the risk-taking behavior of global investors such as global banks
This paper develops a theoretical model in which:

- monetary and financial conditions spill over from a center country to a small open economy with flexible exchange rates

- spillover due to capital inflows/outflows by global investors

- these capital flows create/are fuelled by self-fulfilling abnormal returns on carry trades due to a strong failure of Uncovered Interest Parity
Introduction

- Perfect-foresight model
- Stochastic model
Perfect-foresight model

- Unique tradable good with unit price in the world currency ("USD")
- Small open economy with a domestic currency that trades at $S_t$ USD per unit
- Unit mass of households born at each date and live for two dates
- Set firms and work when old
- Can trade a one-period domestic nominal bond in zero net supply
- Quasi-linear preferences:

$$\ln C_t + \frac{C_{t+1} - N_t^{1+\eta}}{R}$$
Perfect-foresight model

- Domestic consumption services $C_t$ are produced combining the tradable good $C_t^T$ and two nontradable goods $C_t^{N1}$ and $C_t^{N2}$:

$$C_t = \frac{(C_t^T)^{\alpha} (C_t^{N1})^{\beta} (C_t^{N2})^{\gamma}}{\alpha^\alpha \beta^\beta \gamma^\gamma}$$

where

$$\alpha + \beta + \gamma = 1$$

yielding a domestic CPI:

$$P_t = (P_t^T)^{\alpha} (P_t^{N1})^{\beta} (P_t^{N2})^{\gamma}$$

- Important ingredient: prices of nontradable goods are more rigid than that of the tradable good (Burstein, Eichenbaum, and Rebelo, 2005)
Nominal rigidities

“PPP at the docks:”

\[ P^T_t S_t = 1 \]

The first nontradable good has a flexible price and can be transformed into \( F \) units of the tradable good:

\[ P_{t}^{N_1} = F P^T_t \]

The second nontradable good has a fully rigid price:

\[ P_{t}^{N_2} = 1, \]

which implies:

\[ P_t = \left(P^T_t\right)^\alpha \left(P^{N_1}_t\right)^\beta \left(P^{N_2}_t\right)^\gamma = \left(P^T_t\right)^{1-\gamma} F^\beta = (S_t)^{\gamma-1} F^\beta \]
Global investors

Unit mass of global investors consume the tradable good and can

- invest in USD-denominated assets earning a return $I^*$
- trade bonds denominated in the domestic currency with young households
- position in domestic bonds of any global investor must lie in the interval $[P_tL^-, P_tL^+]$, where these limits are denominated in the domestic currency

- $L_t \in [L^-, L^+] = \text{aggregate real borrowing by young households from global investors at date } t$
Local monetary policy

- The local central bank pins down inflation using an interest rate feedback rule

\[ I_{t+1} = R \left( \frac{P_t}{P_{t-1}} \right)^{1+\Phi} \]

- \( \Phi > 0 \) (Taylor principle)
A perfect-foresight equilibrium is such that

- The small open economy is in equilibrium
- Global investors trade optimally:

\[ L_t = \begin{cases} 
  L^+ & \text{if } \Theta_{t+1} > 1 \\
  L^- & \text{if } \Theta_{t+1} < 1 \\
  \in (L^-, L^+) & \text{if } \Theta_{t+1} = 1
\end{cases} \]

where

\[ \Theta_{t+1} = \frac{S_{t+1}/l_{t+1}}{S_t/l^*} \]

is the USD return on domestic bonds relative to that on USD-denominated bonds.
This is a simple log-linear model. Let

\[ r = \ln R \]
\[ r - \delta = \ln I^* \]
\[ \theta_t = \ln \Theta_t \]
\[ i_t = \ln I_t \]
\[ s_t = \ln S_t \]
\[ l_t = \ln L_t \]
\[ \pi_{t+1} = \ln \left( \frac{P_{t+1}}{P_t} \right) \]
Equilibrium

- Taylor and Euler yield

\[
\pi_{t+1} = r + (1 + \Phi)\pi_t
\]

\[
\pi_{t+1} = r - l_t + \pi_{t+1}
\]

\[
\pi_t = \frac{-l_t}{1 + \Phi} + \frac{\pi_{t+1}}{1 + \Phi}
\]

\[
\pi_t = -\sum_{k\geq 0} \frac{l_{t+k}}{(1 + \Phi)^{k+1}}
\]

- Future capital inflows (outflows) lead inflation to be below (above) targets
“Pass through” equation \( P_t = (S_t)^{\gamma - 1} F^\beta \)

\[ \rightarrow s_{t+1} - s_t = -\frac{1}{1 - \gamma} \pi_{t+1} \]

Thus

\[ \theta_{t+1} = s_{t+1} - s_t + i_{t+1} - \ln I^* \]

\[ = -\frac{1}{1 - \gamma} \pi_{t+1} + \pi_{t+1} - l_t + \delta \]

\[ = \frac{\gamma}{1 - \gamma} \sum_{k \geq 0} \frac{l_{t+k+1}}{(1 + \Phi)^{k+1}} - l_t + \delta \]
Steady-states with constant \( l \)

- Let \( l^{*} \) such that

\[
\frac{\gamma - \Phi (1 - \gamma)}{(1 - \gamma) \Phi} l^{*} + \delta = 0.
\]

Then \( l = l^{*} \) is a steady-state in which uncovered interest parity (UIP) holds. If \( \Phi(1 - \gamma) > \gamma \), there is no other steady-state solution. However, if \( \Phi(1 - \gamma) < \gamma \), there are two further steady-state solutions; there is a steady-state with maximum capital inflows, and there is a steady-state with maximum capital outflows.

In the steady-state with maximum inflows, the domestic currency appreciates. In the steady-state with maximum capital outflows, the domestic currency depreciates. Uncovered interest parity fails in both cases and global investors earn rents.
Intuition

1. Capital inflows push local bond prices up and lead inflation to be below target
2. Sticky prices of nontradable goods → tradable prices need to adjust more
3. This leads to an appreciation of the nominal exchange rate which more than compensates the low return on domestic bonds for global investors → Multiple self-justified equilibria

Next: model with a unique equilibrium in which a stochastic interest-rate differential serves as a coordination device for global investors
Stochastic model

- Time is continuous

- The USD interest rate is stochastic: $R\left(1 - w_t\right)$, where $w_t$ is a Brownian motion

- Each global investor can revise his lending policy only at discrete switching dates that are generated by a Poisson process with intensity $\lambda$. In between two switching dates, each investor commits to lend a fixed real amount
Stochastic model

- Investor "long" if committed to maximum lending $L^+$ at his last switching date, "short" if committed to the minimum lending $L^-$

- $x_t =$ fraction of long investors at date $t$. Endogenous state variable, Lipschitz continuous
Main proposition

Suppose that

$$\gamma > \Phi(1 - \gamma).$$

For $\lambda$ sufficiently small, there exists a unique equilibrium defined by a decreasing Lipschitz function $f$ such that

$$\frac{dx_t}{dt} = \begin{cases} 
-\lambda x_t & \text{if } w_t < f(x_t), \\
\lambda(1 - x_t) & \text{if } w_t > f(x_t).
\end{cases}$$
Equilibrium dynamics (1)

\[ w = f(x) \]

\[ dx = \lambda(1-x)dt \]

\[ dx = -\lambda x dt \]
Equilibrium dynamics (2)

Sample paths of $x$ and $w$
Profitability of FX momentum strategies

- Because returns are positively auto-correlated
- Particularly so if frontier flat and \( \sigma \) small
  \( \rightarrow \) long, frequent bifurcations
Profitability of FX carry trades

A sufficiently positive (negative) interest-rate differential predicts a positive (negative) return on the carry-trade for sufficiently large absolute differentials.
Peso problem

- Fix $\epsilon$ small
- As $\sigma \to 0$, most paths starting from $(f(\epsilon), \epsilon)$ will exhibit long periods of appreciation of the domestic currency ended with rare (and large) depreciations, while paths starting from $(f(1 - \epsilon), 1 - \epsilon)$ will feature a symmetric prolonged depreciation.
- The interest-rate differential is positive in the former case and negative in the latter
- Thus, finite samples should yield that a positive interest-rate differential predicts a positive excess return on the carry trade even when the true return is zero.
Leverage and currency appreciation predict financial crises

- Gourinchas and Obstfeld (2011) find that credit expansion and appreciation of the domestic currency predict financial crises.
- The build up of leverage and currency appreciation correspond to paths in which $x$ increases for a long time.
- Such paths are the ones in which sharp deleveraging and important capital outflows are most likely to occur soon other things being equal.
Monetary policy and carry-trade returns
- The frontier is flatter when $\Phi$ is smaller and $\gamma$ larger.
- If an economy is such that the CPI is not too sensitive to the exchange rate, and/or the central bank not too aggressive, then this economy should be more prone to large fluctuations in carry-trade activity.
- Returns on carry-trade and momentum strategies should have fatter tails.