Macroeconomics B, EI060

Class 8

Mundell-Fleming and overshooting

Cédric Tille

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What you will get from today class

LINK NOM ⟷ REAL

- Exchange rate in the presence of sticky prices.
- The Mundell-Fleming model. IS-LM
    - Solution in charts and analyitcal terms (Harms IX.2).
    - Policy choice depending on the exchange rate regime.
- Exchange rate overshooting (Obstfeld and Rogoff 9.2.1-9.2.3, Harms VIII.5 (secondary).
    - Phase diagram solution.
    - Analytical results, and intuition for overshooting.

A question to start

RECESSION → FX DEPR. → COMPETITIVE
! VOLATILITY

FRIEDMAN / MUNDELL

Movements in the global business cycle transmit to a small country's output. Letting the exchange rate move is the best way to insulate local domestic activity.

TRILEMMA
→ FX FIX
→ INDEP.
→ K FLOWS

Do you agree? Why or why not?

SIMPLE MACROECONOMIC MODEL

Keynesian open economy

- Based on IS-LM. ! LUCAS CRITIQUE
  - Ad-hoc behavioral rules, no optimization.
  - Prices are set and output is driven by demand (enough unused capacity to produce).
  - Useful first step for analysis, but then proceed to models with more solid foundations.
- Interaction between three markets: goods, money, international financial market.
  - Each represented by one line linking GDP and the interest rate.

    Y i

The market for goods

- Allocation of GDP y between private consumption c, government spending g, investment inv, and net exports, nx :

$$y = c + inv + g + nx$$

- Consumption is linked to GDP through the propensity to consume ($\gamma < 1$), and investment is negatively linked to the interest rate i^H:

$$c = \gamma y \quad ; \quad inv = -\sigma i^H$$

- Net exports are higher when the exchange rate e is depreciated (higher value of e). Imports in proportion to GDP:

$$nx = e - \rho y$$

- Negative relation between y and i^H, moved by shocks ξ (foreign demand, consumer or business confidence):

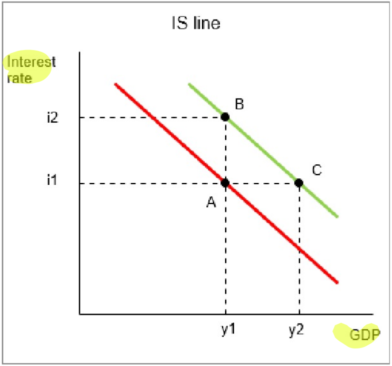
ENDOG.

$$y = \gamma y - \sigma i^H + g + \delta e - \rho y + \xi$$

$$y = -\frac{\sigma}{1-\gamma+\rho} i^H + \frac{\delta}{1-\gamma+\rho} e + \frac{g+\xi}{1-\gamma+\rho}$$

The IS line

- Higher interest rate reduces investment and output (movement **along** the line).
- For a given interest rate, higher government spending, a depreciated currency, or positive shock increase output (movement **of** the line to the right / top from IS0 to IS1).



The market for money

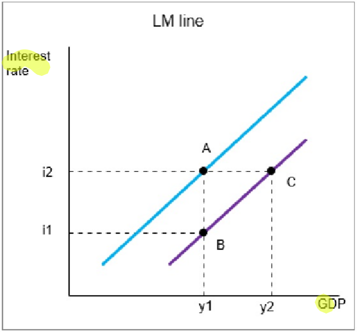
- Demand for money (real balances) $m - p$ is increasing with output, decreasing with the interest rate, i^H, and reflects a shock ζ.

$$m - p = \phi y - \lambda i^H + \zeta$$

- Positive relation between y and i^H, shifted by m.
  - Higher output raises the demand, must be offset by a higher interest rate.

The LM line

- Higher interest rate in reaction to higher output (movement **along** the line).
- For a given interest rate, an monetary expansion *m* raises output (movement **of** the line to the right / bottom from TR0 to TR1).



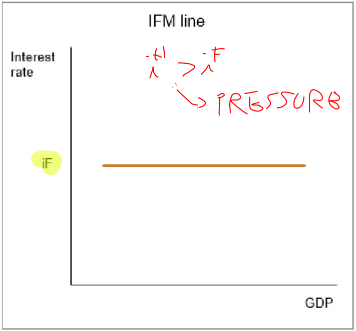
Global financial market

- Uncovered interest parity. Domestic interest rate tied to foreign rate, i^F, and expected depreciation, $e^e - e$:

$$i^H = i^F + e^{e\text{xp}} - e$$

- This relation does not depend on GDP. For simplicity, consider permanent shocks such that $e^e - e$, $= 0$ which implies $i^H = i^F$.
    - The exchange rate may be pegged.
    - The exchange rate may float, but the movement happens entirely
JUMP today, and from then on it is stable at a new level (which can be different from yesterday).
- At a point where $i^H > i^F$, there is an appreciation pressure on the currency (but this point is not the final equilibrium).

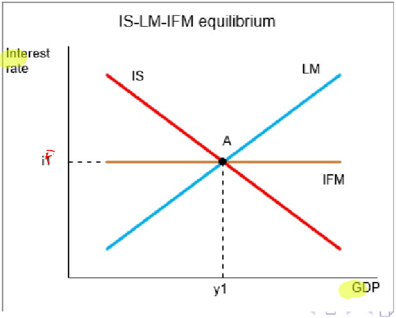
- Horizontal line, as y does not enter.
- It is only shifted by a movement in i^F, i.e. conditions on world financial markets.



$i^H > i^F$ → PRESSURE APPR.

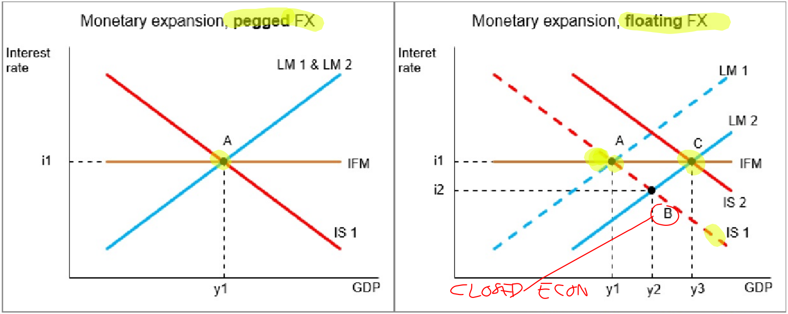
Equilibrium

- The three lines cross. How can we be sure?
- 3 endogenous variables: GDP y, interest rate i^H, and exchange rate e (implicit in IS). One line will always do the adjustment.
- i^F is given, so IFM is set.
  - Floating exchange rate: line ~~TR~~ LM is set, so e is such that the line IS is in the right place.
  - Pegged exchange rate: e is set, and so is the line IS. The central bank sets m so ~~TR~~ LM is in the right place.



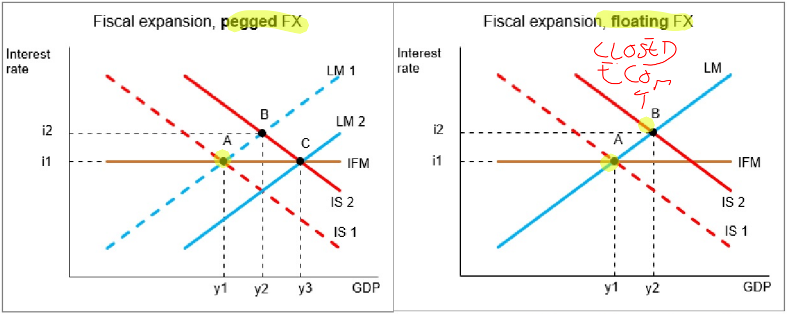
Monetary expansion

- Start at point A, and increase m. Line LM shifts to the right.
- With a floating exchange rate (right panel) we get to point B, where $i^H < i^F$. Pressure for depreciation, so e increases, and moves IS to the right. Final equilibrium at point C, with big GDP increase.
- With a pegged exchange rate (left panel), central bank cannot let the exchange rate depreciate. It must move ~~IR~~ LM back to the initial situation (point A). Nothing happens.



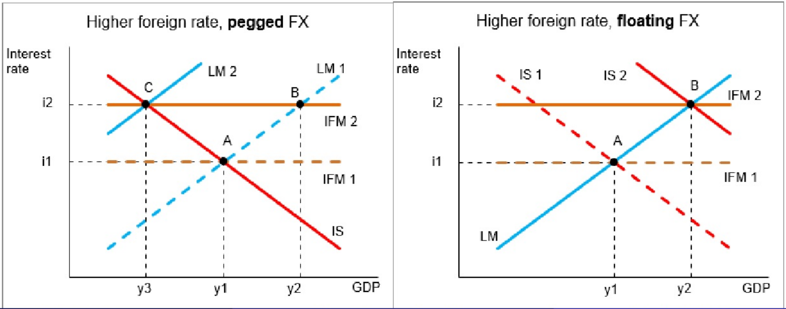
Fiscal expansion

- Start at point A and increase g. Line IS shifts to the right.
- With a floating exchange rate (right panel) we get to point B, where $i^H > i^F$. Pressure for appreciation, so e decreases, and moves IS to the left. Final equilibrium back at point A, nothing has changed.
- With a pegged exchange rate (left panel), central bank cannot let the exchange rate appreciate. It must move LM to the new intersection of IFM and IS (point C) by raising m. Large GDP increase.



Higher world interest rate

- Start at point A and increase i^F (could be due to a risk premium on the country). Line IFM shifts up. At the intersection of initial IS and LM TR, $i^H < i^{F,new}$, pressure for depreciation.
- With a floating exchange rate (right panel) e increases, and moves IS to the right. Final equilibrium at point B, with GDP expansion.
- With a pegged exchange rate (left panel), central bank cannot let the exchange rate depreciate. It must move LM to the new intersection of IFM and IS (point C) by reducing m. GDP decreases.



Analytical solution

- The interest parity implies that $i^H = i^F$.
- With a peg, e is set. IS gives output and LM the money supply:

$$y = \frac{-\sigma i^F + (g + \delta e) + \xi}{1 - \gamma + \rho}$$

X m

$$m = \frac{1}{1 - \gamma + \rho}\left[\phi\left(g + \delta e\right) - \left(\lambda\left(1 - \gamma + \rho\right) + \sigma\phi\right) i^F + \xi\right] + \zeta$$

RESID

  - Output is only affected by fiscal policy and real shocks to the market for goods, ξ.
- With a float, m is set. LM gives output and IS the exchange rate:

$$y = \frac{m}{\phi} + \frac{\lambda i^F - \zeta}{\phi}$$

X g X ξ

$$e = \frac{1 - \gamma + \rho}{\phi\delta} m - \frac{g}{\delta} + \left(\frac{1 - \gamma + \rho}{\phi\delta}\lambda + \frac{\sigma}{\delta}\right) i^F - \left(\frac{1 - \gamma + \rho}{\phi\delta}\zeta + \frac{\xi}{\delta}\right)$$

  - Output is only affected by monetary policy and nominal shocks to the money market, ζ.

General message: policy effectiveness

- Effectiveness of policies depend on the exchange rate regime.
- With a pegged exchange rate, monetary policy is geared totally towards stabilizing the exchange rate.
  - Independent monetary expansions are not possible.
  - Fiscal expansions are powerful, as amplified by monetary reactions.
  - Tighter conditions in world financial market leads to recessions.
- With a floating exchange rate, monetary policy is not constrained and the exchange rate can move.
  - Monetary expansions are powerful, as the exchange rate movements are another transmission channel.
  - Fiscal expansions are do not affect GDP, but impact the composition. An expansion raise government spending, offset by lower net exports because the exchange rate appreciates.
  - Tighter conditions in world financial market are absorbed by the exchange rate.

General message: optimal stabilization

MIN V(Y)

REAL

- Which policy should we use if there are shocks moving IS and LM? Aim is to stabilize GDP.

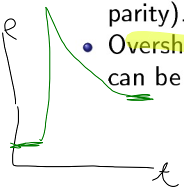
NOMINAL

- A shock moving LM can be absorbed by moving m to offset it.
  - Pegged exchange rate is a way to do that. All the central bank has to to is keep the exchange rate steady.
  - A floating exchange rate would let IS move and amplify the impact of the shock. TRANSMLISSION
- A shock moving ~~LM~~ IS can be absorbed by letting e offset it.
  - Floating exchange rate is a shock absorber for shocks affecting the goods market, such as movements in foreign demand.
  - A pegged exchange rate would move ~~TR~~ LM in a way that amplifies the shocks.
- Peg if you face shocks mostly in LM, otherwise float.

EXCHANGE RATE OVERSHOOTING

High exchange rate volatility

- Move to flexible exchange rates after Bretton Woods (1973), followed by very volatile exchange rates.
- Hard to reconcile with fundamentals, even accounting for the forward looking nature of the exchange rate.
- Stickiness in the price of goods can help.
  - The exchange rate must clear both the market for goods (through its level) and the money market (through its dynamics, uncovered interest parity).
  - Overshooting – a higher depreciation on impact than in the long run – can be the only way to achieve this.



- Perfect foresight for simplicity.
- Money demand and uncovered interest rate parity:

$M^s \uparrow \quad M^d \uparrow \quad Y \uparrow \quad i \downarrow \Rightarrow \boxed{e_{t+1} - e_t}$

$$
\begin{aligned}
m_t - p_t &= -\eta i_{t+1} + \phi y_t \qquad = LM \\
i_{t+1} &= i^* + e_{t+1} - e_t
\end{aligned}
$$

- Increasing the money demand could require a low interest rate i_{t+1}.
  - This can only happen if the currency is expected to appreciate $e_{t+1} - e_t < 0$.
  - The exchange rate clears the money market through its dynamics.

Adjustment of the price of goods

- Real exchange rate: $q_t = e_t + p^* - p_t$. If prices are flexible, the real rate is $\bar{q}$. PPP : $\bar{q} = \emptyset$
- $\tilde{p}_t$: price that gives $q_t = \bar{q}$, given the nominal exchange rate e_t :

$$\tilde{p}_t = e_t + p^* - \bar{q}$$

- Prices of goods are sticky. Inflation is driven by two components. The output gap, y minus its flexible price value $\bar{y}$, and inflation under flexible prices.

AS →

$$\begin{aligned} p_{t+1} - p_t &= \psi (y_t - \bar{y}) + (\tilde{p}_{t+1} - \tilde{p}_t) \\ p_{t+1} - p_t &= \psi (y_t - \bar{y}) + (e_{t+1} - e_t) \end{aligned}$$

- With constant p^*, the real exchange rate dynamics reflect the output gap:

$$q_{t+1} - q_t = -\psi (y_t - \bar{y})$$

.

Output

- Output deviates from $\bar{y}$ (flexible price value) when the real exchange rate is weaker than $\bar{q}$:

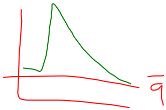
AD/IS ←

$$y_t - \bar{y} = \delta(q_t - \bar{q})$$

- A weak currency stimulates demand.
- The exchange rate clears the money market through its level (via the real exchange rate and output).

Real exchange rate dynamics

- Dynamics of the real exchange rate (from price adjustment), combined with level impact on output gap:

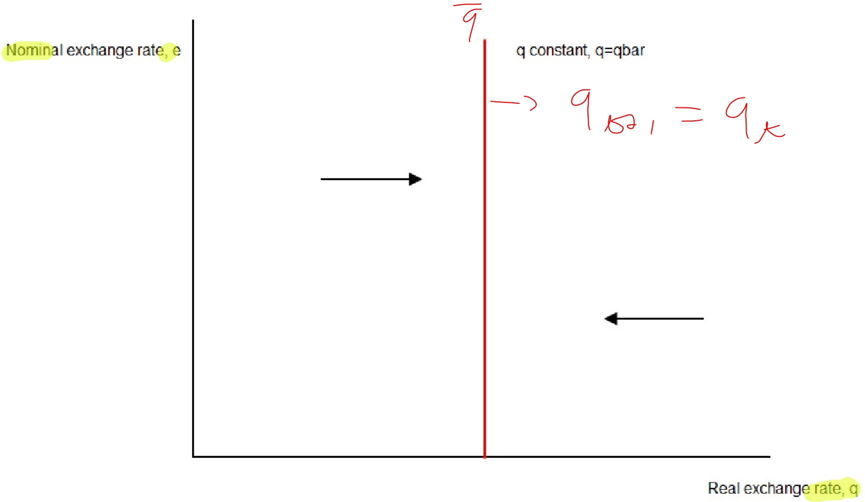


$$
\begin{aligned}
\text{AS} \quad q_{t+1} - q_t &= -\psi \left(y_t - \bar{y} \right) \\
q_{t+1} - q_t &= -\psi\underbrace{\delta \left(q_t - \bar{q} \right)}_{\text{AD}}
\end{aligned}
$$

- Reversion to the mean, the faster when $\psi\delta$ is high.
- Assume sluggish adjustment is sluggish: $\psi\delta < 1$.
  - δ: output sensitivity to real exchange rate (aggregate demand).
  - ψ: inflation sensitivity to the output gap ψ (slope of Phillips curve).
- First line of a phase diagram in a q - e space.

Phase diagram: q

- Real exchange rate constant if $q_t = \bar{q}$.
- Converges to that line if we start away from it.



Nominal exchange rate dynamics

- Combine the money demand, interest parity, and aggregate demand (foreign variables and $\bar{y}$ set to zero):

$$\begin{aligned} m_t - p_t &= -\eta i_{t+1} + \phi y_t \\ m_t - p_t &= -\eta \left(e_{t+1} - e_t\right) + \phi\delta \left(q_t - \bar{q}\right) \end{aligned}$$

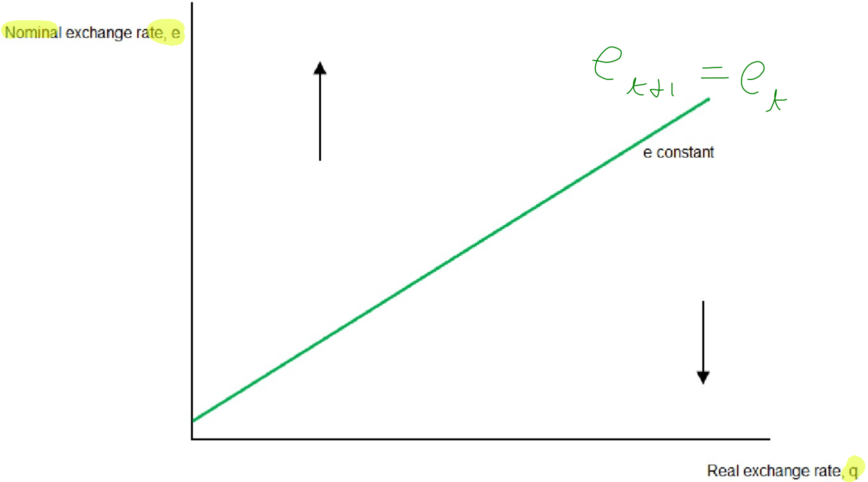
- Definition of the real exchange rate then gives the dynamics $e_{t+1} - e_t$ as a function of the level e_t, the level of q_t, and m_t:

$$e_{t+1} - e_t = \frac{e_t}{\eta} - \frac{1 - \phi\delta}{\eta} q_t - \frac{\phi\delta\bar{q} + m_t}{\eta}$$

- Second line of a phase diagram in a q - e space. $e_{t+1} - e_t = 0$ implies a positive relation between e_t and q_t (assuming $\phi\delta < 1$).
  - Nominal depreciation ($e_{t+1} - e_t > 0$) from a point above the line.
  - Higher m shifts the line upwards.

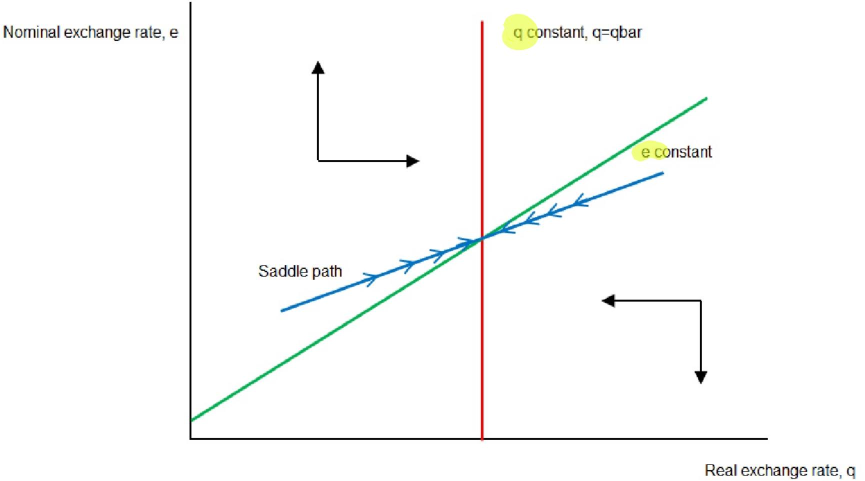
Phase diagram: e

- Nominal exchange rate constant on the line
- Diverge from the line if we start away from it.



Phase diagram

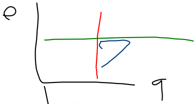
- Unique saddle path for convergence to constant real and nominal and exchange rates (ensures a unique solution).



Exchange rate overshooting

$M^s \uparrow$

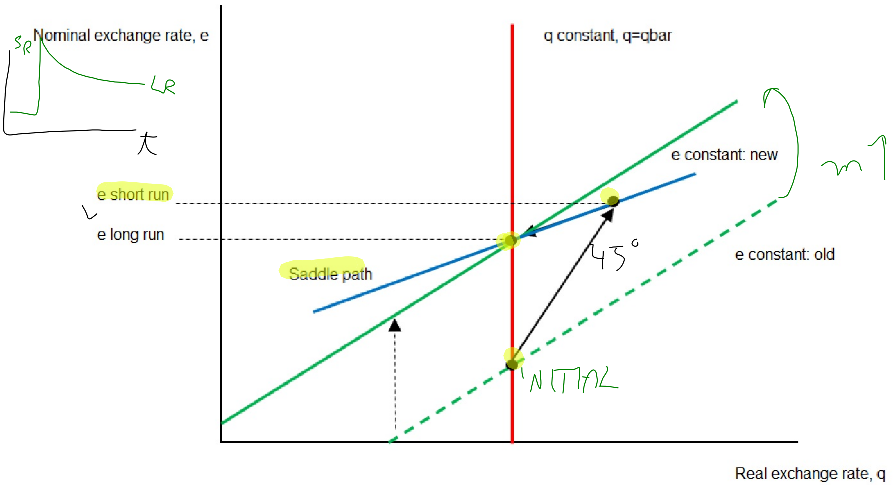
$L, q\uparrow \Rightarrow Y\uparrow \Rightarrow m^d\uparrow\ i = ?$ NOT $\Rightarrow i\downarrow$



- Start at the steady state where the two lines cross.
- Permanent increase in m: shifts the nominal exchange rate line up.
- Nominal depreciation larger in the short run than in the long run.
  - Necessary to be on the saddle path. The exchange rate then gradually converges.
- Depreciation identical in the short and long run if the nominal exchange rate line is flat, i.e. $\phi\delta = 1$.
  - Money demand is sensitive to output (ϕ), and /or output demand is sensitive to the real exchange rate (δ).
  - Depreciation raises output and money demand by enough to absorb the money supply without needing a change to the interest rate.

Adjustment

- Shift of the nominal exchange rate line, leading to a jump on the saddle path.



ANALYTICAL SOLUTION

- The economy starts at a steady state with $m_t = \bar{m}$.
- From that point m_t increases to $\bar{m}'$ permanently.
- In the long run the real exchange rate converges to $\bar{q}$.
- The money expansion depreciates the nominal exchange rate and raise the price of goods one-for-one:

$$\bar{e}' - \bar{e} = \bar{p}' - \bar{p} = \bar{m}' - \bar{m}$$

Real exchange rate dynamics

- Iterate forward the dynamic relation for the nominal exchange rate (green line in the diagram), with constant money:

$$e_t - \bar{q} = \frac{1-\phi\delta}{1+\eta\psi\delta}(q_t - \bar{q}) + m_t$$

  - Solution we saw under flexible prices: $q_t = \bar{q}$.
- Right after the shock, the price level has not moved: $p_0 = \bar{p} = \bar{m}$. Real exchange rate $q_0 = e_0 - p_0$ is then:

$$\begin{aligned} e_0 - \bar{q} &= \frac{1-\phi\delta}{1+\eta\psi\delta}(q_0 - \bar{q}) + \bar{m}' \\ q_0 + \bar{m} - \bar{q} &= \frac{1-\phi\delta}{1+\eta\psi\delta}(q_0 - \bar{q}) + \bar{m}' \\ q_0 &= \bar{q} + \frac{1+\eta\psi\delta}{\phi\delta+\eta\psi\delta}(\bar{m}' - \bar{m}) \end{aligned}$$

- Gradual convergence of real exchange to $\bar{q}$:

$$q_s - \bar{q} = (1-\psi\delta)^s (q_0 - \bar{q})$$

Nominal exchange rate dynamics

- Nominal exchange rate right after the shock is:

$$e_0 = p_0 + q_0 = \bar{m} + \bar{q} + \frac{1 + \eta\psi\delta}{\phi\delta + \eta\psi\delta} \left(\bar{m}' - \bar{m} \right)$$

- Long run nominal exchange rate is $\bar{e}' = \bar{q} + \bar{m}'$, hence:

$$e_{S.R} - e_{L.R} \longrightarrow \quad e_0 - \bar{e}' = \frac{1 - \phi\delta}{\phi\delta + \eta\psi\delta} \left(\bar{m}' - \bar{m} \right)$$

- $e_0 > \bar{e}'$ if $\phi\delta < 1$, i.e. money demand is not too sensitive to output, which is not too sensitive to the real exchange rate.
  - Exchange rate jumps to a level above the long run depreciation: high depreciation, followed by gradual appreciation.

- Higher money supply. Long run money market clears through higher prices and a weaker currency:

$$\bar{m}' = \bar{p}' - \eta i^* + \phi \bar{y}$$

- Short run depreciation raises output, which raises money demand.
  - If $\phi\delta < 1$ the extra output does not raise money demand enough.
  - Short run money demand is lower than money supply.
  - Money demand need to increase further through a decrease in interest rate (cannot happen through the sticky price level).
- Low interest rate requires a future appreciation because of interest parity $(e_{t+1} < e_t)$.
- Only way to generate a long run depreciation reach via an appreciation path is to depreciate even more in the short run.

Numerical illustration

- Set $\delta = 0.7$, $\eta = 2$, $\phi = 0.7$, $\psi = 0.5$, and move from $\bar{m} = 0$ to $\bar{m}' = 1$.