International Monetary Theory: Mundell Fleming Redux

by
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Motivation

- Global currency spillovers
  - “Flight to safety” - Dollar appreciation when risk rises
  - Local currency: good store of value/hedge for idiosyncratic risk
  - Global currency: good hedge for international competitiveness risk

- When to peg to world currency? When to dollarize?

- MoPo space: “Nuanced Mundell-Fleming Trilemma”
  - Local and global money have different risk profile (imperfect substitutes)
    ⇒ increases MoPo space
  - Too high inflation: local citizens substitute local currency for global currency
    ⇒ limits MoPo space

- Reserve currency management – Irrelevance theorem
# Modelling Framework

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### Risk & Dynamic financial frictions

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Basic “I Theory”
## Modelling Framework

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**Dynamic Impulse response**

- New Keynesian
- Obstfeld-Rogoff

**Modelling Framework**

- **Closed economy**
  - Static: Hick’s IS-LM

- **Open Economy**
  - Mundell-Fleming

- **Risk & Dynamic financial frictions**
  - Samuelson
  - Diamond
  - Bewley
  - Aiyagari
  - I Theory of Money

**Formulas**

- \( f'(k^*) = r^* \)
- Dynamic inefficiency: \( r < r^*, K > K^* \)
- Inefficiency: \( r < r^*, K > K^* \)
- Pecuniary externality: \( r > r^*, K < K^* \)
Frictions

- Incomplete markets
  - Within country
    - only w.r.t. idiosyncratic risk $d\tilde{Z}_t^i$
    - (other risks can be shared within national economy)
  - Across countries
    - Only global money can be traded

Money is a bubble
Like in Samuelson, Bewley

- Price are fully flexible
International setting

- **Small Economy**
  - Local currency
    - Store of value
    - Hedge against idiosyncratic risk
  - Consumption basket

- **Large Economy**
  - Global currency* $*
    - ...*
    - Hedge for SOE’s citizens against “international competitive risk”
  - Consumption basket*
International setting

- Small Economy
  - Local currency
    - Store of value
    - Hedge against idiosyncratic risk
  - Consumption basket
    - Non-tradable local good
    - Tradable good 1
    - Tradable good 2

- Large Economy *
  - Global currency* $ 
    - ... 
    - Hedge for SOE’s citizens against “international competitive risk”
  - Consumption basket*
    - Non-tradable good* $ a K_t^* 
    - Tradable global good 1 $ b_{1,t}^* K_t^* 
    - Tradable global good 2 $ b_{2,t}^* K_t^* 

\[
\frac{b_{2,t}^*}{b_{1,t}^*} \frac{b_{2,t}}{b_{1,t}} < \frac{b_{2,t}}{b_{1,t}}
\]
Intuition

- Purchase good 2 in exchange of good 1 (depends on ToT)
- Hold global money as Net Foreign Asset Position

Value of money – money is safe asset
  - Local money is store of value with nice hedge against idiosyncratic risk
  - Global money ($) hedges better "export risk" (competitiveness = ToT + productivity)
  - 2 money can coexist (even though both are "bubbles")
    - Different return-risk profile
Overview

- **Large country**
  - Portfolio choice between
    - Physical capital $k_t^*$
    - US Dollar, $ – “bubble in positive net supply”
  - No state variable: due to scale invariance

- **Small country**
  - Portfolio choice between
    - Physical capital $k_t$
    - Peso “hedge against idiosyncratic shocks”
    - US Dollar, $ “hedge against ToT + export productivity shocks”
  - State variable $\nu_t$:
    Accumulation dynamics of foreign asset position (in $)$
Large country

\[ E \left[ \int_0^\infty e^{-\rho t} \log c_t^* \, dt \right] \]

- **Consumption** Cobb-Douglas preferences (over 1 non-tradable one 2 tradable goods)
  \[(c_{0,t})^{(1-\alpha)} ((c_{1,t})^\beta (c_{2,t})^{(1-\beta)})^\alpha\]

- **Investment** rate \( i^* \) in terms of non-tradable local good

- **Evolution of physical capital stock**
  \[ \frac{dk_t^*}{k_t^*} = (\Phi(i^*) - \delta) \, dt \]

- **Output shocks** *per unit of capital*
  - Determines relative prices
  - ... has to be indifferent

- **Idiosyncratic real cash flow shocks**

- **Net worth dynamics:**
  \[ \frac{dn_t^*}{n_t^*} = \theta_t^* r^M^* \, dt + (1 - \theta_t) r^K^* \, dt - \frac{c_t^*}{n_t^*} \, dt + \tilde{\sigma} \frac{k_t^*}{n_t^*} d\tilde{Z}_t^* + \frac{\tau_t^*}{n_t^*} \, dt \]

- **Value of output of all goods produced**
  \[ a^* K_t^* \]

- Numeraire is non-tradable local good
Non-tradeable to consumption basket

- Tradeable, non-tradeable good 1 and 2
  - $a^*$ units of non-tradeable good buy
    - $b_{1,t}^*$ of tradeable good, or
    - $(a^*)^{1-\alpha}(b_{1,t}^*)^{\alpha\beta}(b_{2,t}^*)^{\alpha(1-\beta)}$ units of the “aggregate good” (consumption basket).
  - Hence, production of consumption basket is

\[
(a^* - \ell_t^*)(b_t^*)^\alpha K_t^*, \text{ with } b_t^* = \frac{(b_{1,t}^*)^\beta(b_{2,t}^*)^{1-\beta}}{a^*}
\]

Numeraire is consumption basked in large country
Return on global money ($)

- In terms of non-tradable local good (as numeraire)
  (which is used for investment rate $i_t^*$)

\[
r^* dt = (\Phi(i^*) - \delta) dt \quad \text{is risk free}
\]

- Change of numeraire
  In terms of tradable basket (change of numeraire)

\[
r_t^G \equiv r^* dt + \frac{d b_t^*}{b_t^*}
\]

- Where price of non-tradable good in terms of tradable basket

\[
b_t^* = \left(\frac{b_1^*}{a^*}\right)^\beta \left(\frac{b_2^*}{a^*}\right)^{1-\beta}
\]

- Special case: \((b_{1,t}^*)^\beta (b_{2,t}^*)^{1-\beta}\) and hence \(b_t^*\) is constant
1. Postulate
   • Price processes \( \frac{dp_t^*/p_t^*}{dt} = \mu_t^p \ dt + \sigma_t^p dZ_t^*, \quad \frac{dq_t^*/q_t^*}{dt} = \ldots \)
   • Portfolio processes \( \frac{d\theta_t^*/\theta_t^*}{dt} \)

2. Derive return processes
   • \( dr^{K*} = (\Phi(i^*) - \delta) dt + \frac{a^* - i^*}{q} dt + \tilde{\sigma} d\tilde{Z}_t \)
   • \( dr^{M*} = (\Phi(i^*) - \delta) dt - (\mu_t^{M*} - \mu_{M_i^*}) dt \)

   money supply growth rate that is NOT distributed via interest payment
   Set \( \mu_{M_i^*} = 0 \)

3. Optimality conditions & Market clearing conditions

4. Solve "undetermined coefficients" \( (\mu^x(s_t), \sigma^x(s_t)) \)
   • Solving ODE with boundary conditions
   • For large country: simply solve for constants
Solving

1. Postulate
   - Price processes $p^*_t, q^*_t$
   - Portfolio processes $\theta^*_t$

2. Derive return processes
   - $dr^K = (\Phi(l^*) - \delta)dt + \frac{a^*-l^*}{q}dt + \frac{\bar{\sigma}}{q}d\tilde{Z}_t$
   - $dr^M = (\Phi(l^*) - \delta)dt - (\mu^M - \mu^{Mi*})dt$

   money supply growth rate that is NOT distributed via interest payment
   Set $\mu^{Mi*} = 0$

3. Optimality conditions & Market clearing conditions

4. Solve “undetermined coefficients” $(\mu^x(s_t), \sigma^x(s_t))$
   - Solving ODE with boundary conditions
   - For large country: simply solve for constants
Optimality (=) & market clearing (=)

- **Investment rate, \( i^* \)**
  - Tobin’s q: \( \Phi'(i^*) = \frac{1}{q^*} \) (static problem)
    - For \( \Phi(i^*) = \frac{1}{\kappa} \log(\kappa i^* + 1) \Rightarrow \kappa i^* = q^* - 1 \)

- **Portfolio choice, \( \theta^* \)**
  - \( E[dr^{K*} - dr^{M*}] / dt = Cov[dr^{K*} - dr^{M*}, \frac{dn^*_t}{n^*_t}] = (1 - \theta^*)(\bar{\sigma}^*/q)^2 \)
  - \( 1 - \theta^* = \frac{E[dr^{K*} - dr^{M*}] / dt}{(\bar{\sigma}^*/q^*)^2} = \frac{(a^* - i^*)/q^* + \mu^M_*}{(\bar{\sigma}^*/q^*)^2} = \frac{q^*}{q^* + p^*} \)  
    - Dividend yield on capital must be \( \rho \)

- **Consumption**
  - Demand: \( \rho N^*_t = \rho (q^* + p^*) K^*_t = (a^* - i^*) K^*_t \)  
    - Supply: \( q^* = \frac{q^*}{q^* + p^*}(a^* - i^*)/\rho \)  
      \( = 1 - \theta^* \)  
      - Capital market clearing
  - Output market clearing
### Equilibrium

#### Moneyless equilibrium

\[ p_0^* = 0 \]

\[ q_0^* = \frac{\tilde{\sigma}^*}{\sqrt{\rho + \hat{\mu}^{M*}}} \]

\[
\text{where } \hat{\mu}^{M*} = \frac{(1 - \theta^*)}{\text{portfolio share}} \mu^{M*} \text{ (monotone transformation)}
\]

- Numeraire is local good

#### Money equilibrium

\[ p^* = \frac{\tilde{\sigma}^*(1 + \kappa \rho)}{\sqrt{\rho + \hat{\mu}^{M*}}} - (1 + \kappa a^*) \]

\[ q^* = (1 + \kappa a^*) - \frac{\kappa \rho \tilde{\sigma}^*}{\sqrt{\rho + \hat{\mu}^{M*}}} \]
Optimal Monetary Policy

- Money growth $\mu$ affects inflation in two ways
  \[ \pi = \mu^M - (i^* (\mu^M - \mu^{M,i^*}) - \delta) \]
  *$g$* boosts growth like in Tobin (1965)

- MoPo can **correct pecuniary externality**
  - Citizens take real interest rate as given when choosing their portfolio between money & physical capital
  - Money exists for $\sigma^* > \sqrt{\rho}$
  - Money growth $> 0$ is optimal for $\sigma^* > 2\sqrt{\rho}$ (for $\kappa = 0$)

- MoPo **improves insurance** provided by “safe asset”
  - Constrained optimal!
  - Incentive compatible

- Money is neither neutral nor super-neutral (no price stickiness)
Overview

- **Large country**
  - Portfolio choice between
    - Physical capital $k^*_t$
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- **Small country**
  - Portfolio choice between
    - Physical capital $k_t$
    - Peso “hedge against idiosyncratic shocks”
    - US Dollar, $-$ “hedge against ToT + export productivity shocks”
  - State variable $\nu_t$:
    
    Accumulation dynamics of foreign asset position (in $)\n    \[ \mu_t^x = \mu^x(\nu_t), \quad \sigma_t^x = \sigma^x(\nu_t) \]
Small country

- Small country cannot produce tradable good 2
- Tradable basket can be traded for global good 1 at rate

\[ b_t := \underbrace{b_{1,t}}_{\text{Productivity}} \left( \frac{b_{2,t}^*}{b_{1,t}^*} \right)^{1-\beta} = \frac{b_{1,t}^*}{b_{1,t}} \left( \frac{b_{2,t}^*}{b_{1,t}^*} \right)^{\beta} \left( \frac{b_{2,t}}{b_{1,t}} \right)^{1-\beta} \]

- Short-cut thinking: one unit of capital produces \( b_t \) units of tradable basket (while actually it produces only good 1 at rate \( b_1 \) and trades some of them for tradable good 2)

\[ \frac{db_t}{b_t} = \mu^b dt + \sigma^b dZ_t \]

since all \( b_{1,t}^*, b_{2,t}^*, b_{1,t}^* \) are (correlated) geometric Brownian.

Ito product rule: \( d(X_t Y_t) = dX_t Y_t + X_t dY_t + \sigma_X \sigma_Y dt \)

- Return on global money can be written as

\[ dr_t^G = \mu^G dt + \sigma^G dZ_t + \sigma^{G,*} dZ^* \]

Part of \( b_t^* \) which is orthogonal to \( b_t \)
Small country

- **Same preferences:**
  - \( E \left[ \int_0^\infty e^{-\rho t} \log c_t \, dt \right] \)
  - \( (c_{0,t})^{(1-\alpha)} (c_{1,t}^{\beta} c_{2,t}^{(1-\beta)})^{\alpha} \)

- \( \hat{\alpha}_t K_t \) devoted to **produce** tradable good 1
  - Can be traded for tradable basket since small county can’t produce tradable good 2 itself

- \( \xi_t b_t K_t \) **consumption** of tradable goods basket

- \( (\hat{\alpha}_t - \xi_t) b_t K_t \) **trade-imbalance** (net export)

- \( G_t > 0 \) **Net foreign asset position** (only global money)
  (in tradable goods basket)

\[
\frac{dG_t}{G_t} = dr_t^G + \frac{(\hat{\alpha}_t - \xi_t) b_t K_t}{G_t} dt
\]
State variable

- Equilibrium is a map

Histories of shocks \( \{Z_\tau, Z^*_\tau, 0 \leq \tau \leq t\} \) \hspace{1cm} \text{to prices } q_t, p_t, \text{ allocation } \hat{\alpha}_t, \iota_t, \xi_t \& \text{portfolio } (1 - \theta_t - \zeta_t, \theta_t, \zeta_t)

net foreign asset position to tradable production potential

\[ \nu_t = \frac{G_t}{b_t K_t} \]

- Evolution

\[
\frac{d\nu_t}{\nu_t} = d'r^G_t + \frac{\hat{\alpha}_t - \xi_t}{\nu_t} dt - \frac{db_t}{b_t} - (\Phi(\iota_t) - \delta) dt + \sigma^b (\sigma^b - \sigma^G) dt = \\
\frac{\hat{\alpha}_t - \xi_t}{\nu_t} dt + \left(\mu^G - \mu^b + \sigma^b (\sigma^b - \sigma^G) + \delta\right) dt - \Phi(\iota_t) dt + (\sigma^G - \sigma^b) dZ_t + \sigma^{G,*} dZ^*_t.
\]
Portfolio choice & Asset pricing

- Portfolio share (processes)
  - Local money
    \[ \frac{d\theta_t}{\theta_t} = \mu_t^\theta \, dt + \sigma_t^\theta \, dZ_t + \sigma_t^{\theta,*} \, dZ^*_t \]
  - Global money
    \[ \frac{d\zeta_t}{\zeta_t} = \mu_t^\zeta \, dt + \sigma_t^\zeta \, dZ_t + \sigma_t^{\zeta,*} \, dZ^*_t \]
Portfolio choice & Asset pricing

- Portfolio share (processes)
  - Local money
    \[ \frac{d\theta_t}{\theta_t} = \mu_t^\theta dt + \sigma_t^\theta dZ_t + \sigma_t^{\theta,*} dZ^* \]
  - Global money
    \[ \frac{d\zeta_t}{\zeta_t} = \mu_t^\zeta dt + \sigma_t^\zeta dZ_t + \sigma_t^{\zeta,*} dZ^* \]

- Returns expressed with country net worth \( N_t \) as numeraire
  - Return on individual net worth
    \[ dr^n_t = \rho dt + \left( 1 - \theta_t - \zeta_t \right) \bar{\sigma}(q_t) \]
  - Return on local money
    \[ dr^{ML}_t = \frac{d\theta_t}{\theta_t} \]
    Money worth \( \theta \) net worths
  - Return on global money (\$)
    \[ dr^{MG}_t = \frac{\xi_t - \tilde{\alpha}_t}{\nu_t} dt + \frac{d\zeta_t}{\zeta_t} \]
    Assuming no seignorage
Portfolio choice & Asset pricing

- Portfolio share (processes)
  - Local money
    \[ \frac{d\theta_t}{\theta_t} = \mu_{\theta} dt + \sigma_{\theta} dZ_t + \sigma_{\theta}^* dZ^* \]
  - Global money
    \[ \frac{d\zeta_t}{\zeta_t} = \mu_{\zeta} dt + \sigma_{\zeta} dZ_t + \sigma_{\zeta}^* dZ^* \]

- Returns expressed with country net worth \( N_t \) as numeraire
  - Return on individual net worth
    \[ dr_t^n = \rho dt + (1 - \theta_t - \zeta_t) \frac{\sigma(q_t)}{\sigma^n} d\tilde{Z}_t \]
  - Return on local money
    \[ dr_t^{ML} = \frac{d\theta_t}{\theta_t} \]
  - Return on global money ($)
    \[ dr_t^{MG} = \frac{\xi_t - \tilde{\alpha}_t}{\nu_t} dt + \frac{d\zeta_t}{\zeta_t} \]

- Asset pricing equation (due to log utility)
  \[ E[dr_t^n - dr_t^{ML}] = Cov[dr_t^n - dr_t^{ML}, dr_t^n] \Rightarrow \rho - \mu_{\theta} = (\tilde{\sigma}^n)^2 \]
  \[ E[dr_t^n - dr_t^{MG}] = Cov[dr_t^n - dr_t^{MG}, dr_t^n] \Rightarrow \rho - \frac{\xi_t - \tilde{\alpha}_t}{\nu_t} - \mu_{\zeta} = (\tilde{\sigma}^n)^2 \]

Price of risk × risk
Consumption & Investment

- Consumption Demand
  \[ \rho \frac{G_t}{\zeta_t} = \frac{\xi_t b_t K_t}{\alpha} \]
  Supply (incl. net exports)

  - Cobb-Douglas \( \Rightarrow \) constant consumption expenditure shares

  Consumption of tradables
  \[ \frac{\xi_t b_t K_t p^g_t}{\alpha} = \frac{[(1-\alpha_t) a - \nu_t]}{1-\alpha} p^l_t \]
  Output of non-tradable

- Production allocation

- Investment rate \( \nu_t \)
  - Depends on \( q_t \)
  \[ q_t K_t = (1 - \zeta_t - \theta_t) \frac{G_t}{\zeta_t} \frac{p^g_t}{P^l_t} \]
  \[ q_t = a \nu_t \frac{1 - \zeta_t - \theta_t}{\zeta_t} \left( 1 - \alpha_t \right) a - \nu_t (q_t) \frac{\zeta_t}{1-\alpha} a \rho \nu_t \]
  1 if \( \alpha_t \in (0, 1) \)
(Co-)Existence of Money

Proposition 1:

• If \( \tilde{\sigma}^2 > \rho \) and \( M \leq \Phi(t_{\nu=0}) \), then local money has value and \( \nu = 0 \) (no NFAP) is absorbing state.

• Otherwise, if \( \tilde{\sigma}^2 - \rho + M - \Phi(t_{\nu=0}) > 0 \), then global money has value for citizens in small country (and local money may or may not have value).

\[
M - \Phi(t) = \mu^G - \mu^b + (\sigma^b - \sigma^G)\sigma^b - \Phi(t) + \delta
\]

attractiveness of global money

\[
\tilde{\sigma}^2 \text{ attractiveness of local money}
\]
Numerical Example

- \( \rho = 5\%, \tilde{\sigma} = .3, \alpha = .2, \mu^b = 1\%, \sigma^b = .15, \mu^G = 2.2\%, a = .13, \delta = 2\%, \sigma^G = \sigma^G_\ast = 0, \kappa = 2 \Rightarrow M = .0545, \sigma^\nu = .15 \)
Exchange rate dynamics - UIP

\[ i_t^* - i_t = E_t[\Delta \varepsilon] + \psi_t \]

\[ \psi_t = \frac{-\sigma^\theta (\sigma^\zeta - \sigma^\theta)}{\sigma^\zeta - \sigma^\theta} \]

(risk premium in terms of Peso)

- For \( i_t = i_t^* (= 0) \)
  - foreign currency is expected to appreciate relative to local currency (whenever it is held in positive quantity).
    - Local currency is a hedge, it appreciates relative to net worth when \( v \) drops.
    - Global currency is risky, so to be held in positive amount it must earn a risk premium

- UIP violation, \( \psi_t \), depends whether money is “printed”
  - to pay interest \( \mu^{Mi} \)
    - No real changes (portfolio choice is not affected)
    - Higher inflation \( \pi = \mu^{Mi} - (\phi(t) - \delta) \)
    - \( E_t[\Delta \varepsilon] = \mu^{Mi} \) (dollar appreciates)
  - to generate seignorage (redistributed \( \propto \) wealth share) \( (\mu^M - \mu^{Mi}) \)
    - Affects portfolio choice, \( q \), investment rate \( t \), growth rate
      risk premium \( \psi_t \)
Flight to safety (into dollar)

- Unanticipated increase in $\sigma^b$
  - E.g. ToT becomes more volatile

- Portfolio share held in dollars increases
  - Dollar valuation is higher

- (increase in volatility of $\nu$)

- Transition
  - Start with current (dollar holding) $G$
  - Recalculate new state variable $\nu_t$
  - Our full dynamics also includes transition dynamics
Spillover from lower $\mu^G$

- Higher money supply growth $\mu^{M*}$ in large country
- Lower growth $\Phi(\ell^*) - \delta$ in large country
- Loss of competitive edge in global tradable basket
Higher Peso inflation $\pi_t$

- Seniorage $(\mu^M - \mu^{Mi})$ is distributed $\propto$ capital holding
- Store of value is less attractive
  - Pricing equation now
    \[ \rho + \pi_t - \mu^\theta = (\tilde{\sigma}^N)^2 \]
- Higher investment $\nu_t \Rightarrow$ boosts growth, but higher idio risk

![Graph](image)
Mundell-Fleming Trilemma

- Trilemma: Can only pick a 2 desiderata out of 3 – 1 side

“Dilemma”: Pick only 1
Mundell-Fleming Trilemma

- Trilemma: Can only pick 2 desiderata out of 3 – 1 side

- “Dilemma”: Pick only 1
Floating Exchange Rate

- With floating exchange rate & open capital account, still range of Monetary policy, since local and global money are imperfect substitutes.
  - Inflation boosts growth, but only possible up to a limit $\bar{\pi}(\mu^G)$. Beyond $\bar{\pi}(\mu^G)$ monetary policy has little bite.
    - Global money becomes too attractive.
  - Range is higher with higher inflation in large country (global money).
    - Large country’s MoPo determines range for small country.

- Policy range is larger if local money is backed by taxes ($\bar{\pi}$ depends on distribution of seignorage).
Closed capital account

- Range of Monetary policy is much larger, up $\bar{\pi} = \tilde{\sigma}^2 - \rho \approx 4\%$
  (physical capital is risky store of value)

- Total money holding is larger with closed capital account
  - Global money would be a better hedge for “export risk”
Fixed exchange rate regimes & no MoPo

- **Dollarization** = (fully backed) **Currency Board**

- **Exchange rate peg**
  - Requires strong fiscal backing (since no backing through holding of global reserves)
  - After a string of adverse shocks, government must tax and use proceeds to remove some of the local currency in circulation
Foreign Currency Reserves

- Irrelevance Theorem:
  - If central bank holds global money (reserves)
  - Citizens in small country will hold accordingly less

- Remark:
  - If central banks holds more $-reserves than citizens would like to hold, then agents borrow foreign currency from abroad.
  - If local money is worthless (without foreign reserves), then the value of local money with reserves only derives from the latter (currency board)
  - With fiscal backing of the local money, complicates analysis
Optimal Monetary Policy

- LARGE COUNTRY
  MoPo can correct pecuniary externality
  - Citizens take real interest rate as given when choosing their portfolio between money & physical capital
  - Money exists for \( \tilde{\sigma}^* > \sqrt{\rho} \)
  - Inflation is optimal for \( \tilde{\sigma}^* > 2\sqrt{\rho} \) (For \( \kappa = 0 \), no adjustment costs)

  - MoPo improves insurance provided by “safe asset”
    - Constrained optimal!
    - Incentive compatible

- SMALL COUNTRY
  - Additional savings decision due open capital account

- Generally, optimal monetary policy depends on control social planner has
Conclusion

- Endogenous value of money (safe asset) in 2 countries
  - Local currency: better hedge for idiosyncratic risk (non-tradable consumption)
  - Global currency: hedge against ToT + export productivity shocks
- Spillover effects from US monetary policy
- Flight to safety
- When to peg? When to dollarize?
- “Nuanced Mundell-Fleming Trilemma”
  - Local and global money have different risk profile (imperfect substitutes)
    ⇒ increases MoPo space
  - Too high Peso inflation:
    local citizens substitute local currency for global currency
    ⇒ limits MoPo space
- Central Bank’s foreign reserves holding: Irrelevance Result
- Optimal Monetary Policy
  - Idiosyncratic risk – correct pecuniary externality (real interest rate)
  - International savings