Optimal Monetary Policy under Dollar Pricing

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Optimal monetary policy:
- closed economy: inflation vs. output
Motivation

Optimal monetary policy:
- closed economy: inflation vs. output
- open economy: domestic vs. foreign shocks

Friedman (1953): exchange rates insulate from international spillovers
- yet “fear of floating” in the data (Calvo & Reinhart 2002)

Two potential sources of asymmetric spillovers:
1. countries borrow in dollars ⇒ “Global Financial Cycle” (Rey 2013)
2. international prices sticky in dollars ⇒ “Global Monetary Cycle” (this paper!)
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2. What is the optimal response – *float* vs. *peg*? (Friedman’53)

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5. Is there “*exorbitant privilege*” from DCP for U.S.? (Gourinchas-Rey’07)

6. Are there gains from a currency union (*Eurozone*)? (Mundell’61)
Our Approach

Key ingredients:

- prices sticky in dollars (DCP)
- input-output linkages across firms (GVC)
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- **Main challenge:** solve for the optimal *non-cooperative* policy
  - much progress recently for cooperative policy (Engel’11, CDL’18)

Relation to Goldberg-Tille’09, Casas-Diez-Gopinath-Gourinchas’17:
- generalize some insights
- IO linkages give rise to the GMC
- optimal policy for both the U.S. and the RoW

Our analysis is both normative and positive
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Relation to the Literature

- **Empirical evidence:**
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- **Empirical evidence:**

- **Theories of currency choice:**

- **Optimal monetary policy in open economy:**
  - non-U.S. + DCP + log preferences: Goldberg & Tille (2009), Casas, Diez, Gopinath & Gourinchas (2017)
STATIC MODEL
- Continuum of small open economies (Gali & Monacelli 2005)
Setup

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- One period and multiple states of the world:
  - firms preset prices, h/h’s trade Arrow securities
  - shocks are realized
  - consumption and production take place

Key assumptions:

1. International prices are sticky in dollars
2. Foreign intermediates in production

Static model = fully sticky prices + discretionary policy

Assumptions that we relax later:

- CRRA utility and CD technology
- Asset markets are complete
- Only productivity shocks
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Households

- Preferences:
  \[ U_i = \mathbb{E} \left[ \frac{C_i^{1-\sigma}}{1-\sigma} - L_i \right] \]

- Ex-ante budget constraint:
  \[ \sum_h \mathcal{P}_h B^h_i = 0 \]
  — asset \( h \) pays one dollar in state \( h \)

- Ex-post budget constraint:
  \[ P_i C_i = W_i L_i + \Pi_i + T_i + \mathcal{E}_i B^h_i \]
  — \( \mathcal{E}_i \) is the nominal exchange rate against the dollar

- Consumption aggregator:
  \[ C_i = \left[ (1 - \gamma)^{\frac{1}{\theta}} C_{ii}^{\theta-1} \theta \right] + \gamma^\theta \int C_{ji}^{\theta-1} \, dj \]
  \[ C_{ji} = \left( \int C_{ji}(\omega)^{\frac{\nu-1}{\nu}} \, d\omega \right)^{\frac{\nu}{\nu-1}} \]
• Cobb-Douglas technology:

\[ Y_i = A_i X_i^\alpha L_i^{1-\alpha} \]

• Same bundle of intermediates \( X_i \) as in consumption

• Price setting:

1. **Domestic market** → **in local currency**:

\[ \mathbb{E} \Theta_i (P_{ii} - \frac{\varepsilon}{\varepsilon - 1} \tau MC_i)(C_{ii} + X_{ii}) = 0 \]

2. **Foreign markets** → **in dollars**:

\[ \mathbb{E} \Theta_i (\varepsilon_i P^*_i - \frac{\varepsilon}{\varepsilon - 1} \tau MC_i) \int (C_{ij} + X_{ij}) \, dj = 0 \]

• Assume production subsidy \( \tau = \frac{\varepsilon - 1}{\varepsilon} \)
Equilibrium Conditions

- Goods and asset market clearing:

\[ Y_i = (C_{ii} + X_{ii}) + \int (C_{ij} + X_{ij}) \, dj \]

\[ \int B_i^h \, di = 0, \ \forall h \]
Equilibrium Conditions

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- Define relative prices:
  - global import price index: \( P^* = \left( \int P_i^{1-\theta} \, di \right)^{\frac{1}{1-\theta}} \)
  - real exchange rate: \( Q_i = \frac{\varepsilon_i P^*}{P_i} \)
  - terms of trade: \( S_i = \frac{P^*}{P_i} \)
  - deviations from the law of one price: \( \Phi_i = \frac{\varepsilon_i P_i^*}{P_{ii}} \)
**Equilibrium Conditions**

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- Follow Ramsey approach:
  - monetary instrument \( M_i = \Theta_i^{-1} \equiv C_i^\sigma P_i \) at the background
OPTIMAL POLICY
Non-U.S. Policy

- Planner's problem:

\[
\max_{C_i, L_i, X_i, \Phi_i, Q_i} \frac{C_i^{1-\sigma}}{1 - \sigma} - L_i
\]

s.t. \[A_i X_i^\alpha L_i^{1-\alpha} = (1 - \gamma) \left( \frac{\Phi_i S_i}{Q_i} \right)^\theta (C_i + X_i) + \gamma S_i^\theta C^* \]

\[
\gamma P^* \left[ S_i^{\theta-1} C^* - Q_i^{-\theta} (C_i + X_i) \right] + B_i^h = 0
\]

\[
Q_i^{\theta-1} = \gamma + (1 - \gamma) (\Phi_i S_i)^{\theta-1}, \quad X_i = X(C_i, L_i)
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- Securities \( B_i^h \) pay in dollars ⇒ no debt-devaluation motive
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- \( P_i^* \) is fixed ⇒ predetermined exports ⇒ predetermined value of imports ⇒ given fixed \( P^* \), imports also predetermined
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- Securities \( B^h_i \) pay in dollars \( \Rightarrow \) no debt-devaluation motive

- \( P_i^* \) is fixed \( \Rightarrow \) predetermined exports \( \Rightarrow \) predetermined value of imports \( \Rightarrow \) given fixed \( P^* \), imports also predetermined

- Optimal policy focuses on domestic margin:

\[
MC_i = \frac{W_i^{1-\alpha} P_i^\alpha}{A_i}
\]
Non-U.S. Policy

- Planner’s problem:

\[
\max_{C_i, L_i, X_i, \Phi_i, Q_i} \quad \frac{C_i^{1-\sigma}}{1 - \sigma} - L_i
\]

s.t. \quad A_i X_i^{\alpha} L_i^{1-\alpha} = (1 - \gamma) \left( \frac{\Phi_i S_i}{Q_i} \right)^\theta \left( C_i + X_i \right) + \gamma S_i^\theta C^*

\gamma P^* \left[ S_i^{\theta-1} C^* - Q_i^{-\theta} \left( C_i + X_i \right) \right] + B_i^h = 0

\quad Q_i^{\theta-1} = \gamma + (1 - \gamma) (\Phi_i S_i)^{\theta-1}, \quad X_i = X(C_i, L_i)

---

Proposition

The optimal discretionary policy in non-U.S. countries:

1. stabilizes marginal costs (PPI) of local producers,
2. partially pegs exchange rate to the dollar,
3. gives rise to a Global Monetary Cycle.
U.S. Policy

- Planner’s problem:

\[
\max_{C_i,L_i,X_i,C^*} \frac{C_i^{1-\sigma}}{1-\sigma} - L_i
\]

s.t. \( A_iL_i = (1 - \gamma) \left( \frac{S_i}{Q_i} \right)^\theta (C_i + X_i) + \gamma S_i^\theta C^* \)

\[
\gamma P^* \left[ S_i^{\theta-1} C^* - Q_i^{-\theta} (C_i + X_i) \right] + B_i^h = 0
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\[ C^* \equiv \int Q_j^{-\theta} (C_j + X_j) \, dj, \quad X_i = X(C_i, L_i) \]
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\max_{c_i, l_i, x_i, C^*} \frac{c_i^{1-\sigma}}{1-\sigma} - l_i
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s.t. \[ A_i l_i = (1 - \gamma) \left( \frac{S_i}{Q_i} \right)^{\theta} (c_i + x_i) + \gamma s_i^{\theta} C^* \]

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Nash equilibrium = Stackelberg equilibrium!
U.S. Policy

- Planner's problem:

\[
\max_{C_i, L_i, X_i} U(C_i, L_i)
\]

s.t. \( P_{ii} A_i F(L_i, X_i) = P_i (C_i + X_i) - \frac{S_i}{P^*} B_i^h \)

\( X_i = X(C_i, L_i) \)
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- Trade-off isomorphic to a closed economy:

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MC_i = \frac{W_i^{1-\alpha} P_i^\alpha}{A_i}
\]
Planner's problem:

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s.t. \[P_{ii} A_i F(L_i, X_i) = P_i (C_i + X_i) - \frac{S_i}{P^*} B^h_i\]

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The optimal discretionary policy in the U.S.

1. is independent from shocks and policy in other countries,
2. stabilizes marginal costs (PPI) of local producers.
Planner's problem:

\[
\max_{C_i, L_i, X_i} U(C_i, L_i)
\]

subject to

\[
P_{ii} A_i F(L_i, X_i) = P_i (C_i + X_i) - \frac{S_i}{P^*} B_i^h
\]

\[
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MC_i = W_i^{1-\alpha} P_i^\alpha
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Proposition

The optimal discretionary policy in the U.S.

1. is independent from shocks and policy in other countries,
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— equilibrium allocation in the U.S. depends on global shocks
Robustness

1. **Functional forms:**
   
   - arbitrary quasi-linear preferences \( U(C, L) = v(C) - L \)
   
   - arbitrary CRS production function \( Y = AF(L, X) \)
Robustness

1. Functional forms:
   - arbitrary quasi-linear preferences $U(C, L) = v(C) - L$
   - arbitrary CRS production function $Y = AF(L, X)$

2. International asset markets:
   - MP does not depend on $B_i^h$
   - can allow for arbitrary asset markets
   - only restriction: the planner cannot inflate away the debt
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3 Shocks:
   — arbitrary real shocks (preferences, production, markups)
   — financial shocks / shocks to capital flows, i.e. \( B_i^h \)
ADDITIONAL INSTRUMENTS
Can capital controls insulate from U.S. spillovers?

Blanchard (2016): “[The use of capital controls by EMs] allows AEs to use monetary policy to increase domestic demand, while shielding EMs of the undesirable exchange rate effects.”
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Augment monetary policy with state-contingent taxes on capital flows

Policy is chosen after prices are set, but before trade in asset markets

Planner can effectively choose any \( \{B_i^h\} \) subject to ex-ante budget constraint
Capital Controls

- Planner's problem:

\[
\max_{C_i, L_i, X_i, \Phi_i, Q_i, B^h_i} E U(C_i, L_i)
\]

s.t.

\[
A_iF(L_i, X_i) = (1 - \gamma) \left( \frac{\Phi_i S_i}{Q_i} \right)^\theta (C_i + X_i) + \gamma S_i^\theta C^*
\]

\[
\gamma P^* \left[ S_i^{\theta - 1} C^* - Q_i^{-\theta} (C_i + X_i) \right] + B^h_i = 0
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Q_i^{\theta - 1} = \gamma + (1 - \gamma) (\Phi_i S_i)^{\theta - 1}, \quad X_i = X(C_i, L_i)
\]
Capital Controls

- Planner’s problem:

$$\max_{C_i, L_i, X_i, \Phi_i, Q_i, B^i_h} \mathbb{E} U(C_i, L_i)$$

s.t.  $$A_i F(L_i, X_i) = (1 - \gamma) \left( \frac{\Phi_i S_i}{Q_i} \right)^\theta (C_i + X_i) + \gamma S_i^\theta C^*$$

$$\gamma P^* \left[ S_i^{\theta-1} C^* - Q_i^{\theta}(C_i + X_i) \right] + B^i_h = 0, \quad \sum_h P^h B^i_h = 0$$

$$Q_i^{\theta-1} = \gamma + (1 - \gamma) (\Phi_i S_i)^{\theta-1}, \quad X_i = X(C_i, L_i)$$

Proposition

Capital controls do not insulate economies from U.S. spillovers and are not used by the planner, i.e. $$\{B^i_h\}$$ are the same w/ and w/o capital controls. — Farhi & Werning (ECM’2016): risk-sharing is generically inefficient when allocation is not the first best due to “AD externality”

— Monetary policy under DCP eliminates AD externality and equalizes private and social values of transfers

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Capital Controls

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Capital Controls

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  \max_{C_i, L_i, X_i, \Phi_i, Q_i, B_i^h} \mathbb{E} U(C_i, L_i)
  \]

  s.t. \[A_i F(L_i, X_i) = (1 - \gamma) \left( \frac{\Phi_i S_i}{Q_i} \right)^\theta (C_i + X_i) + \gamma S_i^\theta C^*\]

  \[\gamma P^* \left[ S_i^{\theta-1} C^* - Q_i^{-\theta} \left( C_i + X_i \right) \right] + B_i^h = 0, \quad \sum_h P^h B_i^h = 0\]

  \[Q_i^{\theta-1} = \gamma + (1 - \gamma) (\Phi_i S_i)^{\theta-1}, \quad X_i = X(C_i, L_i)\]

Proposition

Capital controls do not insulate economies from U.S. spillovers and are not used by the planner, i.e. \(\{B_i^h\}\) are the same w/ and w/o capital controls.

- Farhi & Werning (ECM’2016): risk-sharing is generically inefficient when allocation is not the first best due to “AD externality”
- Monetary policy under DCP eliminates AD externality and equalizes private and social values of transfers
Global planner maximizes total welfare across countries

U.S. policy is used to maximize the welfare of other countries:
- *U.S. welfare* is a trivial fraction of global welfare
- *U.S. monetary policy* has global effects
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The optimal cooperative monetary policy implements

\[ MC_i = 1, \ \forall i \neq \text{U.S.}, \quad \int \frac{MC_i}{\mathcal{E}_i} \, di = 1 \]
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- Non-U.S. countries gain from cooperation, while the U.S. loses
  - contrasts with the PCP case
  - common shocks \( \Rightarrow \) cooperation = non-cooperation = first-best
  - country-specific shocks \( \Rightarrow \) conflict of interests, no first-best
DYNAMIC MODEL
Dynamic Model

- One period ⇒ Infinite horizon
Dynamic Model

- One period $\Rightarrow$ Infinite horizon
- Discretionary policy $\Rightarrow$ Policy with commitment

- Fully sticky prices $\Rightarrow$ Rotemberg pricing
- Labor subsidy $= \theta - 1 + \text{Rotemberg subsidy}$

Other ingredients remain the same:
- complete asset markets
- focus on productivity shocks (can be generalized)
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- no restrictions on elasticities $\sigma$ and $\theta$
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- true despite the fact that MP does affect terms of trade!
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  - depreciate ToT $\Rightarrow$ decrease $MC_{it}/E_{it}$
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**Proposition**

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**Corollary**

*The results for non-U.S. economies about peg, GMC, and no capital controls from the static setup remain true in a dynamic model.*
**Assumption**: focus on *Faia-Monacelli case* with no intermediates \( \alpha = 0 \) and equal inter/intra-temporal elasticities \( \theta = \frac{1}{\sigma} \)

- more general than Cole-Obstfeld case \( \theta = \frac{1}{\sigma} = 1 \) with \( NX_{it} = 0 \)
- similar results in a more general model with \( \alpha > 0 \)

**Use second-order approximations:**

- demand block (standard)
- international prices
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**Lemma**

*Welfare loss function of the U.S.:

$$\mathcal{L}^{US} \approx \frac{L}{2} \mathbb{E} \sum_{t=0}^{\infty} \beta^t \left[ \sigma \hat{y}_{it}^2 + \phi \pi_{iit}^2 + \gamma \Psi \int \hat{s}_{jt}^2 dj \right] + t.i.p.,$$

with output gap $\hat{y}_{it} \equiv y_{it} - \theta a_{it}$ and ToT gap $\hat{s}_{it} \equiv s_{it} - a_{it} + \sigma \bar{c}_t$. 
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*Welfare loss function of the U.S.:

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with output gap $\tilde{y}_{it} \equiv y_{it} - \theta a_{it}$ and ToT gap $\tilde{s}_{it} \equiv s_{it} - a_{it} + \sigma \bar{c}_t$."

**Proposition**

*The optimal policy in the U.S. deviates from price stabilization and in particular, targets the global ToT gap.*
Gains from DCP

- Welfare loss function of the U.S.:

\[ \mathcal{L}^{US} \approx \frac{L}{2} \mathbb{E} \sum_{t=0}^{\infty} \beta^t \left[ \sigma \hat{\tilde{y}}^2_{it} + \varphi \pi^2_{iit} + \gamma \bar{\Psi} \int \tilde{s}^2_{jt} dj \right] \]
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with law-of-one-price gap  \( \tilde{\phi}_{it} \equiv p_{it}^* + e_{it} - p_{iit} \)
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1
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Gains from DCP

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The welfare of the U.S. relative to other countries under DCP

1. is higher if all countries stabilize domestic prices,
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— the U.S. is likely to gain from DCP when openness \( \gamma \) is small
Optimal currency area:
Optimal currency area:
  - loss of independent monetary policy
Optimal currency area:

- loss of independent monetary policy
+ commitment against inflationary bias
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Are there gains from promoting a common currency (euro)?
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- other countries are likely to use currency of a larger monetary union: Rey (2001), Gopinath & Stein (2018), Mukhin (2018), etc.
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Proposition

*In the Faia-Monacelli case, Eurozone problem is isomorphic to the problem of the U.S. and achieves the same welfare under the optimal policy.*
Conclusion

1. Does U.S. monetary policy generate negative spillovers on the RoW? If so, should the Fed be concerned about it?

2. What is the optimal response of other countries float vs. peg?

3. Can capital controls help?

4. Are there gains from international cooperation?

5. Is there an “exorbitant privilege” from DCP for the U.S.?

6. Are there gains from a currency union (Eurozone)?
Conclusion

1. Does U.S. monetary policy generate negative spillovers on the RoW? If so, should the Fed be concerned about it?
   — yes & yes

2. What is the optimal response of other countries float vs. peg?
   — partial peg

3. Can capital controls help?
   — not much

4. Are there gains from international cooperation?
   — not for the U.S.

5. Is there an “exorbitant privilege” from DCP for the U.S.?
   — yes

6. Are there gains from a currency union (Eurozone)?
   — yes
APPENDIX
Dollar as an Anchor Currency

Source: Ilzetzki, Reinhart and Rogoff (2017)
DCP in Imports

Source: Gopinath (2016)
Prices are Sticky in Currency of Invoicing

Figure 1: Aggregate ERPT at different horizons by currency

Source: Gopinath, Itskhoiki and Rigobon (2010)
DCP vs. Response to Fed’s Shocks

Source: Zhang (2018)