
Sushant Acharya\textsuperscript{1} Julien Bengui\textsuperscript{2}

\textsuperscript{1}Federal Reserve Bank of New York
\textsuperscript{2}Université de Montréal

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The views expressed herein are those of the authors and not necessarily those of the Federal Reserve Bank of New York or the Federal Reserve System.
MOTIVATION: POST-2008 GLOBAL ECONOMY

1. Loose monetary policy in advanced economies
   - perception of deficient demand
   - period of binding zero lower bound (ZLB) on interest rate

2. Marked increase in capital flows from advanced to emerging economies
   - appreciation of emerging mkt currencies

3. Some key emerging markets imposed capital controls
   - combat currency appreciation
   - prevent overheating
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In a liquidity trap...

I. what role do capital flows play in macro adjustment?

II. are free capital flows efficient?

III. is capital flow management warranted?
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I. What role do capital flows play in macro adjustment?

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III. Is capital flow management warranted?
Environment

- Multi-country New Keynesian model based on Gali-Monacelli (2005)
- Flexible exchange rates
- Nominal rigidities
- Zero bound on interest rates

Liquidity trap experiment

- Large demand shock pushes part of the world economy to ZLB
- Analysis of global macro adjustment under various capital flow regimes
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RESULTS

I  Capital flows foster demand and expenditure reallocation across countries and alleviate demand-driven recession

II  Free capital flows are constrained inefficient
   - constrained efficiency requires larger flows during and after liquidity trap

III Uncoordinated capital flow management is not warranted
   - optimal uncoordinated CFM might hamper rather than foster global adjustment
RESULTS

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**RELATED LITERATURE**

1. **Optimal monetary policy at ZLB**
   - **closed economy:** Krugman (1998), Eggertsson & Woodford (2003), Werning (2012)

2. **Capital flow management**
   - **financial market frictions:** Caballero & Krishnamurthy (2001), Korinek (2010, 2013), Bianchi (2011)

1. Model

2. Positive analysis: capital flows at the ZLB

3. Normative analysis: efficient capital flows?

4. A case for uncoordinated capital flow management?
MODEL FEATURES

- Continuous time
- Unit mass of small open economies making up world economy:
  - measure $x$ of North economies
  - measure $1 - x$ of South economies
- Monopolistic competition and nominal rigidities in price setting
- Flexible exchange rates
- No uncertainty
MODEL: PREFERENCES AND BUDGET SET

Preferences

\[ \int_{0}^{\infty} e^{-\int_{0}^{t}(\rho + \zeta_{k,h})dh} \left[ \log C_{k,t} - \frac{(N_{k,t})^{1+\phi}}{1 + \phi} \right] dt \]

- \( \zeta_{k,h} \): preference shock

Budget constraint

\[ \dot{a}_{k,t} = i_{k,t}a_{k,t} + W_{k,t}N_{k,t} + T_{k,t} - P_{k,t}C_{k,t} + \int_{0}^{1} \left[ (j_{j,t} - i_{k,t}) + \frac{\dot{E}_{j,k,t}}{E_{j,k,t}} - (\tau_{j,t} - \tau_{k,t}) \right] E_{j,k,t}D_{j,k,t}d\]

- \( a_{k,t} \equiv \int_{0}^{1} E_{j,k,t}D_{j,k,t}d\): wealth of country \( k \) (in own currency)

- \( \tau_{k,t} \): tax on capital inflows into country \( k \)
MODEL: PREFERENCES AND BUDGET SET

Preferences

\[
\int_0^\infty e^{-\int_0^t (\rho + \zeta_{k,h}) dh} \left[ \log C_{k,t} - \frac{(N_{k,t})^{1+\phi}}{1+\phi} \right] dt
\]

- \zeta_{k,h}: preference shock

Budget constraint

\[
\dot{a}_{k,t} = i_{k,t} a_{k,t} + W_{k,t} N_{k,t} + T_{k,t} - \Pi_{k,t} C_{k,t} + \int_0^1 \left[ (l_j - i_{k,t}) + \frac{\dot{E}_j^{k,t}}{E_j^{k,t}} - (\tau_j - \tau_{k,t}) \right] \mathcal{E}_{k,t}^j D_{k,t}^j d_j
\]

- \dot{a}_{k,t} \equiv \int_0^1 \mathcal{E}_{k,t}^j D_{k,t}^j d_j: wealth of country k (in own currency)

- \tau_{k,t}: tax on capital inflows into country k
MODEL: PREFERENCES AND BUDGET SET

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\[ \int_0^\infty e^{-\int_0^t (\rho + \zeta_{k,h})dh} \left[ \log C_{k,t} - \frac{(N_{k,t})^{1+\phi}}{1 + \phi} \right] dt \]

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- \( \tau_{k,t} \): tax on capital inflows into country \( k \)
Model: nested CES goods structure

Consumption basket

\[ C_k \equiv \left( C_k^H \right)^{1-\alpha} \left( C_k^F \right)^{\alpha} \]

- \( 1 - \alpha \): degree of home-bias
- home goods

\[ C_k^H \equiv \left[ \int_0^1 C_k^H(\ell) \frac{\epsilon-1}{\epsilon} d\ell \right]^{\frac{\epsilon}{\epsilon-1}} \]

- foreign goods

\[ C_k^F \equiv \exp \left( \int_0^1 \log C_k^F dj \right) \]
Continuum of monopolistically competitive firms

- differentiated varieties within each country
- production function:
  \[ Y_k(\ell) = AN_k(\ell) \]
- aggregate output defined as
  \[ Y_k \equiv \left[ \int_0^1 Y_k(\ell) \frac{\epsilon-1}{\epsilon} \, d\ell \right]^{\epsilon/(\epsilon-1)} \]

Fully rigid prices + Law of one price

⇒ fixed PPI in own currency (but flexible exchange rates → CPI not fixed)
⇒ terms of trade & real exchange rate related to nominal exchange rate
MODEL: PRODUCTION & PRICE SETTING

Continuum of monopolistically competitive firms

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Fully rigid prices + Law of one price

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MODEL: KEY EQUILIBRIUM CONDITION & EXPERIMENT

- **Backus-Smith condition**

\[ \mathcal{C}_{k,t} = \Theta_{k,t} \mathcal{C}_{n,t} Q_{k,t} \]

with

\[ \frac{\dot{\Theta}_{k,t}^n}{\Theta_{k,t}^n} = (\zeta_{n,t} - \zeta_{k,t}) - (\tau_{n,t} - \tau_{k,t}) \]

- **Liquidity trap experiment**
**MODEL: KEY EQUILIBRIUM CONDITION & EXPERIMENT**

- **Backus-Smith condition**

  \[ c_{k,t} = \Theta_{k,t}^n c_{n,t} \mathcal{Q}_{k,t}^n \quad \text{with} \quad \frac{\dot{\Theta}_{k,t}^n}{\Theta_{k,t}^n} = (\zeta_{n,t} - \zeta_{k,t}) - (\tau_{n,t} - \tau_{k,t}) \]

- **Liquidity trap experiment**

  ![Graph showing the North and South discount rates](#)

- North discount rate

- South discount rate

  - Time: 0 \( T \)
  - \( \rho - \tilde{\zeta} \)
OPTIMAL MONETARY POLICY

Monetary authority in country $k$ solves

$$\max_{\{i_{k,t}\}} \int_0^{\infty} e^{-(\rho + \zeta_{k,h})} dh \left[ (1 - \alpha) \log Y_{k,t} - \frac{1}{1 + \phi} \left( \frac{Y_{k,t}}{A} \right)^{1+\phi} \right] dt$$

subject to:

$$\frac{\dot{Y}_{k,t}}{Y_{k,t}} = i_{k,t} - (\rho + \zeta_{k,t}) - \frac{\alpha x}{\Lambda_{k,t}} \frac{\dot{\Theta}_{n,k,t}}{\Theta_{n,k,t}} - \frac{\alpha (1 - x)}{\Lambda_{k,t}} \frac{\dot{\Theta}_{s,k,t}}{\Theta_{s,k,t}}$$

$$i_{k,t} \geq 0.$$ 

for $\Lambda_{k,t} \equiv (1 - \alpha) \Theta_{n,k,t} + \alpha x + \alpha (1 - x) \Theta_{s,k,t}$

Optimal monetary policy

- If ZLB slacks, target $Y_{k,t} = \bar{Y} = A (1 - \alpha) \frac{1}{1 + \phi}$ by appropriately choosing $i_{k,t}$.
- If ZLB binds, delay exit to $\hat{T}_{k} > T$.

Optimal delay: keep $i_{k,t}$ at zero past liquidity trap to center output around target level $\bar{Y}$

(Eggertson-Woodford(2003), Werning (2012))
OPTIMAL MONETARY POLICY

Monetary authority in country $k$ solves

$$\max_{\{i_{k,t}\}} \int_0^\infty e^{-(\rho + \zeta_{k,h})} \ln \left[ (1 - \alpha) \log Y_{k,t} - \frac{1}{1 + \phi} \left( \frac{Y_{k,t}}{A} \right)^{1+\phi} \right] \, dt$$

subject to:

$$\frac{\dot{Y}_{k,t}}{Y_{k,t}} = i_{k,t} - (\rho + \zeta_{k,t}) - \frac{\alpha x}{\Lambda_{k,t}} \frac{\dot{\Theta}^n_{k,t}}{\Theta^n_{k,t}} - \frac{\alpha (1 - x)}{\Lambda_{k,t}} \frac{\dot{\Theta}^s_{s,t}}{\Theta^s_{s,t}}$$

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**Optimal monetary policy**

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(Eggertson-Woodford(2003), Werning (2012))
EQUILIBRIUM UNDER FREE CAPITAL FLOWS

North interest rate

South interest rate

South exchange rate

North output

South output

North current account

North consumption

South consumption

Free CF
FREE CAPITAL FLOWS VS CLOSED CAPITAL ACCOUNTS

North interest rate

South interest rate

South exchange rate

North output

South output

North current account

North consumption

South consumption

Tax on downstream flows
Is capital efficiently flowing across countries in liquidity trap?

- Consider constrained planner who taxes/subsidizes capital flows from North to South

- Planner maximize global welfare, subject to
  1. making all countries at least as well off as under free CF
  2. interest rate policy set by domestic monetary authorities
  3. private implementability constraints

Questions:
- Is zero tax path optimal?
- How does optimal tax path look like?
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**Formal problem**

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Questions:
1. Is zero tax path optimal?
2. How does optimal tax path look like?
Are free capital flows constrained efficient?

Inefficiency of free capital flows

At ZLB, regime of free capital mobility is constrained inefficient.

- Source of inefficiency: aggregate demand externality associated with agents’ debt choices due to
  - nominal rigidity + constraints on monetary policy
What do constrained efficient capital flows look like?

**Optimal capital flow tax**

For small enough degree of openness $\alpha$, optimal tax satisfies

\[
\begin{align*}
\tau_{s,t} &< 0 \quad \text{for } 0 \leq t < T \\
\tau_{s,t} &> 0 \quad \text{for } T \leq t < \hat{T}_n \\
\tau_{s,t} &= 0 \quad \text{for } t \geq \hat{T}_n
\end{align*}
\]
EFFICIENT CAPITAL FLOW MANAGEMENT

North interest rate

South interest rate

South exchange rate

North output

South output

North current account

North consumption

South consumption

Tax on downstream flows

Free CF
Efficient CF

Labor wedge 19/23
Should countries manage their capital account in liquidity trap?

- Consider local planners who taxe/subsidize capital flows into their countries
- Planners maximize domestic welfare, subject to private implementability constraints
  
Questions:
- Is zero tax path optimal?
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UNCOORDINATED CAPITAL FLOW MANAGEMENT

Should countries manage their capital account in liquidity trap?

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- Planners maximize domestic welfare, subject to
  - private implementability constraints

Questions:
- Is zero tax path optimal?
- How does optimal tax path look like?
Individually optimal capital flow taxes

Country $k$’s optimal capital inflow tax satisfies:

$$
\tau_{k,t} = \Omega_{k,t}^1 \left[ (1 - x) \Theta_{s,t}^n (\zeta_{k,t} + \tau_{s,t}) + x (\zeta_{k,t} - \zeta_{n,t} + \tau_{n,t}) \right] + \Omega_{k,t}^2 \frac{\dot{Y}_{k,t}}{Y_{k,t}}
$$

for $\Omega_{k,t}^1, \Omega_{k,t}^2 > 0$.

1. Independently from ZLB, countries tame capital flows to manipulate dynamic terms of trade (Costinot et al., 2014)
   - tax inflows in response to foreign negative or home positive demand shocks
   - taxes are strategic complements

2. Countries at ZLB also use capital flow management to stabilize aggregate demand, in effort to compensate for impotency of MP
**Nash equilibrium of currency war game**

1. Only South uses taxes

**Currency war among South**

If only South manages capital flows, then taxes slow down but neither shut down nor reverse global capital flows ($0 < \tau_{s,t} < \tilde{\zeta}$ for $0 \leq t < T$ and $\tau_{s,t} = 0$ for $t \geq T$).

2. All countries use taxes: full blown currency war

- North faces trade-off between ToT manip and AD management, and may subsidize outflows, but South fights back by taxing inflows
- North and South neutralize each other, resulting in near zero tax wedge $\tau_{s,t} - \tau_{n,t}$
Nash equilibrium of currency war game

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Currency war among South
If only South manages capital flows, then taxes slow down but neither shut down nor reverse global capital flows \((0 < \tau_{s,t} < \bar{\zeta} \text{ for } 0 \leq t < T \text{ and } \tau_{s,t} = 0 \text{ for } t \geq T)\).

2. All countries use taxes: full blown currency war
   - North faces trade-off between ToT manip and AD management, and may subsidize outflows, but South fights back by taxing inflows
   - North and South neutralize each other, resulting in near zero tax wedge \(\tau_{s,t} - \tau_{n,t}\)
CONCLUSION

1. In liquidity trap, capital flows
   - promote reallocation of demand and expenditure
   - alleviates harm caused by ZLB in most inflicted region

2. Capital flows too slowly to promote efficient reallocation

3. Uncoordinated capital controls particularly harmful during liquidity trap, as ToT management motive works against efficient AD stabilization
Thank you.
BACKUP SLIDES
MODEL: NESTED CES GOODS STRUCTURE (WITHOUT COLE-OBSTFELD)

Consumption basket

\[ C_k \equiv \left[ (1 - \alpha)^{\frac{1}{\eta}} \left( C_k^H \right)^{\frac{n-1}{\eta}} + \alpha \frac{1}{\eta} \left( C_k^F \right)^{\frac{n-1}{\eta}} \right]^{\frac{\eta}{\eta-1}} \]

- \( 1 - \alpha \): degree of home-bias
- home goods

\[ C_k^H \equiv \left[ \int_0^1 C_k^H(\ell) \frac{\epsilon-1}{\epsilon} d\ell \right]^{\frac{\epsilon}{\epsilon-1}} \]

- foreign goods

\[ C_k^F \equiv \left[ \int_0^1 C_k^F(\gamma) \frac{\gamma-1}{\gamma} d\gamma \right]^{\frac{\gamma}{\gamma-1}} \]
MODEL: PRICE INDICES

- domestic CPI

\[
\Pi_k \equiv \left( P^H_k \right)^{1-\alpha} \left( P^F_k \right)^{\alpha}
\]

- domestic PPI

\[
P^H_k \equiv \left[ \int_0^1 P^H_k (\ell)^{1-\epsilon} d\ell \right]^{1/(1-\epsilon)}
\]

- foreign PPI

\[
P^F_k \equiv \exp \left( \int_0^1 \log P^i_k dj \right)
\]
MODEL: PRICE INDICES (WITHOUT COLE-OBSTFELD)

- **domestic CPI**

\[
P_k \equiv \left[ (1 - \alpha) \left( P^H_k \right)^{1-\eta} + \alpha \left( P^F_k \right)^{1-\eta} \right]^{\frac{1}{1-\eta}}
\]

- **domestic PPI**

\[
P^H_k \equiv \left[ \int_0^1 P^H_k (\ell)^{1-\epsilon} d\ell \right]^{\frac{1}{1-\epsilon}}
\]

- **foreign PPI**

\[
P^F_k \equiv \left[ \int_0^1 P^j_{k} \frac{1}{1-\gamma} dj \right]^{\frac{1}{1-\gamma}}
\]
MODEL: RELATIVE PRICE DEFINITIONS

- **bilateral** terms of trade & real exchange rate

\[ S_j^k \equiv \frac{\varepsilon_j^k P_j^k}{P_k^k} \quad \& \quad Q_j^k \equiv \frac{\varepsilon_j^k P_j^k}{P_k^*} \]

- **effective** terms of trade & real exchange rate

\[ S_k \equiv \frac{P_k^F}{P_k^*} = \left[ \int_0^1 S_j^k \, dj \right]^{\frac{1}{1-\gamma}} \quad \& \quad Q_k \equiv \frac{P_k^F}{P_k^*} = \frac{\varepsilon_k P^*}{P_k^*} \]

where world price index & effective nominal exchange rate are

\[ P^* \equiv \left[ \int_0^1 P_j^{1-\gamma} \, dj \right]^{\frac{1}{1-\gamma}} \quad \& \quad \varepsilon_k \equiv \left[ \frac{\int_0^1 \left( \varepsilon_j^k P_j^k \right)^{1-\gamma} \, dj}{\int_0^1 P_j^{1-\gamma} \, dj} \right]^{\frac{1}{1-\gamma}} \]
MODEL: KEY EQUILIBRIUM CONDITIONS (WITHOUT COLE-OBSTFELD)

- Euler equation

\[ \frac{\dot{C}_{k,t}}{C_{k,t}} = \frac{1}{\sigma} [l_{k,t} - \pi_{k,t} - (\rho + \zeta_{k,t})] \]

- Backus-Smith condition

\[ C_{k,t} = \Theta_{n,k,t} C_{n,t} \left( Q_{k,t}^{n} \right)^{\frac{1}{\sigma}} \quad \text{with} \quad \frac{\dot{\Theta}_{n,k,t}^{n}}{\Theta_{n,k,t}^{n}} = \frac{1}{\sigma} [(\zeta_{n,t} - \zeta_{k,t}) - (\tau_{n,t} - \tau_{k,t})] \]

- Market clearing condition

\[ Y_{k,t} = (1 - \alpha) \left( \frac{Q_{k,t}}{S_{k,t}} \right)^{-\eta} C_{k,t} + \alpha x \left( S_{n,t}^{n} C_{n,t} \right)^{\gamma} Q_{n,t}^{\eta} C_{n,t} + \alpha (1 - x) \left( S_{s,t}^{s} C_{s,t} \right)^{\gamma} Q_{s,t}^{\eta} C_{s,t} \]

- Country budget constraint

\[ B_{k,0} = - \int_{0}^{\infty} e^{-\int_{0}^{t}[\rho + \zeta_{n,h} - \tau_{n,h}]dh} C_{n,t}^{1 - \sigma} \left( Q_{k,t}^{n} \right)^{-\frac{1}{\sigma}} [(S_{k,t})^{-\alpha} Y_{k,t} - C_{k,t}] dt \]
## Parametrization

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discount rate</td>
<td>$\rho = 0.04$</td>
<td>Gali-Monacelli (2005)</td>
</tr>
<tr>
<td>Home bias</td>
<td>$\alpha = 0.4$</td>
<td>Gali-Monacelli (2005)</td>
</tr>
<tr>
<td>Inverse elas. of labor supply</td>
<td>$\phi = 3$</td>
<td>Gali-Monacelli (2005)</td>
</tr>
<tr>
<td>Relative size of North</td>
<td>$\chi = 0.4$</td>
<td>Share of advanced economies in world GDP</td>
</tr>
<tr>
<td>Initial NFA</td>
<td>$B_{s,0} = 0$</td>
<td>Symmetric initial conditions</td>
</tr>
</tbody>
</table>

**Liquidity trap experiment**

<table>
<thead>
<tr>
<th>Parameter</th>
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</thead>
<tbody>
<tr>
<td>Duration of liquidity trap</td>
<td>$T = 2$</td>
<td>Werning (2012)</td>
</tr>
<tr>
<td>Demand shock</td>
<td>$\bar{\zeta} = 0.08$</td>
<td>Werning (2012)</td>
</tr>
</tbody>
</table>

**Table**: Parameter values
FIRST BEST ALLOCATION

North consumption & output

South consumption & output
CONSTRAINED PLANNING PROBLEM

\[
\max_{\{\tau_s, t, \tau_s, t, 1n, t\}} \quad \int_0^\infty e^{-\int_0^t (\rho + \zeta) \, dh} \left[ \log \mathcal{C}_{n,t} - \frac{1}{1 + \phi} \left( \frac{Y_{n,t}}{A} \right)^{1+\phi} \right] \, dt \\
+ \quad \Xi_{s,0} \int_0^\infty e^{-\rho t} \left[ \log \mathcal{C}_{s,t} - \frac{1}{1 + \phi} \left( \frac{Y_{s,t}}{A} \right)^{1+\phi} \right] \, dt
\]

subject to:

\[
\overline{W}_{0,k} \leq \int_0^\infty e^{-\int_0^t (\rho + \zeta) \, dh} \left[ \log \mathcal{C}_{k,t} - \frac{1}{1 + \phi} \left( \frac{Y_{k,t}}{A} \right)^{1+\phi} \right] \, dt
\]

\[
\mathcal{C}_{k,t} = \Theta_{k,t}^n \left( \frac{Y_{k,t}}{\Lambda_{k,t}} \right)^{1-\alpha} \left( \frac{Y_{n,t}}{\Lambda_{n,t}} \right)^{\alpha x} \left( \frac{Y_{s,t}}{\Lambda_{s,t}} \right)^{\alpha (1-x)}
\]

\[
\frac{\dot{Y}_{k,t}}{Y_{k,t}} = i_{k,t} - (\rho + \zeta_{k,t}) - \frac{\alpha x}{\Lambda_{k,t}} \frac{\dot{\Theta}_{k,t}^n}{\Theta_{k,t}^n} - \frac{\alpha (1-x)}{\Lambda_{s,t}} \frac{\dot{\Theta}_{s,t}^n}{\Theta_{s,t}} \frac{\dot{\Theta}_{k,t}^s}{\Theta_{k,t}^s}
\]

\[
-\dot{\mu}_{k,t}^Y = \frac{e^{-\int_0^t (\rho + \zeta) \, dh}}{Y_{k,t}} \left\{ (1 - \alpha) - \left( \frac{Y_{k,t}}{A} \right)^{1+\phi} \right\} + \mu_{k,t}^Y \frac{\dot{Y}_{k,t}}{Y_{k,t}}
\]

\[
\mu_{k,t}^Y i_{k,t} = 0
\]

\[
i_{k,t} \geq 0
\]

\[
\frac{\dot{\Theta}_{s,t}^n}{\Theta_{s,t}^n} = \zeta_{n,t} + \tau_{s,t}
\]

for \( k \in \{s, n\} \), with \( \Lambda_{k,t} \equiv (1 - \alpha) \Theta_{k,t}^n + \alpha x + \alpha (1-x) \Theta_{s,t}^n \).

Back
Define labor wedge for country $k$ good as

$$\omega_{k,t} \equiv 1 - (S_{k,t}^n)^{\alpha} (S_{s,t}^n)^{-\alpha(1-x)} \frac{C_{k,t}N_{k,t}^\phi}{A}$$

**Optimal tax and labor wedges**

The optimal tax is related to labor wedges via

$$\tau_{s,t} = \frac{\alpha x (1 - \omega_{s,t}) \zeta_{n,t} + \left[\alpha x + (1 - \alpha x) \Xi_{s,t}^n\right] \dot{\omega}_{s,t}}{\frac{1-\alpha}{1-\alpha x} \Xi_{s,t}^n - \left[\alpha x + (1 - \alpha x) \Xi_{s,t}^n\right] (1 - \omega_{s,t})} + \frac{\dot{\omega}_{n,t}}{1 - \omega_{n,t}}$$
**Optimal tax under extreme home bias**

In the limit of $\alpha \to 0$, the optimal tax is given by

$$\tau_{s,t} = \begin{cases} 
(1 + \phi)(\rho - \zeta) < 0 & \text{for } 0 \leq t < T \\
(1 + \phi)\rho > 0 & \text{for } T \leq t < \hat{T}_n \\
0 & \text{for } t \geq \hat{T}_n 
\end{cases}$$
Define labor wedge for country $k$ good as

$$\omega_{k,t} \equiv 1 - (S_{k,t}^n)^{\alpha} (S_{s,t}^n)^{-\alpha(1-x)} \frac{C_{k,t}N_{k,t}^\phi}{A}$$
DOMESTIC PLANNING PROBLEM

\[
\begin{align*}
\max_{\{\tau_k,t,\iota_k,t\}} & \quad \int_0^\infty e^{-\int_0^t (\rho + \zeta_{k,h}) \, dh} \left[ \log C_{k,t} - \frac{1}{1 + \phi} \left( \frac{Y_{k,t}}{A} \right)^{1+\phi} \right] \, dt \\
\text{subject to:} & \\
C_{k,t} &= \Theta^n_{k,t} \left( \frac{Y_{k,t}}{\Lambda_{k,t}} \right)^{1-\alpha} \left( \frac{Y_{n,t}}{\Lambda_{n,t}} \right)^{\alpha x} \left( \frac{Y_{s,t}}{\Lambda_{s,t}} \right)^{\alpha (1-x)} \\
\dot{Y}_{k,t} &= i_{k,t} - (\rho + \zeta_{k,t}) - \frac{\alpha x}{\Lambda_{k,t}} \Theta^n_{k,t} - \frac{\alpha (1-x) \Theta^n_{s,t}}{\Theta_{k,t}} \frac{\Theta^n_{s,t}}{\Theta_{k,t}} \\
\dot{\Theta}^n_{k,t} &= \zeta_{n,t} + \tau_{k,t} \\
\dot{\Theta}^n_{k,t} &= \zeta_{n,t} + \tau_{k,t} \\
B_{k,0} &= \alpha \int_0^\infty e^{-\int_0^s (\rho + \zeta_{n,s} - \tau_{n,s}) \, ds} \left[ \Theta^n_{k,t} - x - (1-x) \Theta^n_{s,t} \right] \, dt \\
\text{with } \Lambda_{k,t} &\equiv \left[ (1 - \alpha) \Theta^n_{k,t} + \alpha x + \alpha (1-x) \Theta^n_{s,t} \right].
\end{align*}
\]
CURRENCY WAR AMONG ALL

North interest rate
South interest rate
South exchange rate

North output
South output
North current account

North consumption
South consumption
Tax on downstream flows
Define labor wedge for country $k$ good as

$$\omega_{k,t} \equiv 1 - (S_{k,t}^n)^{\alpha} (S_{s,t}^n)^{-\alpha (1-x)} C_{k,t} N_{k,t}^\phi$$

### Optimal tax and labor wedges

The optimal tax is related to labor wedges via

$$\tau_{s,t} = \frac{(1 - \alpha x)}{\alpha x + (1 - \alpha x) \omega_{s,t}} \hat{\omega}_{s,t} + \frac{1}{1 - \omega_{n,t}} \hat{\omega}_{n,t}$$
EFFICIENT CAPITAL FLOW MANAGEMENT WITH COOP MP

North interest rate

South interest rate

South exchange rate

North output

South output

South trade balance

North consumption

South consumption

Tax on downstream flows
Define labor wedge for country $k$ good as

$$
\omega_{k,t} \equiv 1 - \left( S_{k,t}^n \right)^{\alpha} \left( S_{s,t}^n \right)^{-\alpha(1-\chi)} \frac{C_{k,t}N_{k,t}^\phi}{A}
$$

![Labor wedges](image1.png)

![Tax on downstream flows](image2.png)