The Exchange Rate as an Industrial Policy

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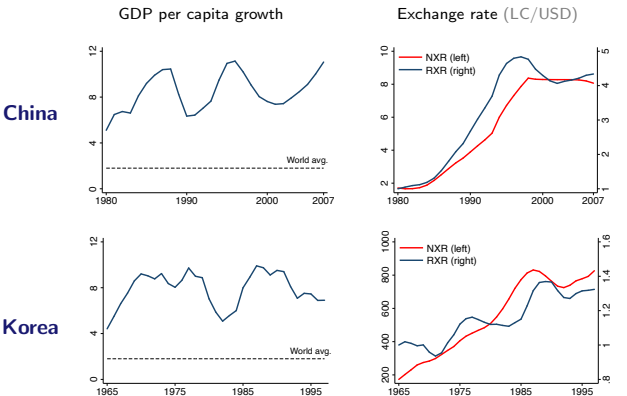
October 17, 2024

Motivation

- Policy circles: Exchange rate as a tool for fostering development
  - Idea: depreciated XR helps strategic sectors via competitiveness
- Narrative based on key examples of EM prolonged growth



▸ more ▸ nx & fx

Can Exchange Rate Be Used As Industrial Policy?

Framework:

- SOE w Marshallian **production externalities**, imperfect capital mobility

Theoretical results:

- Converging economies: **Undervalued XR** during early development stage
  - Temp increases labor & redirects to tradable sector, implemented via FXI
- Non-converging economies: policy not desirable (permanent externalities)

Quantitative analysis: China's growth takeoff

- XR intervention complement to "classic" industrial policies (time invariant)
- Observed reserve accumulation speeded up growth by 1% over 15yrs

Model: Firms

- 2 sectors: Tradable, Non-tradable. Representative firm in each
- Production technology: $y_{it} = Z_{it} l_{it}^{\alpha} \quad i = T, N$
  - Productivity: $Z_{it} = A_t L_{it}^{\gamma_{it}}$, $A_t = \rho\varphi\overline{A} + (1-\rho)A_{t-1}$
- Production **externality**: Learning, knowledge spillovers, labor pooling
  Lucas 88, Krugman 91, Harrison Rodriguez-Clare 10
  - Increasing in distance to technological frontier: $\gamma_{it} \equiv \Gamma_i(\overline{A}/A_t)$
    - Dynamic externalities Redding 99, Melitz 05, Itskhoki Moll 19
  - Stronger in tradable sector: $\gamma_{Tt} > \gamma_{Nt} = 0$ Krugman 87
    - Spillovers stronger in manufacturing than local sectors (relaxed in paper)
- **Tradable labor demand inefficiently low**
  - Strength depends on distance to frontier

Model: Households & Govt

Households:

- Consume tradables & nontradables, supply labor
- Save in local currency bonds

Government:

- Intervenes in XR market: manages portfolio of LC & FC bonds
- Intervention effective because of **segmented asset markets**
  Gabaix Maggiori 15, Itskhoki Mukhin 21
  - Trades LC bonds with households & FC bonds with RoW
  - Affects domestic rate R_t & country's balance-of-payments with policy

First Best Not Attainable with FXI

Definition:

$$\max_{c_{it}, L_{it}, F^*_{t+1}} \quad \sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^{1-\sigma}}{1-\sigma} - \phi L_t \right] \qquad \text{s.t.} \quad \text{BOP}, \quad \text{NT mkt clearing}$$

Proposition:

First best allocation **is not attainable with FX Intervention**.

Reason: FX intervention affects inter-temporal c_{Tt}, not labor margin

Proposition:

First best is attainable w **time-varying labor subsidy** to tradable sector:

$$\tau^L_{Tt} = \frac{\gamma_{Tt}}{\alpha + \gamma_{Tt}}$$

Exchange Rate Industrial Policy

Definition:

$$\max_{c_{it},L_{it},F^*_{t+1},\mathcal{E}_t} \quad \sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^{1-\sigma}}{1-\sigma} - \phi L_t \right] \qquad \text{subject to:}$$

$\mathbf{MRS_{TN}} = \text{Priv } \mathbf{MRT_{TN}}$:
$$\left(\frac{1-\omega}{\omega} \frac{c_{Tt}}{c_{Nt}} \right)^{\frac{1}{\eta}} = \frac{L_{Tt}^{\alpha+\gamma_{\mathbf{Tt}}-1}}{L_{Nt}^{\alpha-1}} \equiv \mathcal{E}_t^{-1}$$

$\mathbf{MRS_{TL}} = \text{Priv } \mathbf{MPL_T}$:
$$\frac{\phi}{(\omega/c_{Tt})^{\frac{1}{\eta}} C_t^{\frac{1}{\eta}-\sigma}} = \alpha A_t L_{Tt}^{\alpha+\gamma_{\mathbf{Tt}}-1}$$

NT mkt clearing:
$$c_{Nt} = A_t L_{Nt}^{\alpha}$$

Balance of Payments:
$$c_{Tt} - A_t L_{Tt}^{\alpha+\gamma_{\mathbf{Tt}}} = R^* F_t^* - F_{t+1}^*$$

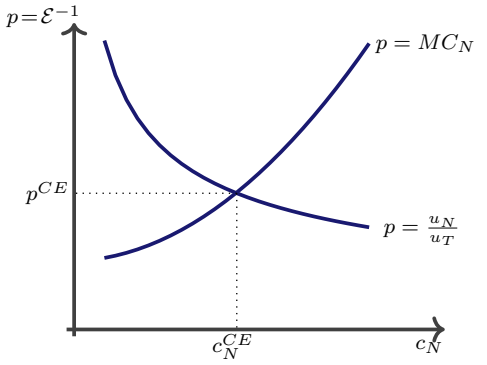
Characterization: Distorted Euler equation → Second-best policy

$$\left(\frac{\omega}{c_{Tt}} \right)^{\frac{1}{\eta}} C_t^{\frac{1}{\eta}-\sigma} = \beta R^* \frac{\theta(\mathbf{x}_{t+1}, \gamma_{\mathbf{Tt+1}})}{\theta(\mathbf{x}_t, \gamma_{\mathbf{Tt}})} \left(\frac{\omega}{c_{Tt+1}} \right)^{\frac{1}{\eta}} C_{t+1}^{\frac{1}{\eta}-\sigma}$$

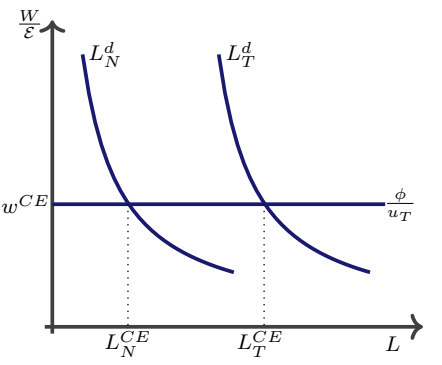
Optimal XR-IP in Converging Economies

In Initial Periods

NT Market



Labor Market



Optimal XR-IP in Converging Economies

In Initial Periods

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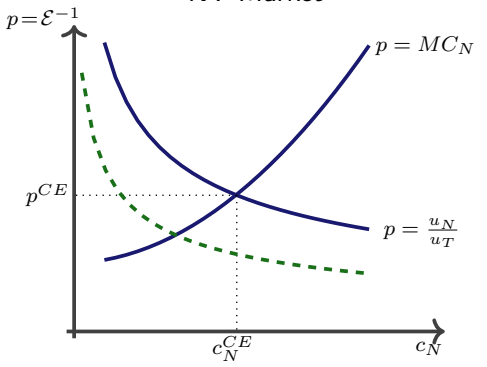

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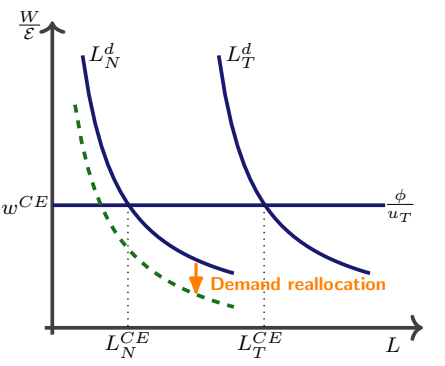

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In Initial Periods

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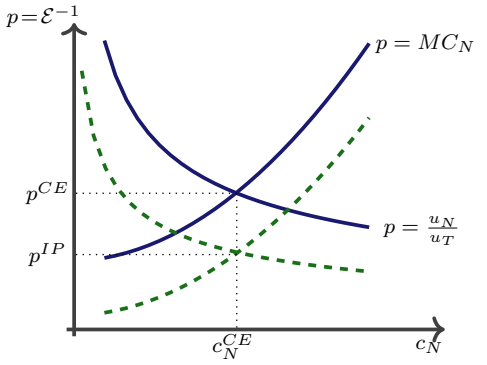

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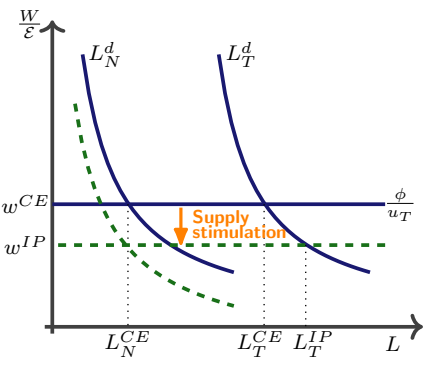

Optimal XR-IP in Converging Economies

In Initial Periods

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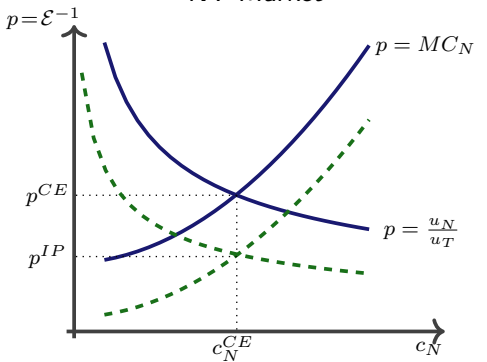

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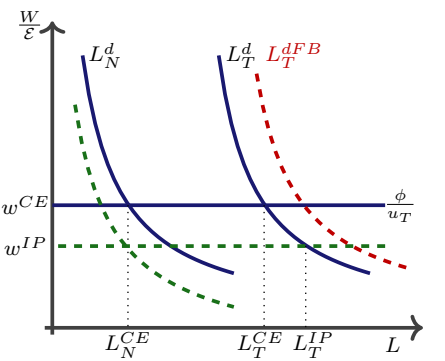
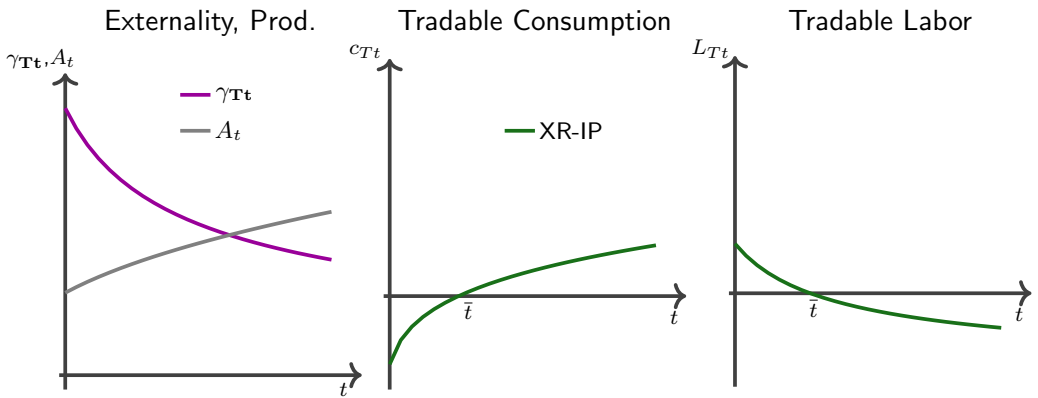


XR-IP Dynamics in Converging Economies

Deviation from laissez-faire CE (where UIP holds)



▸ Proposition

XR-IP Dynamics in Converging Economies

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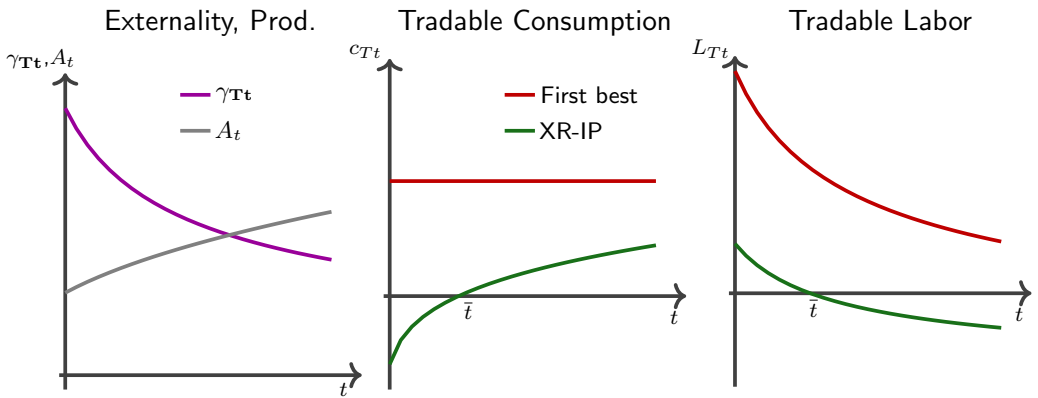

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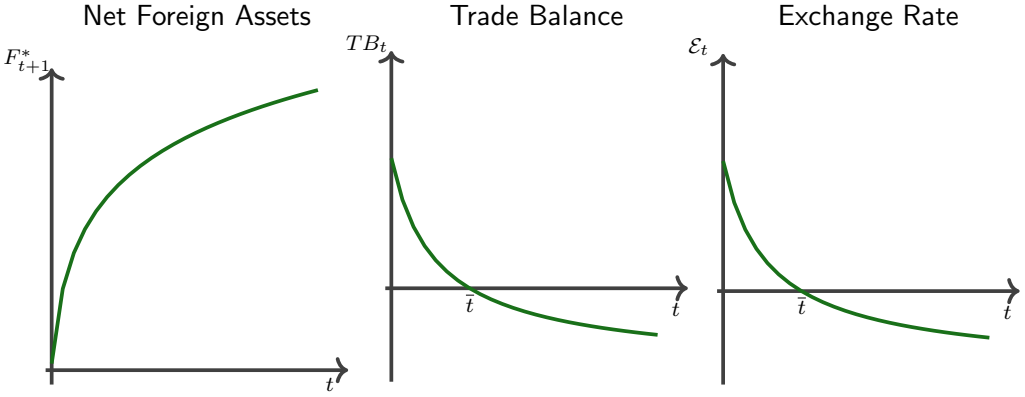


▸ Proposition

Additional Results in Paper: Summary

1. Non-converging economies

- Economies at frontier or stagnant: **XRIP is laissez-faire** (const externalities)

2. Imperfect capital mobility

- **XR-IP less active:** arbitrageurs extract profits from carry trade
- Room for capital management policies:
  - Tax of carry-trade profits + XR-IP
  - **Capital controls as industrial policy**: Equivalence capital control & XR-IP

3. Role of labor supply & multiple sectors

- XR-IP more **desirable & effective** when labor supply more **elastic**
- Multiple trad sectors: XR-IP follows **weighted avg sector externalities**

Historical experiences

Asian growth miracles

- Emblematic example of export-led growth w FXI Page 94, Song et al 14, Cai 16
- Through lens of model meet conditions for XR-IP to be effective
  - Process of convergence to tech frontier
  - Initially underdeveloped financial markets
  - Demographic dividends $\rightarrow$ labor supply elastic

Latin American experiences

- Often cited as unsuccessful examples of these policies
- Through lens of model:
  - Not experiencing convergence process, commodity producers
  - Relatively more open capital account, larger costs of labor reallocation

Quantitative analysis: China's Growth Takeoff

Estimating Production Externalities

- Build on **BCDR methodology** (Bartelme Costinot Donaldson Rodriguez-Clare 2024)
  - Uses sector-country variation to estimate sector-specific production spillovers
- **Goal**: Estimate spillovers sector-country production functions

$$Y_{ik} = A_{ik} L_{ik}^{\alpha+\Gamma_k(\mathsf{df}_i)} \quad \text{with} \quad \Gamma_k(\mathsf{df}) = \gamma_0^k + \gamma_1^k \mathsf{df}$$

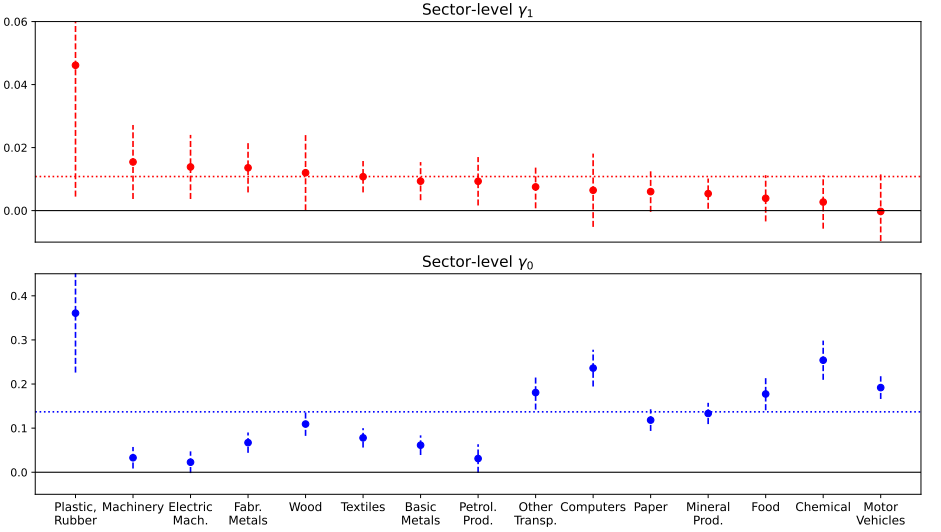
- Estimate empirical model (comes from firms' optimality condition)

$$x_{ik} = \alpha_i + \alpha_k + (\gamma_0^k + \gamma_1^k \mathsf{df}_k) \ln L_{ik} + \varepsilon_{ik}$$

X_{ic}: log expenditure in sector k, country i (adjusted by trade elasticity); L_{ic} employment, in sector k, country i; $\mathsf{df}_k \equiv \frac{y_{us}}{y_c} - 1$ measures the distance to frontier of country c

- BCDR **IV-approach**: population and expenditure shares of country i as instrument of country-sector size

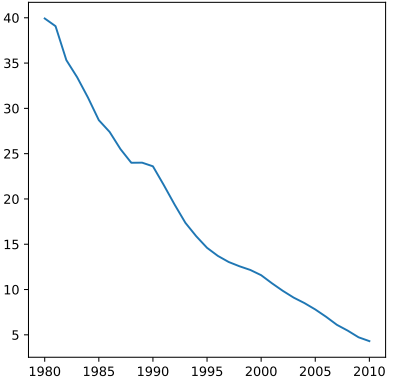
Sector-Level Externality Estimation



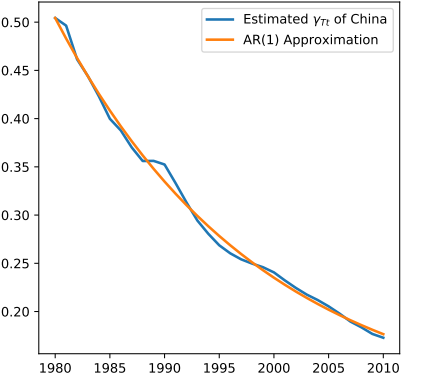
▸ table

Estimated Externality for China

China df_t



Estimated γ_{Tt}



▸ Skip to summary

Quantitative Analysis for China

1. Calibration strategy

- Parameterize model to match share of sectors, nfa, other moments
- Feed in path of productivity & implied dynamic externality

2. Model validation

Avg. annual growth	Data 1980-2010	Model
Output	9.0	7.2
Consumption	7.6	7.1
Net exports	12.5	11.1
Real XR	4.5	1.9

3. Model exercises

- Optimal XR-IP quantitative effects & comparison w other industrial policies
- Assess effects of observed reserve accummulation

▸ Skip to summary

Effects of Optimal XR Policy

	First Best		XR-IP	
	30-yr av	yrs 50-60	30-yr av	yrs 50-60
a. Output				
Agg.	**7.8**	1.1	**1.5**	-1.5
T	**82.1**	2.7	**21.9**	-5.3
b. Consumption				
Agg.	3.7	3.9	-1.2	0.8
T	22.3	12.4	-0.6	0.4
c. Welfare (incl transition)				
Cons. eq.	**0.41**		**0.07**	

$\%\Delta$ relative to CE

XR-IP & "Classic" Industrial Policies

	Welfare Cons. eq.	**Output** 30-yr av
First Best	0.41	7.8
Tradable Labor Subsidy + XR-IP	**0.35**	5.9
Tradable Labor Subsidy	0.27	4.2
Labor Subsidy	0.09	3.4
XR-IP	**0.07**	1.5

$\%\Delta$ relative to CE $\quad \tau^{L*} = 5.8\%, \quad \tau_T^{L*} = 17.1\%$

Macro Effects of Observed Reserve Accumulation

Av $\%\Delta$	**Observed** 1990-2006	**XR-IP** 1990-2006
a. Output		
Agg.	**1.3**	**0.9**
T	4.3	3.3
b. Consumption		
Agg.	-0.6	-0.5
T	-0.3	-0.3
c. External sector		
Reserves	**19.6**	**18.5**
Real XR	1.3	1.0

$\%\Delta$ relative to no Reserves accumulation ‣ reserves

Conclusion

- Developed theoretical framework to study XR as industrial policy
- XR-IP desirable if externalities stronger in early phase of growth
- Effectiveness depends on capital mobility and labor market dynamism
- Observed reserve accumulation helped speed up growth
- Strong macro effects of XRIP when combined w "classic" industrial policies

Quantitative Analysis Key Takeaways

1. Optimal XR-IP stimulates output, postpones consumption

- Output during initial 30 years is 1.5% larger. Tradable output is 22% larger
- At the expense of lower consumption (-1%)

2. Sizeable welfare effects of policy

- Welfare increases by 0.07% permanent consumption equivalence
- Comparable to gains from constant labor subsidy. $1/5$ of first best gains
- Complementary to "classic" industrial policies:
  - Close to first best when combined with constant tradable labor subsidy

3. Observed reserve accummulation speeded up growth

- By 1.3% over 15 years, missed timing

Conclusion

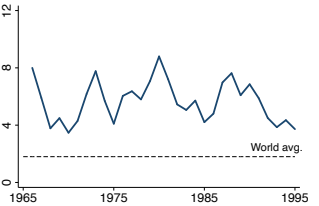
- Developed theoretical framework to study XR as industrial policy
- XR-IP desirable if externalities stronger in early phase of growth
- Effectiveness depends on capital mobility and labor market dynamism
- Observed reserve accumulation helped speed up growth
- Strong macro effects of XRIP when combined w "classic" industrial policies

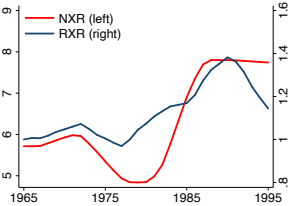
Rapid Growth Asian Economies

GDP per cap growth

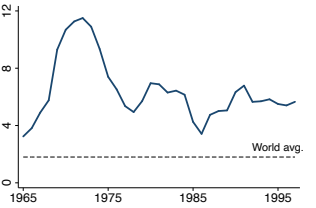
Exchange Rate

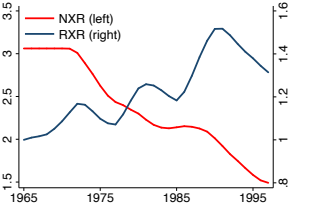
Hong Kong





Singapore

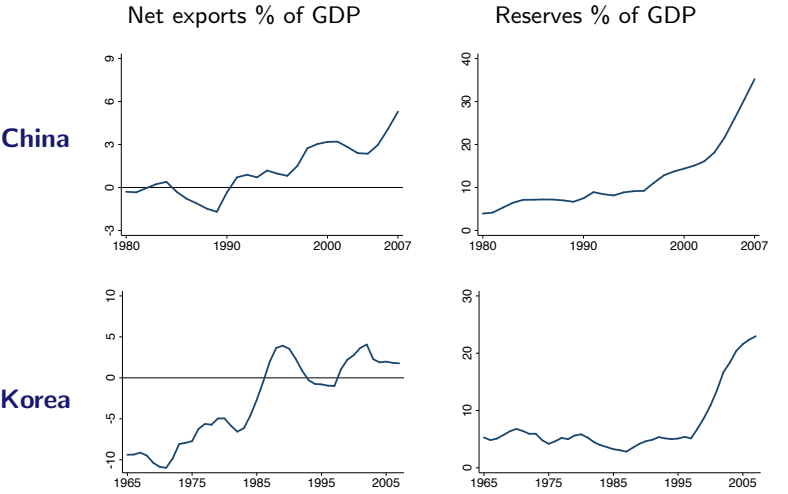




5-yr moving average

▸ Back

Export-led Growth & Reserve Accumulation



5-yr moving average. Reserves of foreign exchange and gold.

▸ Motivation

XR-IP Approx Policy Problem

Back

Define: $z_t = \log c_{Tt} - \log \tilde{c}_{Tt}$, $x_t = \log L_{Tt} - \log \tilde{L}_{Tt}$ log deviations from FB

Lemma 1:

Allocations that solve the XR-IP problem can be approx with those that solve:

$$\begin{aligned} \max_{z_t, x_t} \quad & -\frac{1}{2} \sum_{t=0}^{\infty} \beta^t \left[\omega z_t^2 + \left[\omega(\alpha+\gamma)^2 + \omega(\alpha+\gamma) \right] x_t^2 \right] \\ \text{s.t.} \quad & z_t = \psi_t + (\alpha + \gamma - 1) x_t \\ & \sum_{t=0}^{\infty} \beta^t \left(z_t - (\alpha+\gamma) x_t \right) = 0 \end{aligned}$$

γ weighted function of γ_{Tt} path

$\psi_t = \log \alpha - \log(\alpha + \gamma_{Tt}) \leq 0$

Optimal XR-IP in Converging Economies

Benchmark: Laissez-faire competitive equilibrium

A **laissez-faire CE** is a CE with govt policy such that UIP holds $R_{t+1} = R^* \frac{\mathcal{E}_{t+1}}{\mathcal{E}_t}$

Proposition:

Suppose economy starts below steady state productivity ($A_0 < \varphi \overline{A}$) so γ_{Tt} is decreasing in t.

The optimal XR-IP implies:

$$\mathcal{E}_t^{IP} > \mathcal{E}_t^{CE}, \quad L_{Tt}^{IP} > L_{Tt}^{CE}, \quad c_{Tt}^{IP} < c_{Tt}^{CE}, \quad TB_t^{IP} > TB_t^{CE} \quad \text{if } t < \bar{t}$$

- With opposite inequalities if $t > \bar{t}$
- Achieved through accummulation of intl reserves $F_{t+1}^{*IP} > F_{t+1}^{*CE}$ for all t

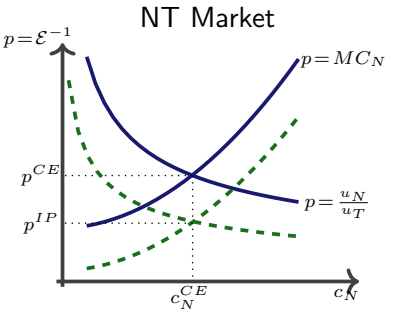
▸ Dynamics

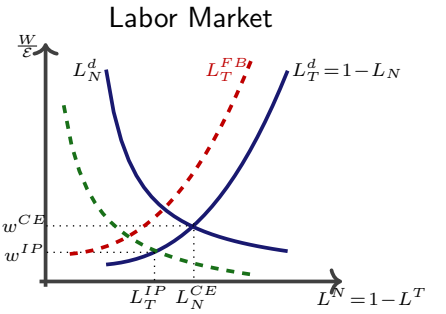
XR-IP with (only) Demand Reallocation

Proposition:

Assume $\gamma_{T0} > \gamma_{Tt} = 0$ for $t \geq 1$, C-O prefs, **fixed labor supply**. Then:

$$\mathcal{E}_0^{IP} > \mathcal{E}_0^{CE}, \quad L_{T0}^{IP} > L_{T0}^{CE}, \quad c_{T0}^{IP} < c_{T0}^{CE}, \quad CA_0^{IP} > CA_0^{CE}$$





- XR depreciation decreases NT demand, frees up labor for trad sector

▸ Back

XR-IP with Non-tradable Externalities

Suppose **any NT production externalities** $\gamma_{\mathbf{Nt}} > 0$.

Proposition: Under Assumption 1, optimal XR-IP is independent of $\gamma_{\mathbf{Nt}}$.

- Eqm NT allocations independent of intertemporal considerations

$$c_{Nt} = y_{Nt} = A_t \left[\frac{\alpha(1-\omega)}{\phi} \right]^{\alpha+\gamma_{\mathbf{Nt}}}$$

- XR-IP cannot exploit this margin via FX intervention

Back

Financial Intermediaries and Limits to Arbitrage

- Inter-temporal resource constraint:

$$\underbrace{\sum_{t=0}^{\infty} \frac{\left(A_t L_{Tt}^{\alpha+\gamma_{\mathbf{Tt}}} - c_{Tt}\right)}{R^{*t}}}_{\text{NPV net exports}} + \underbrace{\frac{1}{\Gamma_B}\left(1 - \frac{R^*\mathcal{E}_1}{R_1\mathcal{E}_0}\right)\left(1 - \frac{R_1\mathcal{E}_0}{R^*\mathcal{E}_1}\right)}_{\leq 0 \text{ bc intermediaries profits}} = -R^* F_0^*$$

- Financial intermediaries profit from FXI intervention
  - Higher profits with larger UIP wedge
  - Rationale for capital controls (related to Trilemma)

XR-IP: Labor supply

Back

- HH prefs with elastic labor supply Berger Herkenhoff Mongey 22

$$\sum_{t=0}^{\infty} \beta^t \left[\log C_t - \phi_T \frac{L_{Tt}^{1+\nu}}{1+\nu} - \phi_N \frac{L_{Nt}^{1+\nu}}{1+\nu} \right]$$

Proposition:

The optimal XR-IP implies:

$$\frac{\mathcal{E}_0^{IP}}{\mathcal{E}_0^{CE}} > 1, \quad \frac{L_{T0}^{IP}}{L_{T0}^{CE}} > 1, \quad \frac{c_{T0}^{CE}}{c_{T0}^{IP}} > 1, \quad \frac{CA_0^{IP}}{CA_0^{CE}} > 1, \quad \frac{F_1^{*IP}}{F_1^{*CE}} > 1$$

- All these ratios are increasing in the elasticity of labor supply ν^{-1}

XR-IP: Multiple sectors

Back

- Multiple tradable sectors $j = 1, 2$ with different $\gamma_{\mathbf{Tjt}}$

$$\sum_{t=0}^{\infty} \beta^t \left[\log C_t - \phi_{T1} \frac{L_{T1t}^{1+\nu_1}}{1+\nu_1} - \phi_{T2} \frac{L_{T2t}^{1+\nu_2}}{1+\nu_2} - \phi_N \frac{L_{Nt}^{1+\nu_N}}{1+\nu_N} \right]$$

- Tradable consumption agg of sector varieties $c_{Tt} = c_{T1t}^{1/2} c_{T2t}^{1/2}$

Proposition:

The optimal XR-IP for baseline and multiple sectors follow same law of motion:

$$(1+D)\epsilon_t + D\psi_t = (1+D)\epsilon_{t+1} + D\psi_{t+1}$$

- D and ψ_t are model specific, weighted avg for multiple sectors
- Multiple sectors: j weight increasing in sector labor supply elasticity ν_j^{-1}