Foreign Reserve Accumulation, Foreign Direct Investment, and Economic Growth

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Introduction

- Foreign reserve accumulation by developing countries.
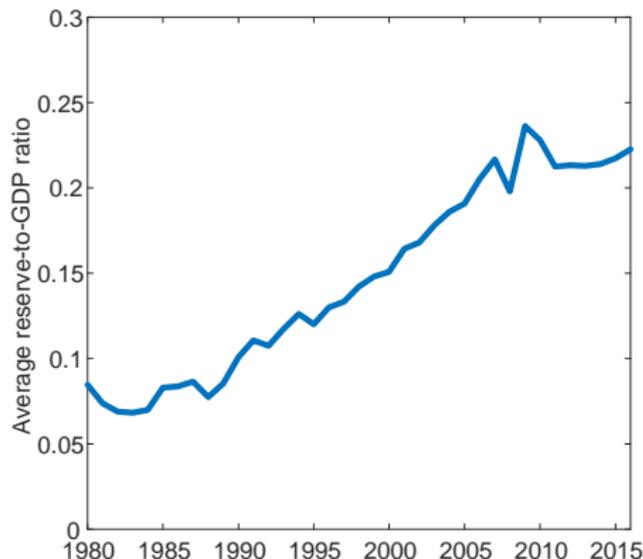
- Traditional views cannot explain this active reserve accumulation.

- Literature: Why do developing countries actively accumulate reserves?

    $\rightarrow$ Precautionary motive and growth strategy `literature`

Introduction

- Wide cross-country variation in reserve accumulation pace.
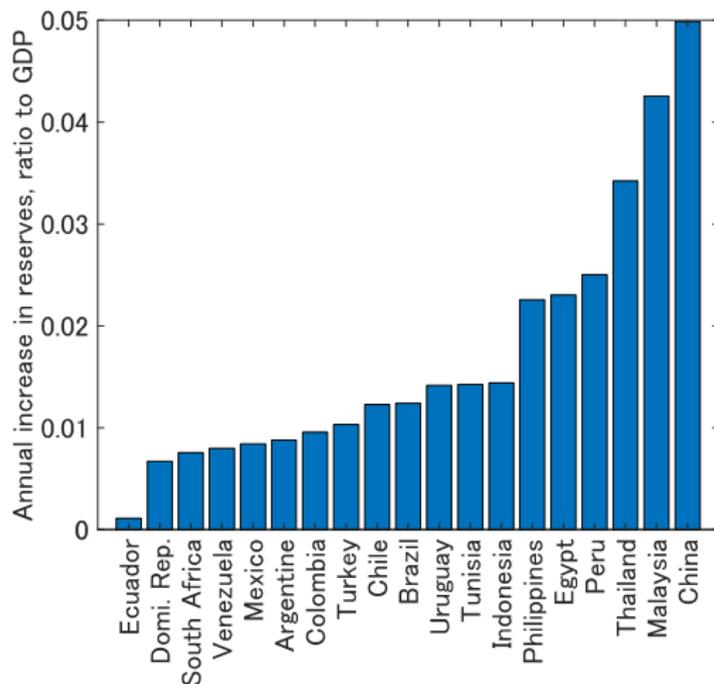
- Questions: What determines reserve accumulation pace across countries?
  Are these heterogeneous paces optimal?

This paper

1. Quantitative SOE model with reserve accumulation: `literature`

   - Endogenous growth with firm dynamics and FDI entry.

   - Sudden stops in capital inflows as occasionally binding constraint.

2. Study what are the key determinants of optimal pace of accumulation.

3. Control for determinants and derive optimal pace for 19 developing countries, and compare with observed pace.

Key Mechanism

- Reserve policy:

  - Reserve accumulation in normal times by collecting taxes

    $\rightarrow$ Real depreciation, labor shift to tradable sector, higher profits for firms

  - Bailouts during crisis

    $\rightarrow$ Prevent severe economic downturns

  - Reserve policy achieves fast and stable growth, long-run $C_t \uparrow$

- Cost of reserve policy:

  Reserve accumulation takes away private resources $\rightarrow$ short-run $C_t \downarrow$

- Key trade-off: short-run $C_t \downarrow \iff$ long-run $C_t \uparrow$

Main Results

- Two determinants of the optimal pace of reserve accumulation:

  1. Elasticity of foreign borrowing spread w.r.t. foreign debt
     - Elastic spread $\rightarrow$ Costly to increase foreign debt to finance reserve accumulation
     - $C_t \downarrow$ in short run $\rightarrow$ Optimal pace is slower

  2. FDI entry cost
     - Higher FDI entry cost $\rightarrow$ Less FDI attracted $\rightarrow$ Optimal pace is slower

- Compare actual and optimal pace by 19 developing countries.

  - Most countries are roughly in line with optimal pace.

 - Two factors explain cross-country variation in reserve accumulation pace.

Contributions in Literature

- Model of reserve accumulation

  - Precautionary saving: Jeanne and Ranciere (2011), Bianchi et al. (2016)

  - Growth promotion: Aizenmann and Lee (2010), Korinek and Serven (2016)

  - Both effects: Benigno and Fornaro (2012)

  - This paper: Quantitative model that **explains heterogeneous paces**

- Cross-country variation in reserve accumulation

  - Obstfeld et al. (2010): Size of domestic financial sector

  - Aguiar and Amador (2011): Political economy friction

  - This paper: **Elasticity of spread** and **FDI entry cost**

- Embed endogenous growth in DSGE to study persistent effect of crisis

  - Comin and Gertler (2006), Gornemann (2015), Queralto (2015), Ates and Saffie (2016), Guerron-Quintana and Jinnai (2018)

 - This paper: **Occasionally binding constraint** and **policy analysis**

Model

Model Overview
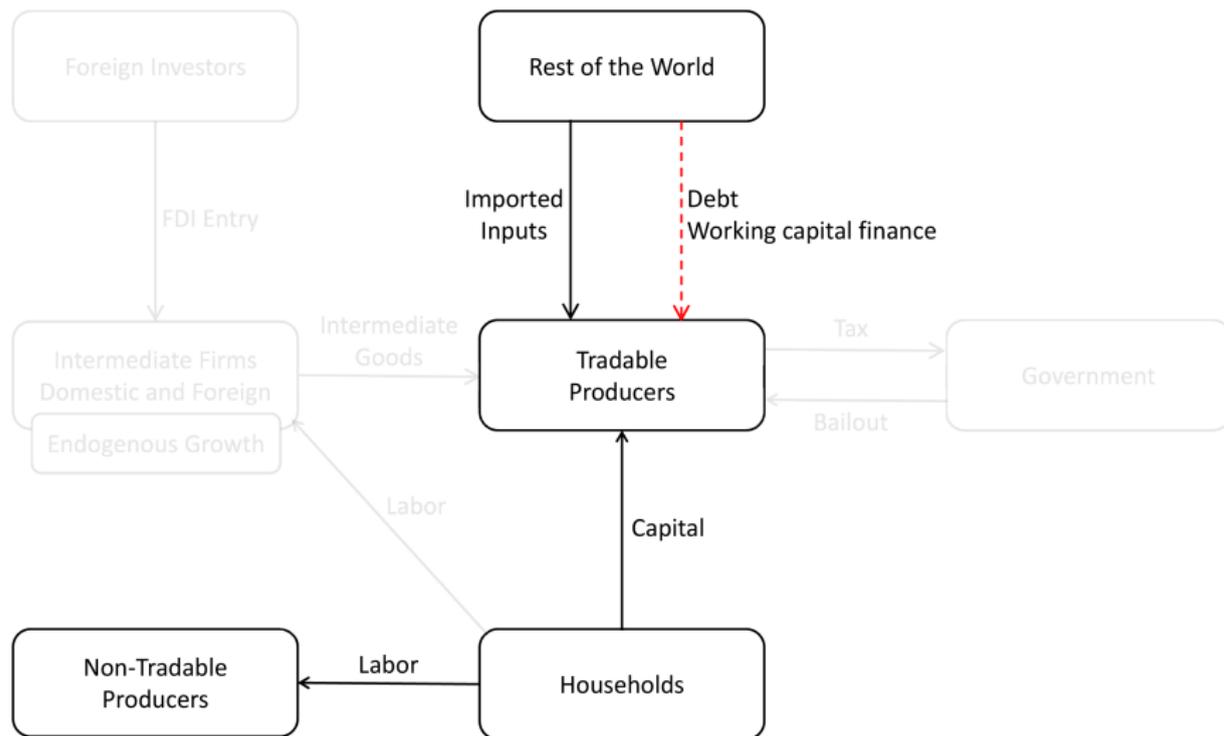
- Small open economy with tradable and non-tradable sectors.
- Start with scarce capital, and accumulate capital toward long-run BGP.

Model Overview
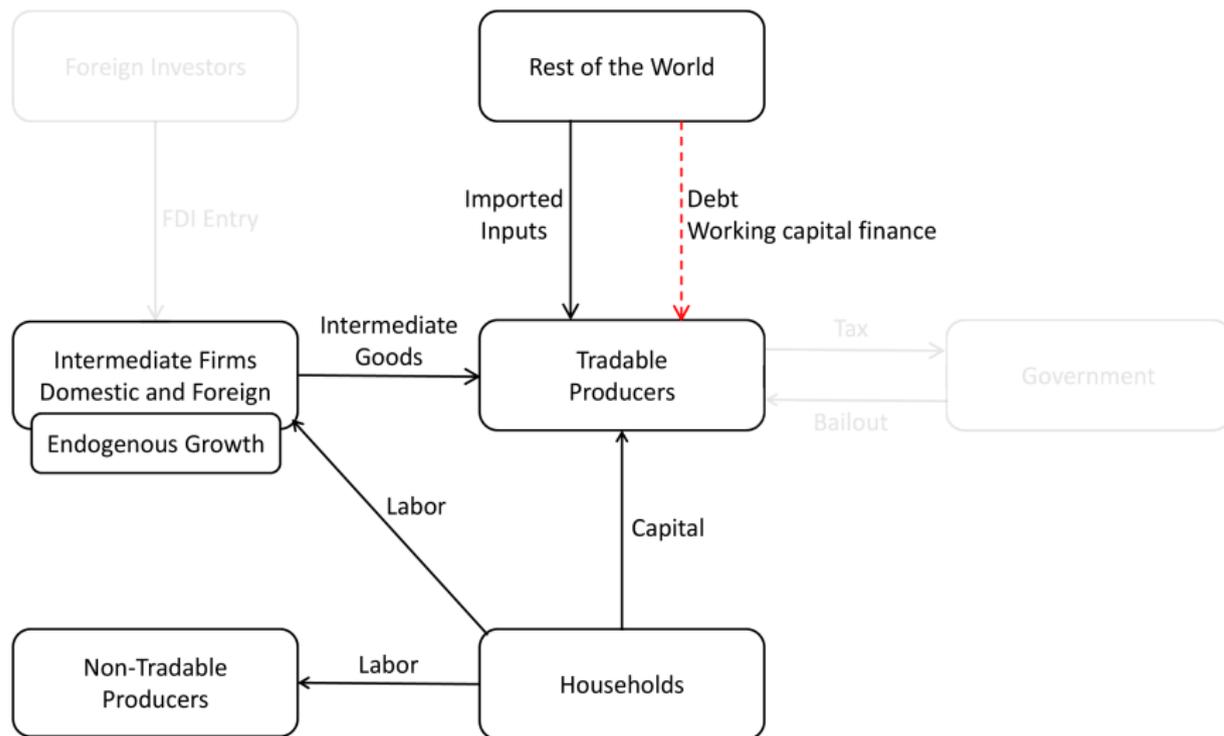
- Many domestic and foreign-owned firms in intermediate sector.
- Firms invest in innovation and increase productivity endogenously.

Model Overview
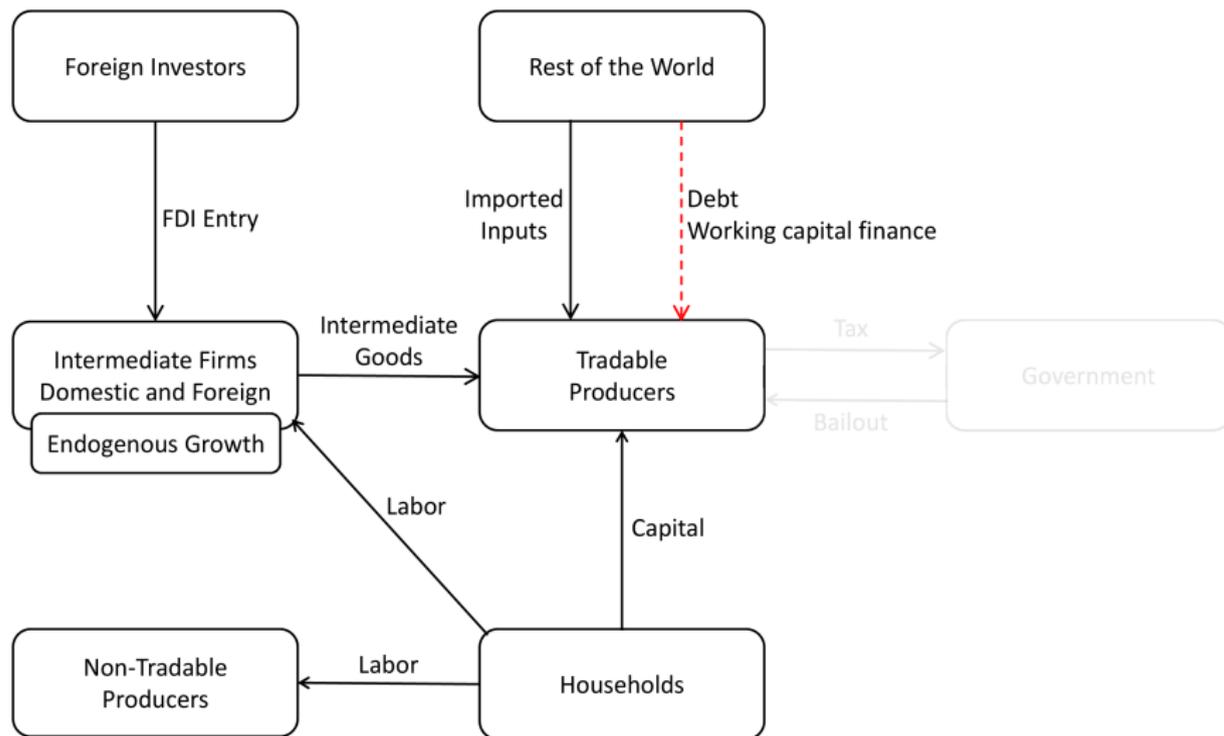
- Foreign investors entry through FDI.
- FDI entry also contributes to productivity growth.

Model Overview
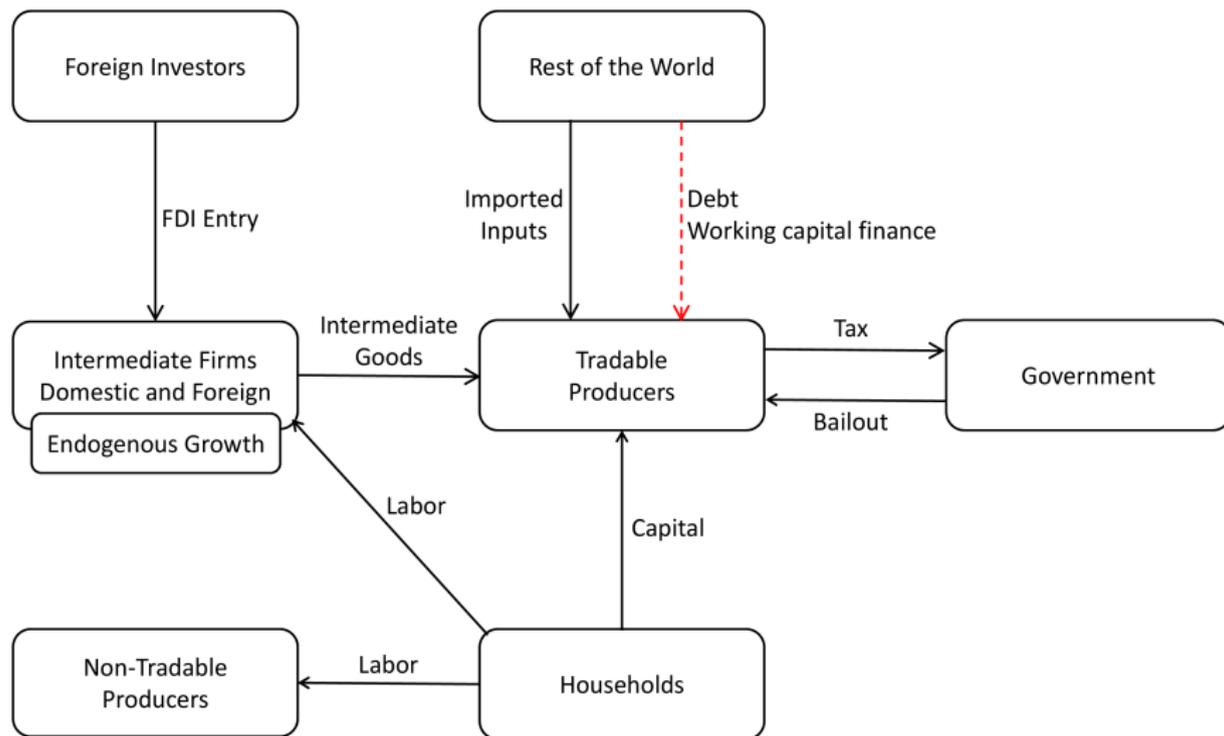
- In normal times, government collects tax and accumulates reserves.
- When crisis occurs, government bails out using accumulated reserves.

Final Tradable Sector

- Production function

$$Y_t^T = (K_t^D)^\alpha (I_t^M)^\theta (M_t)^{1-\alpha-\theta}$$

$$I_t^M = \exp\left(\int_0^1 \ln y_t(i)\,di\right)$$

- Maximization problem

$$\max_{K_t^D, \{y_t(i)\}, M_t, B_t} E_0 \sum_{t=0}^\infty \left[\beta^t \lambda_t \Pi_t^T\right]$$

$$\Pi_t^T = \underbrace{Y_t^T - r_t K_t^D - \int_0^1 p_t(i) y_t(i)\,di - P^M M_t}_{\text{output - input cost}} \underbrace{- B_t + R_{t-1} B_{t-1}}_{\substack{\text{borrowing and} \\ \text{repayment}}} - T_t + V_t$$

subject to the borrowing constraint with $\kappa_t = \{\kappa_H, \kappa_L\}$

$$-B_t + \phi\left[\int_0^1 p_t(i) y_t(i)\,di + P^M M_t\right] - V_t \le \kappa_t K_{t-1} \qquad \text{(FOC)}$$

Debt-Elastic Interest Rate

- Interest rate is elastic to debt, as in Schmitt-Grohe and Uribe (2003):

$$R_t = \overline{R} + \psi_b \left(\exp\left(-\frac{B_t}{GDP_t} + \overline{b} \right) - 1 \right)$$

- ▸ $\overline{R}$: Long-run interest rate

- ▸ $\overline{b}$: Long-run debt-to-GDP ratio

- ▸ ψ_b: Elasticity of spread w.r.t. debt

Intermediate Sector: Overview

- Unit measure of differentiated intermediate goods.

- Schumpeterian growth:

  ▸ Many firms exist, and each firm produces several types of goods.

  ▸ Two types of firms: domestic and foreign-owned.

  ▸ Productivity improves through entry and incumbent innovation.

Intermediate Sector: Firm Dynamics and Growth
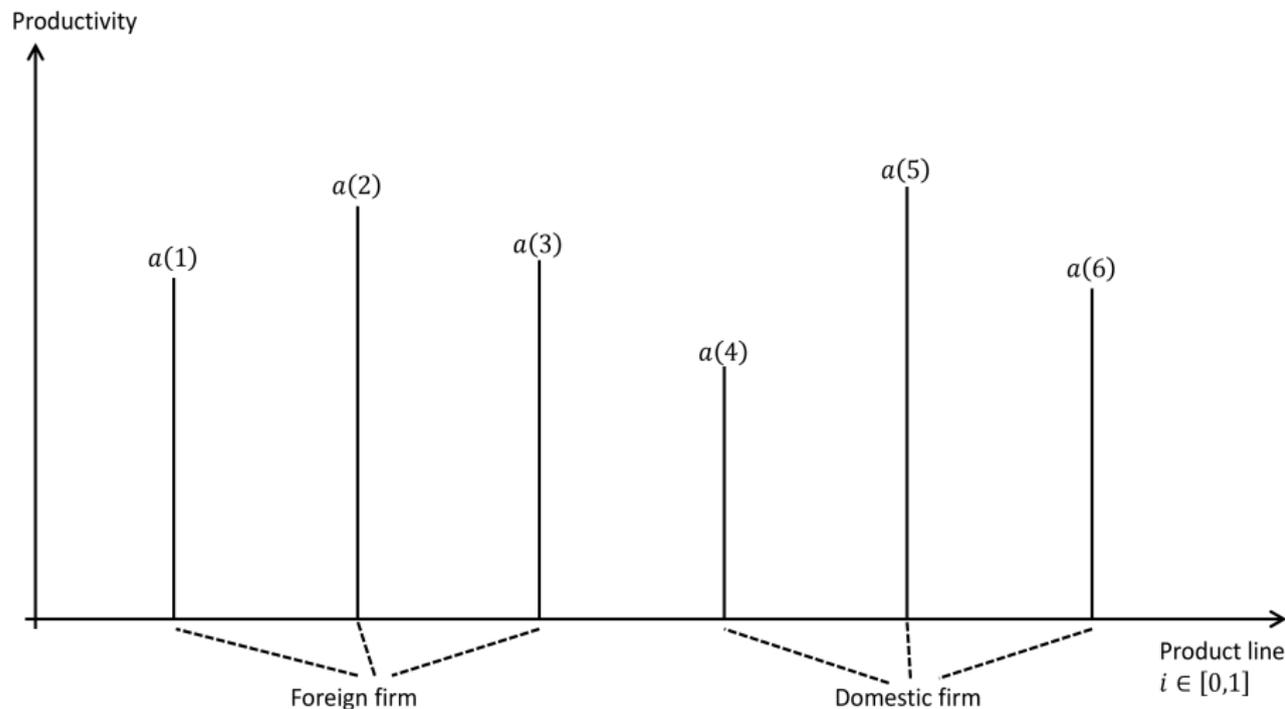
- Each firm produces goods using labor: $y_t(i) = a_t(i)\ell_t(i)$.

Intermediate Sector: Firm Dynamics and Growth
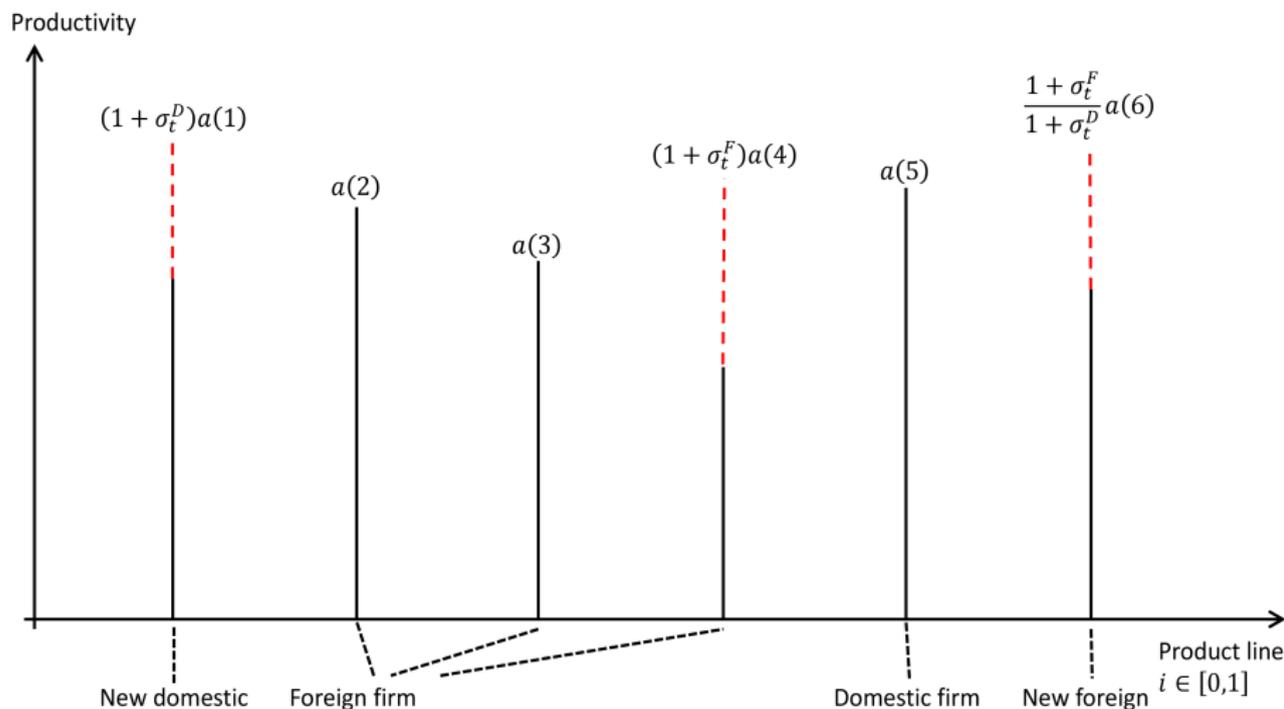
- Domestic entry, incumbent innovation, and FDI entry improve productivity.

Intermediate Sector: Profit

- Profit for each product line, $s = D$ (domestic) or F (foreign):   algebra

$$\pi_t^s = \frac{\sigma_t^s}{1 + \sigma_t^s} \theta Y_t^T \frac{1}{1 + \phi \mu_t / \lambda_t}$$

- Two channels through which reserve policy increases profits:

  ▸ Reserve accumulation increases L_t^T and $Y_t^T \implies$ Higher profit

  ▸ Bailout helps working capital finance and reduces $\mu_t \implies$ Higher profit

Intermediate Sector: Investment in Innovation

- Firms with n product lines have n innovation opportunities.

    - For each opportunity, firms invest final tradable goods to make innovation.

$$\underbrace{i_t^{D\prime}(Z_t^D)}_{\substack{\text{marginal increase in} \\ \text{success probability}}} \underbrace{E_t\left[\Lambda_{t,t+1} V_{t+1}^D\right]}_{\substack{\text{expected value} \\ \text{of a product line}}} = 1$$

- FDI entry by foreign investors:

    - Acquisition price: fraction λ of the expected value of a product line.

    - Entry cost: Congestion cost increases in FDI entry rate e_t^F, and fixed cost.

$$\underbrace{(1-\lambda)\frac{1}{R^F} E_t\left[V_{t+1}^F\right]}_{\text{benefit of FDI entry}} = \underbrace{\chi^F A_t \frac{e_t^F}{1-\theta_{t-1}}}_{\text{congestion cost}} + \underbrace{A_t C^F}_{\text{fixed cost}}$$

Non-Tradable Sector and Household

- Non-tradable goods production

$$Y_t^N = A_t(L_t - L_t^T)^{1-\alpha^N}$$

- Household

$$\max_{\{C_t^T, C_t^N, L_t, K_t, Z_t^E\}} E_0 \sum_{t=0}^{\infty} \beta^t \left[\ln C_t - \psi(L_t)^\omega\right]$$

$$C_t = \left[(\gamma)^{\frac{1}{\varepsilon}}(C_t^T)^{\frac{\varepsilon-1}{\varepsilon}} + (1-\gamma)^{\frac{1}{\varepsilon}}(C_t^N)^{\frac{\varepsilon-1}{\varepsilon}}\right]^{\frac{\varepsilon}{\varepsilon-1}}$$

subject to the budget constraint

detail

Reserve Policy: Accumulation in Normal Times

- Reserve accumulation in normal times

  - Collect tax $T_t = \tau Y_t^T$ from tradable producers to accumulate reserves.

    Optimal pace of accumulation: τ that maximizes HH's expected utility.

  - Partial equilibrium intuition for growth effect:

  $$\frac{C_t^T}{C_t^N} = \frac{\gamma}{1-\gamma}(P_t^N)^\varepsilon$$

  $$W_t = MPL_t^T(L_t^T) = P_t^N \times MPL_t^N(L_t - L_t^T)$$

  Reserve accumulation $\implies C_t^T \downarrow \implies P_t^N \downarrow \implies L_t^T \uparrow \implies \pi_t^D, \pi_t^F \uparrow$

- When borrowing constraint binds, detail

  - Provide accumulated reserves and bail out tradable producers.

Quantitative Analysis

Calibration

- One period is one year
- Standard parameters are set to standard values in literature. (detail)
- Internally-determined parameters:

| Parameter		Value	Target	Model
η^D	Domestic firm innov. coeff.	0.20	Manu. R&D expenditure/GDP 2.4%	2.4%
η^E	Domestic new entry coeff.	0.72	Domestic entry rate 8.11	8.11
η^F	Foreign firm innov. coeff.	0.17	Relative innovation rate 1.39	1.39
χ^F	FDI entry congestion cost	0.60	Value-added share by foreign 32.25%	32.25%
λ	Share of FDI acquisition price	0.71	Manu. FDI inflow/GDP 1.57%	1.57%
C^F	Fixed entry cost	0.16	Value of a line/fixed cost 1.1	1.1
σ^D	Domestic innovation size	0.24	Long-run growth rate 2.1%	2.1%
σ^F	Foreign innovation size	0.36	Productivity gain by FDI entry 11%	11%

- Target average of 19 developing countries.
- Benefit of FDI: relative innovation rate and productivity gain by FDI entry.

Sudden Stops and Initial States

- Transition matrix for κ_t determines frequency and duration of sudden stops.

    - Use data for 33 countries in 1980-2009, as in Jeanne and Ranciere (2011).

    - Unconditional probability: 8.6%

    - Probability to continue next year: 14.9%

- Initial states for simulations:

    - Initial capital K_{-1} is set so that $K_{-1} = 0.30 \times K_{30}$, in line with data.

    - Debt/GDP = 36%, no foreign firms, no reserves.

Sudden Stop Dynamics

Real GDP

Real Consumption

Capital Investment

FDI Inflow-to-GDP Ratio
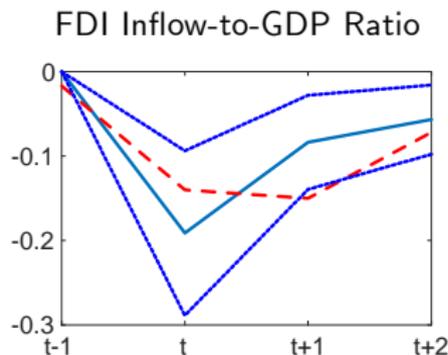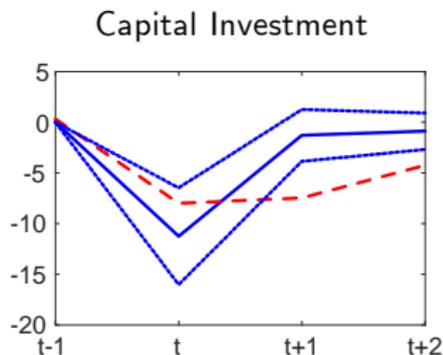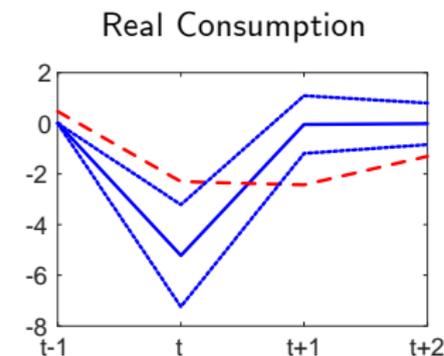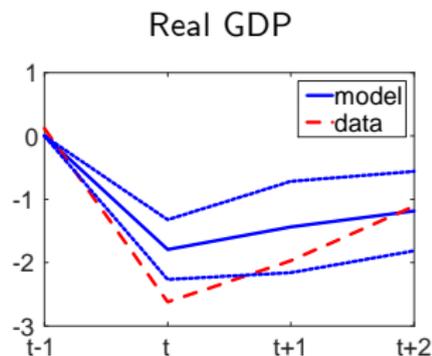
- Model captures sudden stop dynamics quantitatively well.

Simulation Example (ψ_b=0.0561, τ=0.03)
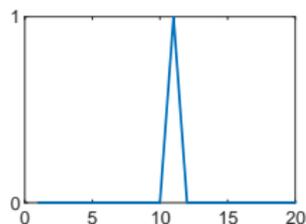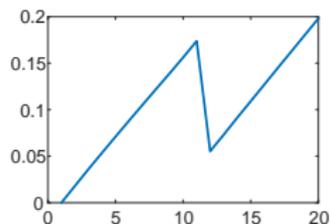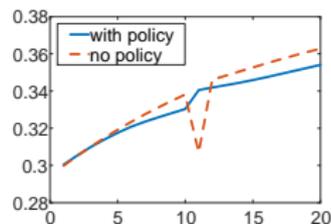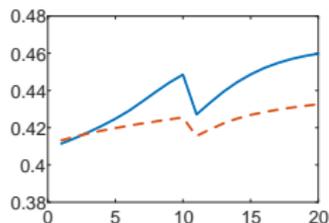
- Reserve policy induces real depreciation and labor shift to tradable sector.

- High and stable domestic innovation rate, and active FDI entry.

Simulation Example (ψ_b=0.0561, τ=0.03)

Aggregate productivity
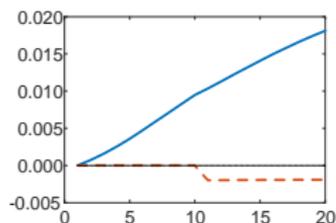
GDP
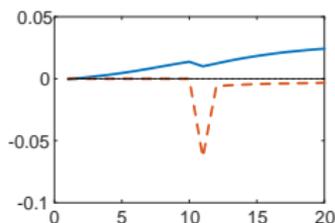
Consumption
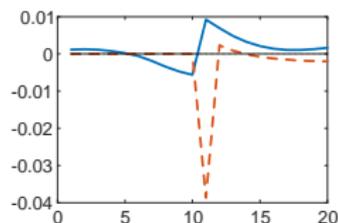
- Log gaps from paths without shocks or policies.

- Policy achieves faster and more stable growth in productivity and GDP.

- Trade-off: $C_t \downarrow$ in short run $\iff$ $C_t \uparrow$ in long run.

other

Main Analysis 1

Determinants of Optimal Pace

Determinant 1: Debt-Elasticity of Spread ψ_b

- Elasticity of foreign borrowing spread w.r.t. foreign debt ψ_b.

  - Estimate using panel regression (details later).

  - Elasticity varies widely across developing countries.

- To show how elasticity affects optimal pace of reserve accumulation:

  - Compare countries with different elasticities, everything else equal.

  - Use 0.0223, 0.0561, 0.0899 from estimation results.

Determinant 1: Debt-Elasticity of Spread ψ_b
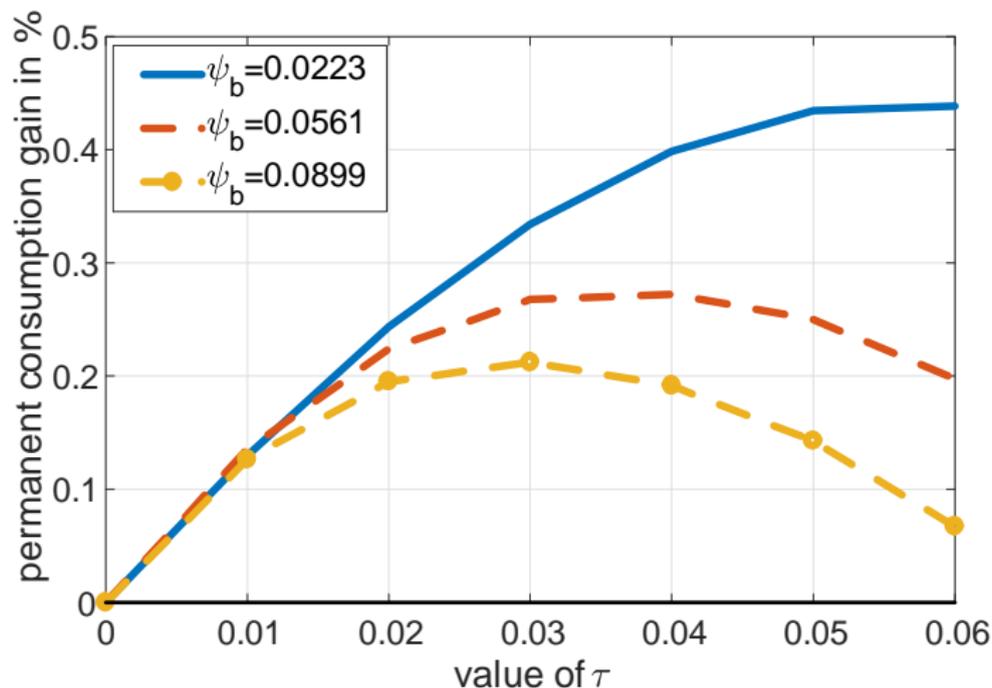
- **Higher** elasticity of spread $\rightarrow$ **Slower** optimal pace, **smaller** welfare gain

Determinant 1: Debt-Elasticity of Spread ψ_b

Foreign debt   Interest spread   Consumption
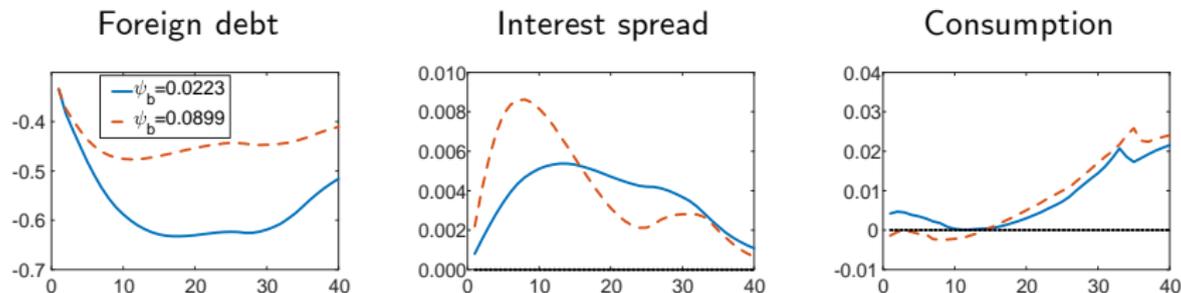
- Average paths with $\psi_b = 0.0223$ and 0.0899, with $\tau = 0.05$

- Higher elasticity causes higher spread $\Longrightarrow$ Prevent foreign borrowing

  $\Longrightarrow$ Cost of short-run lower consumption becomes larger.

Determinant 2: FDI Entry Cost χ_F
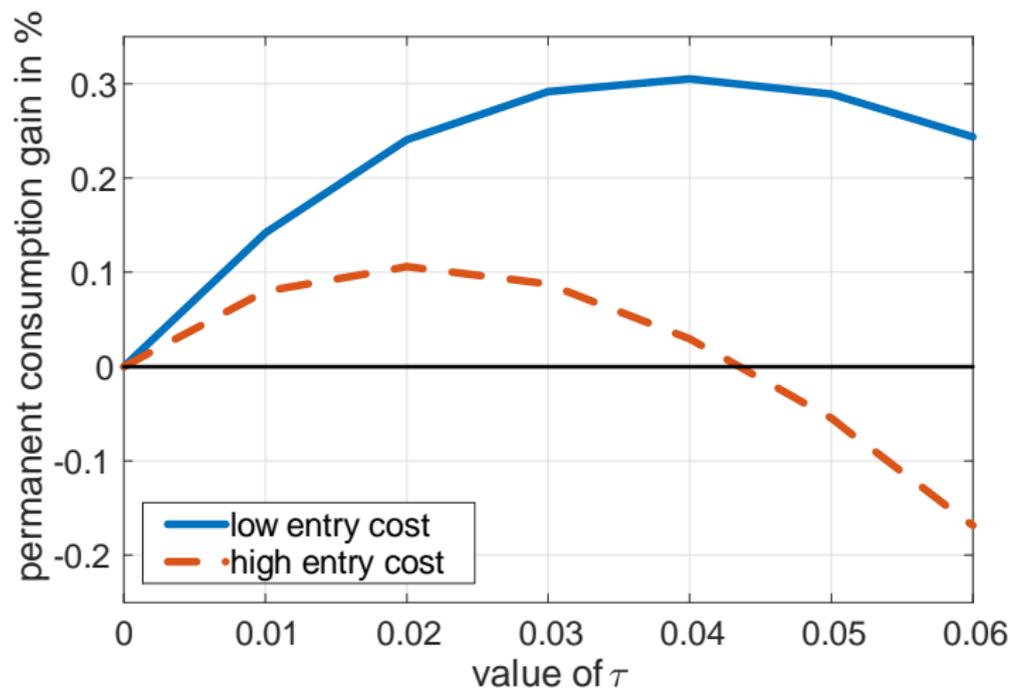
- **Higher** FDI entry cost $\rightarrow$ **Slower** optimal pace, **smaller** welfare gain

Main Analysis 2

Comparison between
Optimal and Actual Pace

Elasticity of Spread to Debt

- Estimate elasticity of foreign borrowing spread to debt:

  ▸ Countries with more defaults have higher elasticity of spread.

    - Number of defaults varies from 0 to 9.

    - Divide 19 countries into 5 groups, and assign an index from 0 to 4.

  ▸ Unbalanced panel regression with annual 323 observations (1994-2015):

  $$S_{i,t} = \beta_0 + \beta_1 \text{debtGDP}_{i,t} + \beta_2(\text{debtGDP}_{i,t} \times \text{default}_i) + \alpha_i + \tau_t + \varepsilon_{i,t}$$

Explanatory Variables	Coefficient (S.E.)		t-value
β_1: debt-GDP ratio	0.0223	(0.0161)	1.39
β_2: debt-GDP ratio $\times$ default	0.0169***	(0.0049)	3.45

 ▸ $\beta_1 + \beta_2 = $ 0.0223, 0.0392, 0.0561, 0.0730, 0.0899

FDI Entry Cost

- FDI entry cost for each country:

  - Adjust χ^F to target FDI inflow-to-GDP ratio.

  - Alternative: Estimate using WB's Starting Business Index.   alternative

- Derive the optimal pace of reserve accumulation for each country, and compare with the actual pace.

Comparison of Optimal and Actual Pace
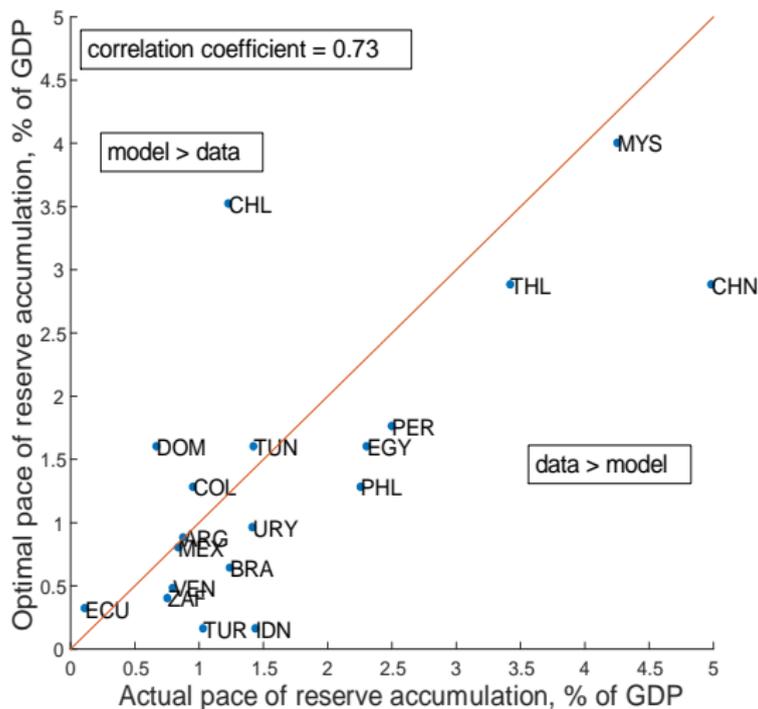
- Average 1.71%(data) vs. 1.43%(model) ; $\rho = 0.73$

Comparison of Optimal and Actual Pace: Welfare
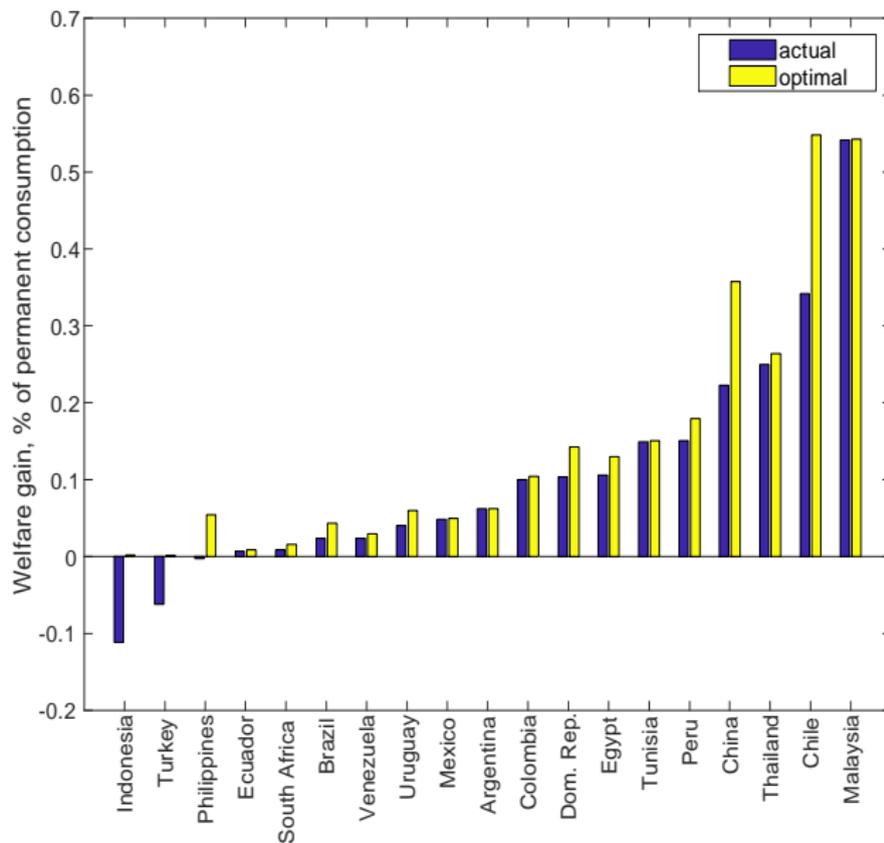
Additional Analysis

- Relative importance: use $\psi_b = 0.0561$ for all countries `figure`

  - Pace: average 1.71%(data) vs. 1.40%(model) ; $\rho = 0.43$

- Estimate FDI entry cost using WB's Starting Business Index `link`

  - Pace: average 1.71%(data) vs. 1.78%(model) ; $\rho = 0.45$

- Decomposition of policy effect on productivity `link`

  - 68% from reserve accumulation, 32% from bailouts.

- Decomposition of policy effect on welfare `link`

  - Working capital finance is more important than rebating reserves.

Conclusion

- Model

  - Quantitative model of reserve accumulation:
    - Endogenous productivity growth with FDI
    - Sudden stops caused by occasionally binding constraint

  - Reserve accumulation in normal times and bailouts during crisis
    $\rightarrow$ Fast and stable growth, at the cost of short-run lower consumption

- Determinants of the optimal pace of reserve accumulation:

  - Elasticity of foreign borrowing spread w.r.t. debt

  - FDI entry cost

- Comparison of actual and optimal pace of reserve accumulation

  - Most countries are roughly in line with the optimal pace.

  - Two factors can explain cross-country variation in accumulation pace.

Appendix

Literature on Reserve Accumulation and Growth

- Reserve accumulation and real exchange rate
  - ▸ Aizenman and Lee (2007), Levy-Yeyati et al. (2013)
  - ▸ Aizenman and Riera-Clichton (2008), Blanchard et al. (2015)

- Real undervaluation and GDP growth
  - ▸ Rodrik (2008), Levy-Yeyati et al. (2013)

- Horse-race between precautionary and growth strategy
  - ▸ Aizenman and Lee (2007), Ghosh et al. (2016)

- Models
  - ▸ Benigno and Fornaro (2012), Korinek and Serven (2016)

- Reinhart et al. (2016)
  - ▸ "leaning against the wind of an appreciation has been an important driver of reserve accumulation"

Literature on Reserve Accumulation back

- Reserve accumulation and FDI

  - ▸ Determinants of FDI relevant for reserve accumulation:
    - Real depreciation
    - Cheaper wage
   - Fast and stable growth

  - ▸ Dooley et al. (2007, 2014):

    Asian countries' growth strategy is to repress wage and attract FDI by reserve accumulation

  - ▸ Aizenman and Lee (2010):

    FDI into China increases along with active reserve accumulation since 2000

- Crowding-out by reserve accumulation

  - ▸ Cook and Yetman (2012): Reserve accumulation reduces bank lending

  - ▸ Reinhart et al. (2016): Negative correlation between reserve and investment

Facts that Motivate Model

Reserve and Growth
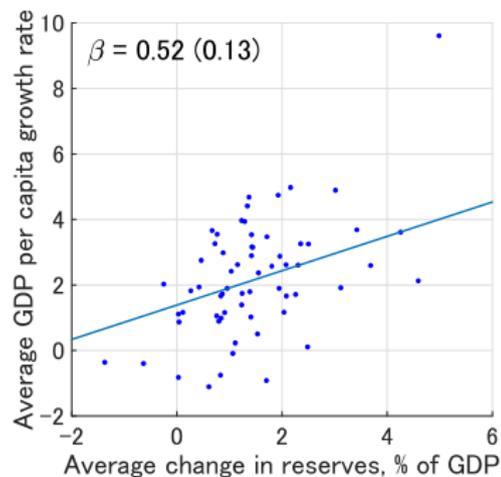
Reserve and FDI Inflows
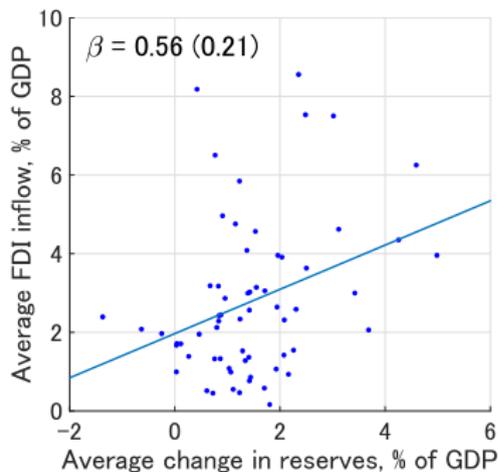
- Empirical papers suggest:
  - ▸ Reserve accumulation $\rightarrow$ real undervaluation
  - ▸ Real undervaluation $\rightarrow$ More labor in tradable sector $\rightarrow$ Faster growth

Final Tradable Sector: FOCs back

$$K_t^D \quad : \quad r_t = \alpha \frac{Y_t^T}{K_t^D}$$

$$y_t(i) \quad : \quad p_t(i)\left(1 + \phi \frac{\mu_t}{\lambda_t}\right) = \theta \frac{Y_t^T}{y_t(i)}$$

$$M_t \quad : \quad P^M\left(1 + \phi \frac{\mu_t}{\lambda_t}\right) = (1 - \alpha - \theta)\frac{Y_t^T}{M_t}$$

$$B_t \quad : \quad \lambda_t - \mu_t = \beta R_t E_t(\lambda_{t+1})$$

Intermediate Firms' Profit (back)

- Intermediate firms' profit:

$$\pi_t^s(i) = p_t(i)y_t(i) - W_t \ell_t(i)$$

  where $s = D, F$ indicates the leader type, domestic or foreign

- Using optimal price $p_t(i) = W_t/\widetilde{a}_t(i)$ and production $y_t(i) = a_t(i)\ell_t(i)$,

$$\pi_t^s(i) = p_t(i)y_t(i) - p_t(i)\frac{a_t(i)}{1+\sigma_t^s}\frac{y_t(i)}{a_t(i)} = \frac{\sigma_t^s}{1+\sigma_t^s}p_t(i)y_t(i)$$

- Using demand from the final tradable producers,

$$\pi_t^s(i) = \frac{\sigma_t^s}{1+\sigma_t^s}\theta Y_t^T \frac{1}{1+\phi\mu_t/\lambda_t}$$

  which shows that π_t^s depends only on the aggregate variables and σ_t^s

Domestic Product Line ⓑⓐⓒⓚ

- Value function of a domestic product line

$$V_t^D(1) = \max_{Z_t^D} \pi_t^D - Z_t^D$$

$$+ \left[i_t^D(Z_t^D) + \underbrace{(1 - d_t)\left(1 - \frac{e_t^F}{1 - \theta_{t-1}}\right)}_{\text{survival rate}} \right] E_t\left[\Lambda_{t,t+1} V_{t+1}^D(1)\right]$$

$$+ \left[(1 - d_t)\frac{e_t^F}{1 - \theta_{t-1}}\right] Q_t^F$$

- FOC w.r.t. Z_t^D:

$$\underbrace{\eta^D(1 - \rho^D)\left(\frac{Z_t^D}{A_t}\right)^{-\rho^D}\frac{1}{A_t}}_{\substack{\text{marginal increase in} \\ \text{success probability}}}\underbrace{E_t\left[\Lambda_{t,t+1}V_{t+1}^D(1)\right]}_{\substack{\text{expected value of} \\ \text{a product line}}} = 1$$

- FOC for domestic entry by households:

$$\eta^E(1 - \rho^E)\left(\frac{Z_t^E}{A_t}\right)^{-\rho^E}\frac{1}{A_t}E_t\left[\Lambda_{t,t+1}V_{t+1}^D(1)\right] = 1$$

Foreign Product Line

- Value of a foreign firm satisfies $V_t^F(n) = nV_t^F(1)$, where

$$V_t^F(1) = \max_{Z_t^F} \left\{ \pi_t^F - Z_t^F + \left(i_t^F(Z_t^F) + (1 - d_t) \right) \frac{1}{R^F} E_t \left[V_{t+1}^F(1) \right] \right\}$$

- FOC w.r.t. Z_t^F:

$$\eta^F (1 - \rho^F) \left(\frac{Z_t^F}{A_t} \right)^{-\rho^F} \frac{1}{A_t} \frac{1}{R^F} E_t \left[V_{t+1}^F(1) \right] = 1$$

Linear Relation in Value Function

- Using binomial distribution $P(i, n, p) = \binom{n}{i} p^i (1-p)^{(1-i)}$

$$V_t^F(n) = \max_{z_t^F} \left\{ n\pi_t^F - nz_t^F + \frac{1}{R^F} \left[\sum_{i=0}^n P(i, n, i_t^F) \sum_{j=0}^n P(j, n, d_t) E_t \left(V_{t+1}^F(n+i-j) \right) \right] \right\}$$

- Guess $V_t^F(n) = nV_t^F(1)$

$$
\begin{aligned}
V_t^F(n) &= \max_{z_t^F} \left\{ n\pi_t^F - nz_t^F + \frac{1}{R^F} \left[\sum_{i=0}^n P(i, n, i_t^F) \sum_{j=0}^n P(j, n, d_t)(n+i-j) E_t \left(V_{t+1}^F(1) \right) \right] \right\} \\
&= \max_{z_t^F} \left\{ n\pi_t^F - nz_t^F + \frac{1}{R^F} E_t \left(V_{t+1}^F(1) \right) \left[\sum_{i=0}^n P(i, n, i_t^F) \sum_{j=0}^n P(j, n, d_t)(n+i-j) \right] \right\}
\end{aligned}
$$

- Inside of the bracket:

$$\sum_{i=0}^n P(i, n, i_t^F) \sum_{j=0}^n P(j, n, d_t)(n+i-j) = n + ni_t^F - nd_t$$

- Therefore we verify:

$$
\begin{aligned}
V_t^F(n) &= \max_{z_t^F} \left\{ n\pi_t^F - nz_t^F + \frac{1}{R^F} E_t \left(V_{t+1}^F(1) \right) (n + ni_t^F - nd_t) \right\} \\
&= n \max_{z_t^F} \left\{ \pi_t^F - z_t^F + \frac{1}{R^F} E_t \left(V_{t+1}^F(1) \right) (1 + i_t^F - d_t) \right\} = nV_t^F(1)
\end{aligned}
$$

Intermediate Sector: Aggregation back

- Labor in the tradable sector:

$$L_t^T = (1 - \theta_{t-1})\ell_t^D + \theta_{t-1}\ell_t^F$$

- Replacement probability:

$$d_t = (1 - \theta_{t-1})i_t^D + \theta_{t-1}i_t^F + e_t^D$$

- Aggregate productivity growth:

$$\frac{A_{t+1}}{A_t} = \underbrace{\left(\frac{1 + \sigma_t^F}{1 + \sigma_t^D}\right)^{e_t^F}}_{\text{FDI entry}} \underbrace{(1 + \sigma_t^F)^{\theta_{t-1}i_t^F}}_{\text{foreign innovation}} \underbrace{(1 + \sigma_t^D)^{e_t^D}}_{\text{domestic entry}} \underbrace{(1 + \sigma_t^D)^{(1-\theta_{t-1})i_t^D}}_{\text{domestic innovation}}$$

- Share of product lines owned by foreign firms:

$$\theta_t = \theta_{t-1} + \underbrace{e_t^F}_{\substack{\text{FDI entry}}} - \underbrace{e_t^D\theta_{t-1}}_{\substack{\text{domestic entry} \\ \text{on foreign lines}}} + \underbrace{(i_t^F - i_t^D)\theta_{t-1}(1 - \theta_{t-1})}_{\text{incumbents' innovation}}$$

Household Maximization

- Maximize expected utility:

$$\max_{\left\{ C_t^T, C_t^N, L_t, K_t, Z_t^E \right\}} E_0 \sum_{t=0}^{\infty} \beta^t \left[\ln C_t - \psi(L_t)^\omega \right]$$

$$C_t = \left[(\gamma)^{\frac{1}{\varepsilon}} \left(C_t^T \right)^{\frac{\varepsilon-1}{\varepsilon}} + (1-\gamma)^{\frac{1}{\varepsilon}} \left(C_t^N \right)^{\frac{\varepsilon-1}{\varepsilon}} \right]^{\frac{\varepsilon}{\varepsilon-1}}$$

subject to the budget constraint

$$C_t^T + P_t^N C_t^N + Z_t^E + K_t - (1-\delta)K_{t-1} - \psi_k(K_t, K_{t-1}) =$$
$$W_t L_t + r_t K_{t-1} + \Pi_t^T + \Pi_t^N + (1-\theta_{t-1})(\pi_t^D - Z_t^D) + e_t^F Q_t^F$$

- FOCs:

$$\frac{C_t^T}{Y_t^N} = \frac{\gamma}{1-\gamma}(P_t^N)^\varepsilon$$

$$\psi\omega(L_t)^{\omega-1} = \frac{W_t}{C_t} \left(\gamma \frac{C_t}{C_t^T} \right)^{1/\varepsilon}$$

$$\lambda_t \left[1 + \psi_k \left(\frac{K_t}{K_{t-1}} - (1+\overline{g}) \right) \right] = \beta E_t \left[\lambda_{t+1} \left\{ r_{t+1} + 1 - \delta - \frac{\psi_k}{2} \left((1+\overline{g})^2 - \left(\frac{K_{t+1}}{K_t} \right)^2 \right) \right\} \right]$$

Bailouts during Crisis

- Baliouts:

  ▸ Provide accumulated reserves and bail out tradable producers

  ▸ Shortage of borrowing $= \max\{-B_t + \phi(1-\alpha)Y_t^{T,\text{full}} - \kappa_L K_{t-1}, 0\}$

  ▸ Size of bailout $V_t = \min\{\text{Shortage of borrowing}, R^F F_{t-1}\}$

- Transition of reserves:

$$F_t = \begin{cases} R^F F_{t-1} + \tau Y_t^T & \text{when } \kappa_H \\ R^F F_{t-1} - V_t & \text{when } \kappa_L \end{cases}$$

- Government optimally stops accumulating reserves:

  ▸ Productivity step sizes σ_t^D, σ_t^F shrink as capital accumulates

  ▸ Borrowing constraint never binds when capital accumulates enough

Definition of Equilibrium $\quad$ back

- Equilibrium of the model economy is defined as follows:

  - Initial states $\{A_0, R_{-1}B_{-1}, K_{-1}, \theta_{-1}, F_{-1}, \kappa_{-1}\}$

  - Government policy $\{T_t, V_t\}_{t=0}^{\infty}$

  - Stochastic shock $\{\kappa_t\}_{t=0}^{\infty}$

  - Tradable producers optimally choose $\{K_t^D, \{y_t(i)\}_{i\in[0,1]}, M_t, B_t\}_{t=0}^{\infty}$

  - Domestic intermediate firms optimally choose $\{p_t(i), \ell_t^D, Z_t^D, i_t^D\}_{t=0}^{\infty}$

  - Foreign intermediate firms optimally choose $\{p_t(i), \ell_t^F, Z_t^F, i_t^F\}_{t=0}^{\infty}$

  - Foreign investors optimally choose $\{e_t^F\}_{t=0}^{\infty}$

  - Non-tradable producers optimally choose $\{L_t^N\}_{t=0}^{\infty}$

  - Households optimally choose $\{C_t^T, C_t^N, K_t, L_t, Z_t^E, e_t^D\}_{t=0}^{\infty}$

  - Markets for capital, labor, tradable and non-tradable goods clear

  - $\{A_t, \theta_t\}_{t=0}^{\infty}$ evolve according to their laws of motion

# Calibration: Externaly-Determined Parameters back

Parameter		Value	Source
β	Discount rate	0.96	Standard
ε	CES between T and NT	0.6	Middle value in literature
γ	Tradable share in utility	0.34	Mendoza (2005)
ψ	Labor disutility	0.525	Labor supply 1
ω	Elasticity of labor supply	1.455	Mendoza (1991)
α	Capital share	0.3	Standard
θ	Intermediate input share	0.54	Imported input/GDP 10%
δ	Capital depreciation	0.1	Standard
$1 - \alpha^N$	labor share in non-tradable	0.75	Schmitt-Grohe Uribe (2016)
$\bar{b}$	Long-run debt/GDP	−0.36	Recent data
$\bar{R}$	Long-run interest rate	1.0635	Consistent with BGP growth rate
R^F	Reserve interest rate	1.02	Standard
ρ	Curvature of innov. input	0.5	Akcigit and Kerr (2015)

Calibration: Parameters in Transitional Dynamics back

Parameter		Value	Target
ϕ	Share of input cost s.t. WK	1.05	Private debt/GDP 47%
ψ_k	Capital adjustment cost	15	Investment dynamics in sudden stops
κ_L	Low borrowing limit	0.85	Sudden stop dynamics
P_{HL}, P_{LH}	Transition matrix for κ_t	0.08,0.85	Frequency and duration of SS

Simulation Example (ψ_b=0.0561, τ=0.03)   back

Foreign debt
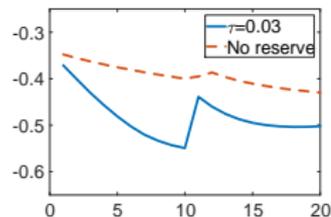
Interest spread
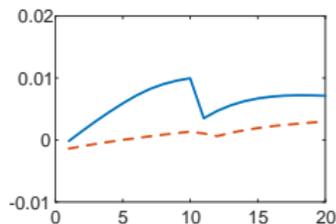
Current account/GDP
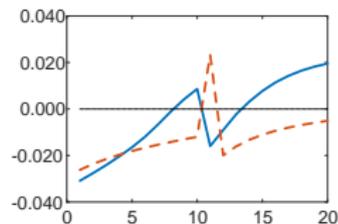
Capital investment
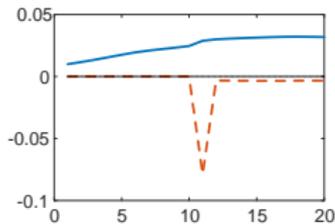
Productivity growth rate
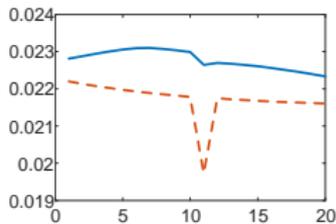
Share of foreign lines

Legend: τ=0.03 / No reserve
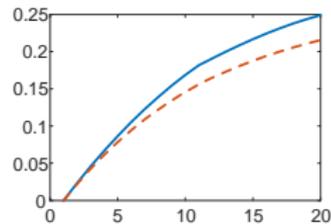
Decomposition of Policy Effect

- Decompose policy effect on productivity into two channels:

  - Real depreciation

  - Bailouts, including anticipation of future bailouts

- Compare three policy schemes:

  - Baseline policy

  - No-bailout: government does not bail out

  - Lending: government lends reserves, and private agents repay after production
    Lending helps working capital financing, but no rebates

Decomposition of Policy Effect back

Baseline policy · No-bailout · Lending
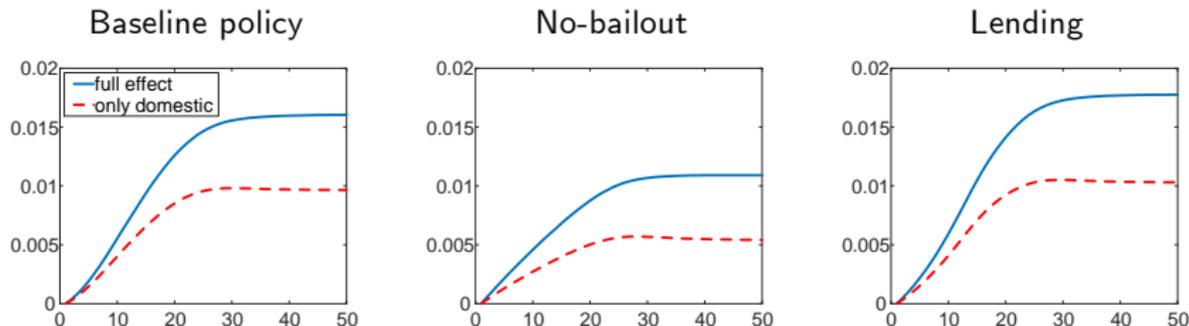
- Average log gaps in productivity over no-policy case

- Productivity gain by three policy schemes

  - 68% of gain comes from reserve accumulation, 32% from bailouts

  - In bailouts, helping working capital financing is more important than rebating

 - 50-60% of gain comes from domestic factors, 40-50% from foreign factors

Evaluation of Actual Reserve Policy

Country	Acc. Pace (%)		Welfare (%)		Elasticity of	FDI Inflow
	Actual	Optimal	Actual	Optimal	Spread	/ GDP (%)
Argentine	0.88	0.88	0.06	0.06	0.0730	2.44
Brazil	1.24	0.64	0.02	0.04	0.0899	2.34
Chile	1.23	3.52	0.34	0.55	0.0899	5.85
China	4.99	2.88	0.22	0.36	0.0392	3.96
Colombia	0.96	1.28	0.10	0.10	0.0730	2.86
Dominican Rep.	0.67	1.60	0.10	0.14	0.0730	3.19
Ecuador	0.11	0.32	0.01	0.01	0.0899	1.71
Egypt	2.31	1.60	0.11	0.13	0.0392	2.58
Indonesia	1.44	0.16	-0.11	0.00	0.0392	0.86
Malaysia	4.26	4.00	0.54	0.54	0.0223	4.35
Mexico	0.84	0.80	0.05	0.05	0.0899	2.42
Peru	2.50	1.76	0.15	0.18	0.0899	3.63
Philippines	2.26	1.28	0.00	0.05	0.0223	1.55
South Africa	0.76	0.40	0.01	0.02	0.0392	1.33
Thailand	3.42	2.88	0.25	0.26	0.0223	3.00
Tunisia	1.43	1.60	0.15	0.15	0.0561	3.02
Turkey	1.03	0.16	-0.06	0.00	0.0561	1.08
Uruguay	1.42	0.96	0.04	0.06	0.0899	2.56
Venezuela	0.80	0.48	0.02	0.03	0.0899	2.12

Decomposition: Welfare Effect
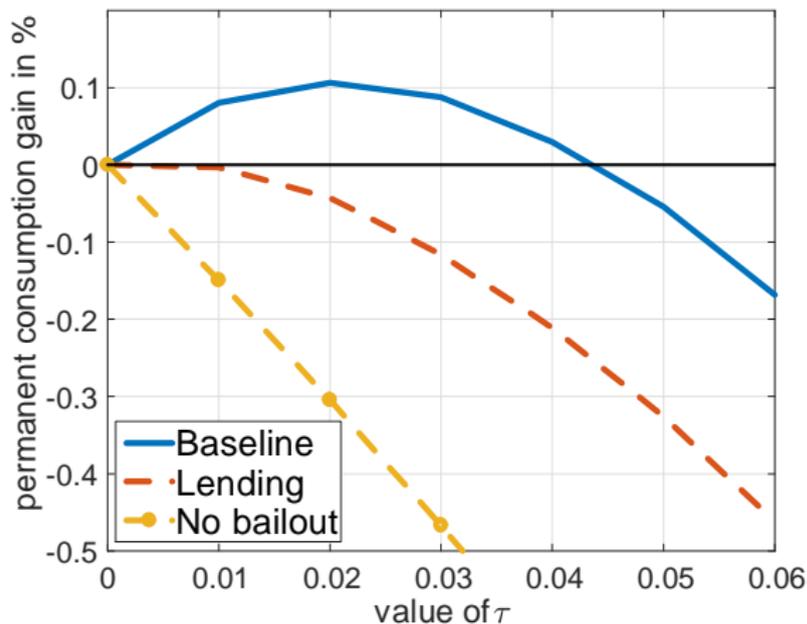
- Bailouts consist of helping working capital financing and rebates
- About 64% of welfare gain by bailouts comes from working capital

# Estimation of FDI Entry Cost

- Starting a Business Index from WB's Doing Business Survey

  - Number of procedures, time and cost to start a new business

  - Focused on domestic firms only, but significant correlation between Index and FDI inflow/GDP ratio across countries

- Assume FDI entry cost is a function of Index for each country:

$$\chi_i^F = \beta_0 + \beta_1 (\text{Index}_i)^{\beta_2}$$

Choose $\beta_0, \beta_1, \beta_2$ to minimize the gaps between data and model in FDI:

$$\min_{\beta_0, \beta_1, \beta_2} \sum_{i=1}^{19} \left[\left(\frac{\text{FDI}}{\text{GDP}} \right)_i^{\text{data}} - \left(\frac{\text{FDI}}{\text{GDP}} \right)_i^{\text{model}} \right]^2$$

Estimation of FDI Entry Cost
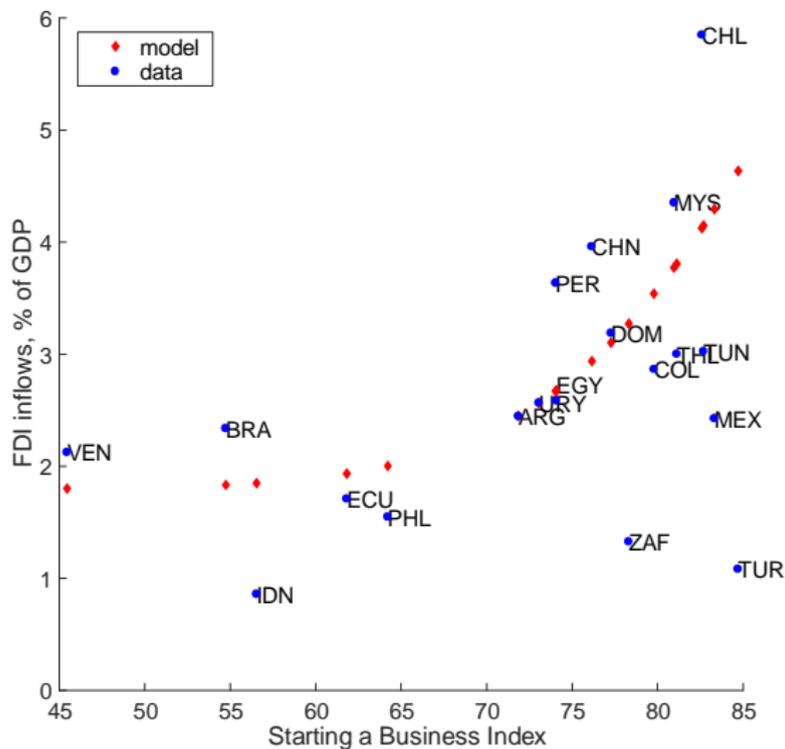
# Evaluation Using Estimated FDI Entry Cost: Pace
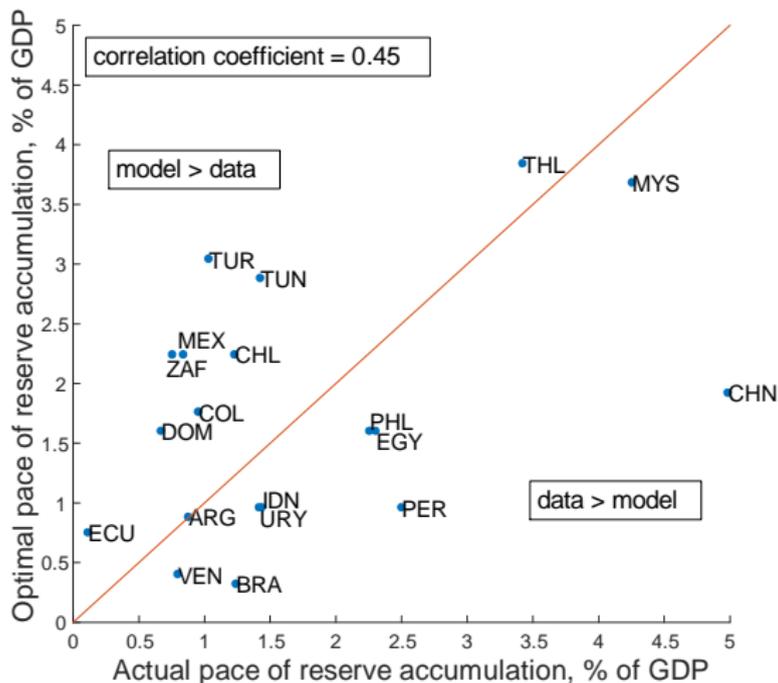
- Average 1.71%(data) vs. 1.78%(model) ; $\rho = 0.45$

Evaluation Using Estimated FDI Entry Cost

Country	Acc. Pace (%)		Welfare (%)		Elasticity of	Implied
	Actual	Optimal	Actual	Optimal	Spread	FDI/GDP
Argentine	0.88	0.88	0.06	0.06	0.0730	2.45
Brazil	1.24	0.32	-0.04	0.02	0.0899	1.83
Chile	1.23	2.24	0.22	0.25	0.0899	4.12
China	4.99	1.92	-0.16	0.18	0.0730	2.94
Colombia	0.96	1.76	0.15	0.19	0.0730	3.53
Dominican Rep.	0.67	1.60	0.10	0.14	0.0730	3.10
Ecuador	0.11	0.75	0.01	0.02	0.0899	1.93
Egypt	2.31	1.60	0.12	0.14	0.0392	2.67
Indonesia	1.44	0.96	0.03	0.05	0.0392	1.85
Malaysia	4.26	3.68	0.41	0.42	0.0223	3.77
Mexico	0.84	2.24	0.18	0.28	0.0899	4.29
Peru	2.50	0.96	-0.06	0.07	0.0899	2.67
Philippines	2.26	1.60	0.09	0.10	0.0223	2.00
South Africa	0.76	2.24	0.13	0.23	0.0392	3.27
Thailand	3.42	3.84	0.43	0.43	0.0223	3.80
Tunisia	1.43	2.88	0.27	0.33	0.0561	4.15
Turkey	1.03	3.04	0.24	0.42	0.0561	4.63
Uruguay	1.42	0.96	0.04	0.06	0.0899	2.56
Venezuela	0.80	0.40	-0.01	0.01	0.0899	1.80

ψ_b=0.0561 for All Countries

- Average 1.71%(data) vs. 1.40%(model) ; $\rho = 0.43$