International Capital Flows: Private versus Public[1]

Yun Jung Kim
Sogang University

Jing Zhang
Federal Reserve Bank of Chicago

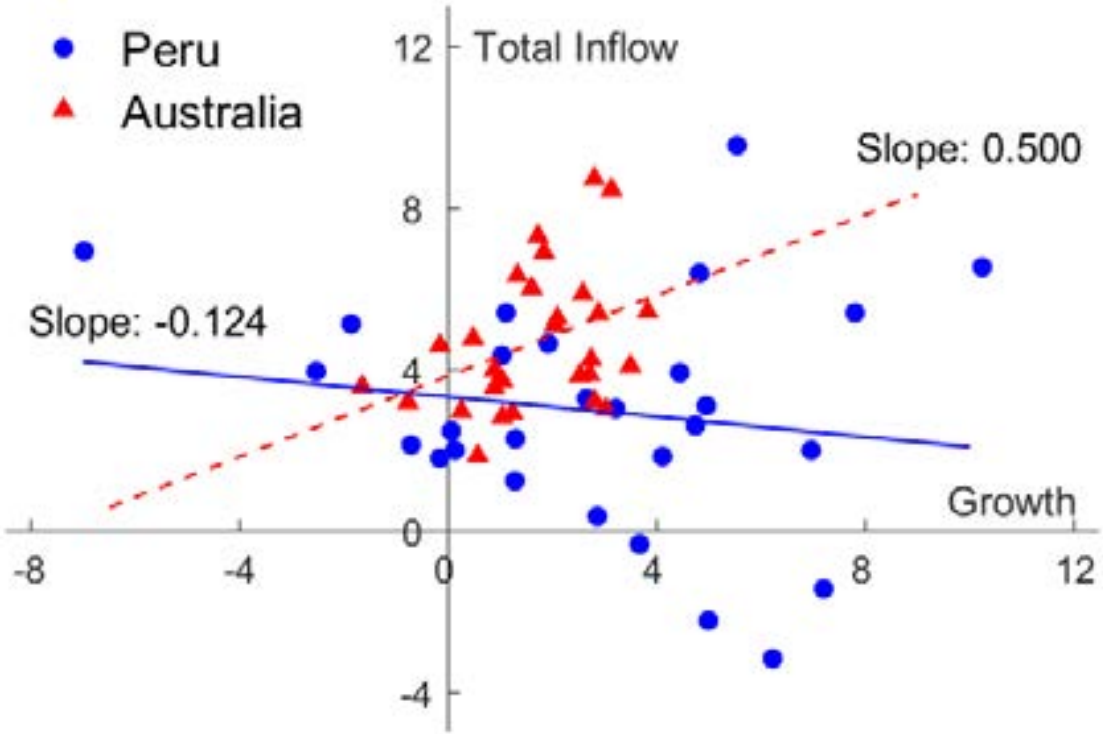
February 4, 2020
IMF·OAP-PRI Economics Workshop

[1] The views expressed here are those of the authors and are not necessarily reflective of views of the Federal Reserve Banks of Chicago and the Federal Reserve System.

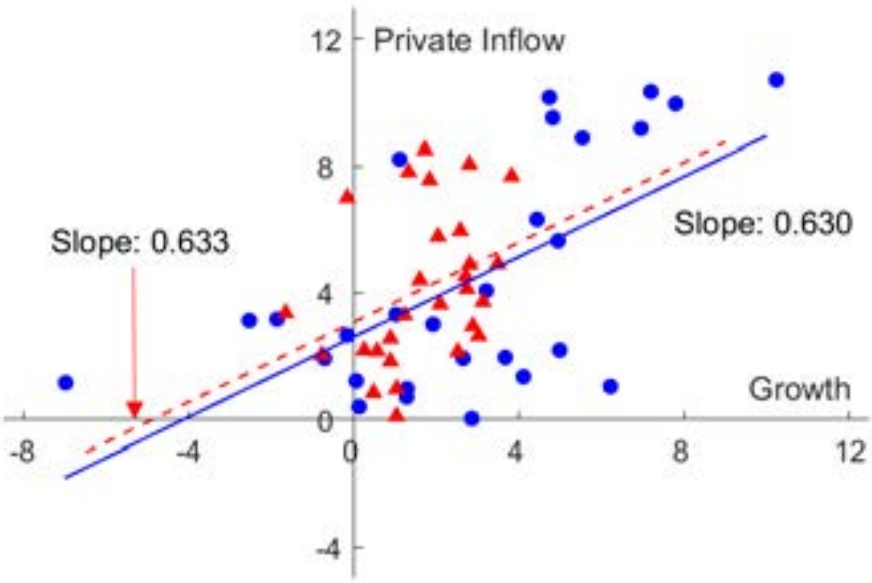
Motivation and Research Questions

- Financial integration stimulated international capital flows
- Dynamics of capital flows become an integral part of fluctuations in open economies
- It is crucial to understand joint dynamics of capital flows and growth
  - What are cyclical patterns of capital flows in the data?
  - Are patterns the same for flows to private and public sector?
  - Are patterns the same for developed and developing countries?
  - What drives differences or similarities?

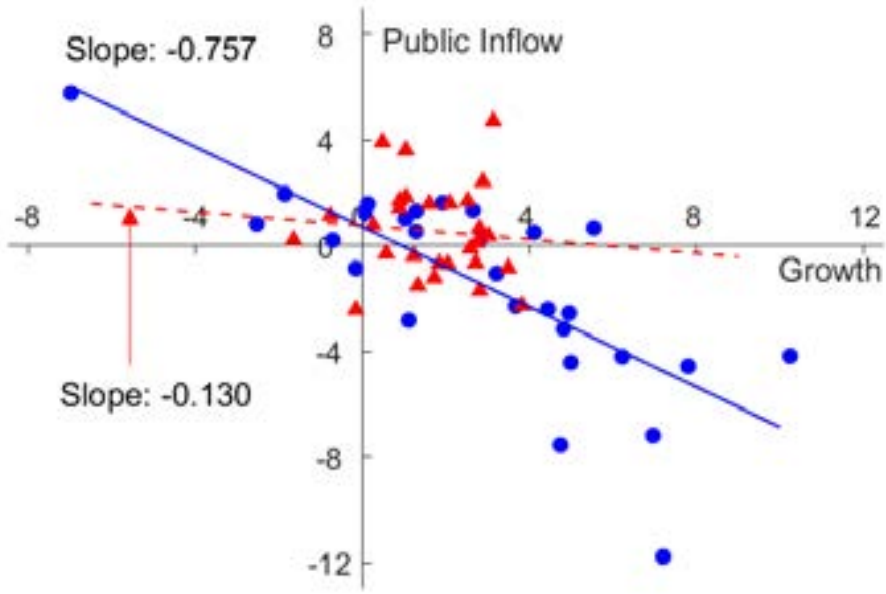
Net Capital Inflows and Growth



Net Capital Inflows and Growth: Private versus Public



(a) Private



(b) Public

Statistics for Peru and Australia

	Peru	Australia
Correlation with Growth		
Total Inflows	-0.16	0.38
Private Inflows	0.62	0.35
Public Inflows	-0.76	-0.10
Absolute Ratio (%)		
Private Inflows	2.74	3.68
Public Inflows	2.93	1.32
Standard Deviation (%)		
Private Inflows	4.09	2.39
Public Inflows	5.58	1.80
Half Covariance Ratio*		
Private Inflows	0.48	0.92
Public Inflows	0.52	0.08

*Half covariance ratio of private inflows: $\frac{var(Private)+cov(Private,Public)}{var(Private+Public)}$

How International Capital Flows Behave over Time?

Study empirical patterns using IMF Balance of Payments data:

- Total capital inflows are counter-cyclical in developing countries, but pro-cyclical in developed countries
  - Private flows are pro-cyclical, while public flows are counter-cyclical, in BOTH developing and developed countries.
  - Public flows dominate in developing countries: total flows are counter-cyclical
  - Private flows dominate in developed countries: total flows are pro-cyclical

What Drives the Patterns of International Capital Flows?

Develop a theory to rationalize both private and public flows:

- A small open economy with tradable and nontradable sectors subject to a collateral borrowing constraint, depending on total income

  Mendoza (2005), Bianchi (2011), and Schmitt-Grohe and Uribe (2016)

  - Financial amplification of borrowing: Depreciation due to repayment and tightening of the borrowing constraint reinforce each other.
  - Private agents do not internalize financial amplification (pecuniary externality) and overborrow in good times, making future borrowing constraint more likely to bind in bad times.
  - Once the borrowing constraint binds in bad times, they have to deleverage.

  : Pro-cyclical private capital flows

What Drives the Patterns of International Capital Flows?

Develop a theory to rationalize both private and public flows:

- The government uses public bonds to alleviate the externality
  - Saves in reserve assets in good times to mitigate inefficient credit booms, making the economy less vulnerable to debt crises.
  - Mitigates exchange rate depreciation and consumption declines by selling reserves in bad times when the private borrowing constraint binds.

  : Counter-cyclical public capital flows

- Tightness of collateral constraints and volatilities of shock processes explain different empirical patterns in developing v.s. developed countries.

Literature on International Capital Flows

- One strand is on the long-run behavior across countries
  - Empirical puzzles: the Lucas puzzle by Lucas (1990), the allocation puzzle by Gourinchas & Jeanne (2013), Alfaro et al. (2014)
  - Theories focus on either total, private, or public flows: Bai & Zhang (2010), Aguiar & Amador (2011), Angeletos & Panousi (2009), Benhima (2013)
- The other strand is on the cyclical behavior within a country
  - International business cycle literature: total flows
  - Sovereign debt literature: public debt flows
  - Very few study the joint dynamics of public and private capital flows across developing and developed countries: Benigno & Fornaro (2012)

Outline of the Talk

- Empirical analysis on the behavior of capital flows over time
- A theoretical model of international capital flows with both the private and public sector
- Calibration and quantitative analysis

Data

- IMF's Balance of Payments Statistics Financial Account

	(1) Net Acquisition of Financial Assets	(2) Net Incurrence of Liabilities	(3) Net Flows (2)−(1)
3.1 Direct Investment			
3.2 Portfolio Investment			
Central bank			
Other deposit taking corporations			
General government			
Other sectors			
3.3 Financial Derivatives			
Central bank			
Other deposit taking corporations			
General government			
Other sectors			
3.4 Other Investment			
Central bank			
Other deposit taking corporations			
General government			
Other sectors			
3.5 Reserves			
Total Net Flows			XX

Data

- Construction of capital flow series:
  - Total net capital flows = total inflow − total outflows
  - Public net capital flows sum net inflows to general governments and central banks, including reserves
  - Private net capital flows = total minus public
- Sample: 28 developed and 74 developing for 1980-2017 annually

Summary Statistics of Capital Flows over GDP

	Developing	Developed
Correlation with Growth		
Total Inflows	−0.15	0.03
Private Inflows	0.19	0.09
Public Inflows	−0.32	−0.14
Reserve Inflows	−0.19	−0.06
Corr(Private, Public)	−0.35	−0.71
Absolute Ratio (%)		
Private Inflows	3.25	3.20
Public Inflows	2.93	1.81
Reserve Inflows	2.08	0.55
Standard Deviation (%)		
Private Inflows	4.49	4.49
Public Inflows	5.00	3.43
Reserve Inflows	3.48	1.71
Half Covariance Ratio		
Private Inflows	0.45	0.75
Public Inflows	0.55	0.25

Panel Regression Analysis

- 102 countries: 74 developing and 28 developed
- 38 years: 1980–2017
- Time and country fixed effects

$$\text{Capital Flows}_{it} = \beta\, \text{GDP Growth}_{it} + \alpha_i + \gamma_t + \nu_{it}$$

	Developing Countries				Developed Countries			
	Total Inflows	Private Inflows	Public Inflows	Reserve Inflows	Total Inflows	Private Inflows	Public Inflows	Reserve Inflows
β	-0.25^{***}	0.05	-0.30^{***}	-0.20^{***}	0.05	0.33^{**}	-0.28^{***}	-0.10
	(0.08)	(0.05)	(0.05)	(0.05)	(0.14)	(0.14)	(0.10)	(0.06)
Obs	2,237	2,237	2,237	2,237	867	867	867	867
Countries	74	74	74	74	28	28	28	28

Summary of Empirical Findings:

- When a country's GDP growth is high, the private sector experiences capital inflows and the public sector experiences capital outflows.
  - True for both developing and developed countries
  - Private capital flows are more procyclical in developed countries, while public flows are more countercyclical in developing countries.
- In developing countries, public flows dominate, so net capital flows are counter-cyclical.
- In developed countries, private flows dominate, so net capital flows are pro-cyclical.

Model

- A dynamic stochastic general equilibrium (DSGE) model of a small open economy with two sectors: tradable and nontradable.
- Households facing income shocks decide on consumption and saving.
  - Bond is in units of tradables.
  - Borrowing is constrained by current income from tradables and nontradables, as in Bianchi (2011).
- A benevolent government facing spending shocks decides on reserves/bonds and consumption taxes.
  - Reserve or sovereign bond is in units of tradables.

Households — Private Sector

Given taxes $\{\tau_t\}$ and prices $\{p_t, r\}$, households solve

$$\max_{c_t^T, c_t^N, b_{t+1}} E_0 \sum_{t=0}^{\infty} \beta^t U(c_t)$$

$$\text{where } U(c_t) = \frac{c_t^{1-\sigma} - 1}{1-\sigma}, \quad c_t = \left[\omega (c_t^T)^{-\eta} + (1-\omega)(c_t^N)^{-\eta}\right]^{-\frac{1}{\eta}}$$

subject to the budget constraint

$$c_t^T(1+\tau_t^T) + p_t c_t^N (1+\tau_t^N) + b_{t+1} = (y_t^T + p_t y_t^N) + b_t(1+r)$$

and the borrowing constraint

$$b_{t+1} \geq -\kappa(y_t^T + p_t y_t^N)$$

Households' First Order Conditions

$$U_{Tt} = \lambda_t(1+\tau_t^T)$$

$$U_{Nt} = \lambda_t p_t(1+\tau_t^N)$$

$$\lambda_t = \beta(1+r)E_t\left[\lambda_{t+1}\right] + \mu_t$$

$$b_{t+1} \geq -\kappa(y_t^T + p_t y_t^N) \text{ with equality if } \mu_t > 0$$

- The relative price of nontradable goods is

$$p_t = \frac{1-\omega}{\omega}\left(\frac{c_t^T}{c_t^N}\right)^{\eta+1}\frac{1+\tau_t^T}{1+\tau_t^N}.$$

The choice of b_{t+1} affects the price of nontradables and the value of collateral, which is not internalized by households.

Government

Taking prices and households' responses as given, the government solves

$$\max_{\boldsymbol{\tau}=\{A_{t+1},\tau_t^T,\tau_t^N\}} E_0 \sum_{t=0}^{\infty} \beta^t U(C_t(\boldsymbol{\tau})),$$

subject to the budget constraints

$$C_t^T(\boldsymbol{\tau})\tau_t^T + p_t(\boldsymbol{\tau})C_t^N(\boldsymbol{\tau})\tau_t^N + A_t(1+r) - A_{t+1} = G_t^T + p_t(\boldsymbol{\tau})G_t^N,$$

and the borrowing constraint

$$A_{t+1} + B_{t+1}(\boldsymbol{\tau}) \geq -\kappa \left[y_t^T + p_t(\boldsymbol{\tau}) y_t^N \right].$$

Market Clearing

The market clearing conditions are given by:

$$\begin{aligned} C_t^T + G_t^T &= y_t^T + (B_t + A_t)(1+r) - B_{t+1} - A_{t+1} \\ C_t^N + G_t^N &= y_t^N \end{aligned}$$

Equilibrium

An equilibrium consists of government choices $\boldsymbol{\tau}$, and functions of prices $\{p_t(\boldsymbol{\tau})\}$, and individual choices $\{c_t^T(\boldsymbol{\tau}),\ c_t^N(\boldsymbol{\tau}),\ b_{t+1}(\boldsymbol{\tau})\}$, aggregate variables $\{C_t^T(\boldsymbol{\tau}),\ C_t^N(\boldsymbol{\tau}),\ B_{t+1}(\boldsymbol{\tau})\}$, such that

- given $\boldsymbol{\tau}$, prices, individual choices, and aggregate variables form the competitive equilibrium:
  - given prices, individual choices satisfy household's FOCs;
  - aggregate variables coincide with individual choices;
  - price clears goods markets:
- given functions of the competitive equilibrium, government choice $\boldsymbol{\tau}$ maximizes the representative household's utility subject to constraints.

Simplify Government Choices to Reserve only

- Nontradable tax finances nontradable spending

$$\tau_t^N = \frac{G_t^N}{y_t^N - G_t^N},$$

- Tradable tax finances tradable spending and reserve accumulation

$$\tau_t^T = \frac{G_t^T + A_{t+1} - (1+r)A_t}{y_t^T - G_t^T + (1+r)B_t - B_{t+1} + (1+r)A_t - A_{t+1}},$$

- Reserve accumulation is positively related to the tax on tradables.

The Centralized Model

Consider the problem of a social planner who faces the same borrowing constraint as the private agents:

$$\max_{c_t^T, b_{t+1}} E_0 \sum_{t=0}^{\infty} \beta^t U(c_t^T, y_t^N),$$

subject to

$$c_t^T + b_{t+1} = y_t^T + b_t(1+r), \text{ and}$$

$$b_{t+1} \geq -\kappa \left(y_t^T + \frac{1-\omega}{\omega} \left(\frac{c_t^T}{y_t^N} \right)^{\eta+1} y_t^N \right),$$

The social planner internalizes the effect of his own borrowing on p_t.

The Decentralized Model

The model with only private agents (Bianchi, 2011):

$$\max_{c_t^T, b_{t+1}} E_0 \sum_{t=0}^{\infty} \beta^t U(c_t^T, c_t^N),$$

subject to

$$c_t^T + p_t c_t^N + b_{t+1} = y_t^T + p_t y_t^N + (1+r) b_t,$$

$$b_{t+1} \geq -\kappa \left(y_t^T + p_t y_t^N \right).$$

Comparing Optimal Borrowing across Models

Case 1: $\mu_t^{sp} = 0$ and $\mu_{t+1}^{sp} > 0$ under some contingency

- Social Planner:

$$U_{Tt} = \beta(1+r)E_t\left[U_{Tt+1} + \mu_{t+1}^{sp}\Psi_{t+1}\right]$$

- Private agents:

$$U_{Tt} = \beta(1+r)E_t\left[U_{Tt+1}\right]$$

- Our model:

$$U_{Tt} = \beta(1+r)E_t\left[U_{Tt+1} + \frac{\tau_t^T - \tau_{t+1}^T}{1+\tau_{t+1}^T}U_{Tt+1}\right].$$

Private agents underestimate borrowing cost, and thus over-borrow. Government prefers $\tau_t^T > \tau_{t+1}^T$ or increase reserve flows.

Comparing Optimal Borrowing across Models

Case 2: $\mu_t^{sp} > 0$ and $\mu_{t+1}^{sp} = 0$ everywhere

- Social Planner:

$$U_{Tt} + \mu_t^{sp}\Psi_t - \mu_t^{sp} = \beta(1+r)E_t\left[U_{Tt+1}\right]$$

- Private agents:

$$U_{Tt} \qquad\qquad - \mu_t = \beta(1+r)E_t\left[U_{Tt+1}\right]$$

- Our model:

$$U_{Tt} - \tau_t^T \mu_t - \mu_t = \beta(1+r)E_t\left[U_{Tt+1} + \frac{\tau_t^T - \tau_{t+1}^T}{1+\tau_{t+1}^T}U_{Tt+1}\right]$$

Private agents underestimate the benefit of borrowing, and under-borrow. Government likes $\tau_t^T < 0$ to subsidize tradables and $\tau_t^T = \tau_{t+1}^T$.

Calibration of Parameters

Parameter		Value
Risk aversion	σ	2.00
Interest rate	r	0.04
Weight on tradables	ω	0.43
Elasticity of substitution	$1/(1+\eta)$	0.50
Discount factor	β	0.95
Collateral constraint	κ	0.20

- β targets $\frac{\text{private inflows}}{\text{GDP}}$ of 18% in developing countries
- κ targets the frequency of sudden stops in developing countries

Calibration of Shocks

- Income shock:

$$\begin{bmatrix} y_t^T \\ y_t^N \end{bmatrix} = \begin{bmatrix} s^T \exp(z_t^T) \\ s^N \exp(z_t^N) \end{bmatrix} \cdot \Gamma_t,$$

  - Aggregate growth shock:

$$\begin{aligned} \Gamma_t &= \gamma_t \Gamma_{t-1}, \\ \ln(\gamma_t) &= \mu_\gamma(1-\rho_\gamma) + \rho_\gamma \ln(\gamma_{t-1}) + \varepsilon_t^\gamma, \text{ where } \varepsilon_t^\gamma \sim N(0, \sigma_\gamma^2), \end{aligned}$$

  - Transitory shocks at the sector level:

$$z_t^j = \mu_z^j(1-\rho_z^j) + \rho_z^j z_{t-1}^j + \varepsilon_t^j, \text{ where } \varepsilon_t^j \sim N(0, \sigma_j^2).$$

- Government spending shock: G^N is a constant share of y^N and

$$\ln G_t^T = \rho_G \ln G_{t-1}^T + \varepsilon_t^G, \text{ where } \varepsilon_t^G \sim N(0, \sigma_G^2).$$

Calibrated Shock Processes: Developing countries

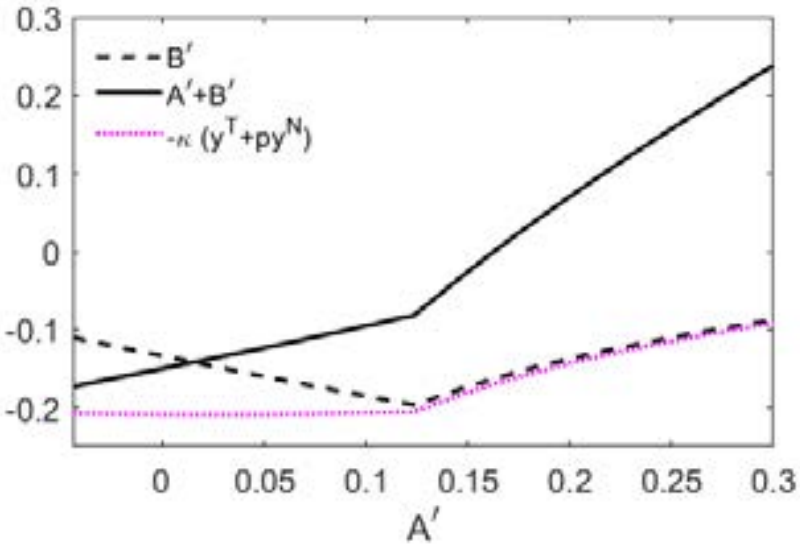
Income shock

$\mu_\gamma = 1.035$	$\rho_\gamma = 0.281$	$\sigma^2_\gamma = 0.0012$	
$\mu_z^T = -0.038$	$\rho_z^T = 0.870$	$\sigma^2_T = 0.0024$	$s^T = 0.43$
$\mu_z^N = 0.024$	$\rho_z^N = 0.845$	$\sigma^2_N = 0.0010$	$s^N = 0.57$

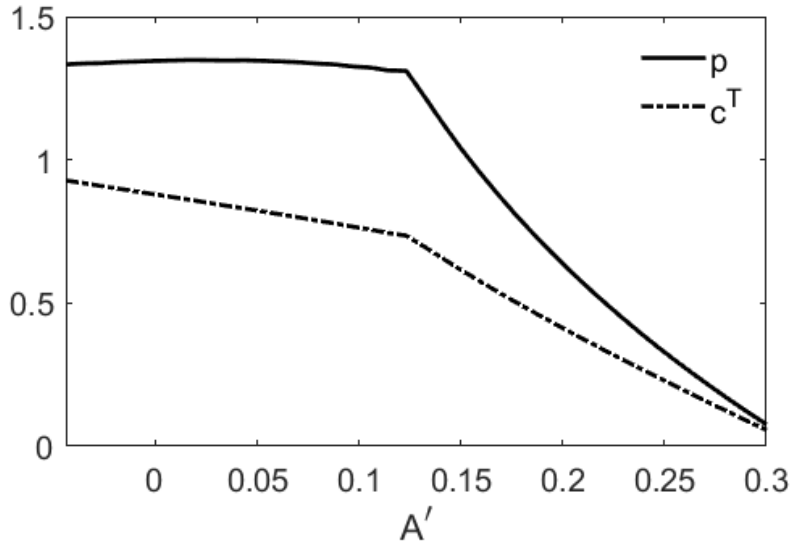
Government spending shock

$\rho_G = 0.549$	$\sigma^2_G = 0.011$

Private and Public Borrowing

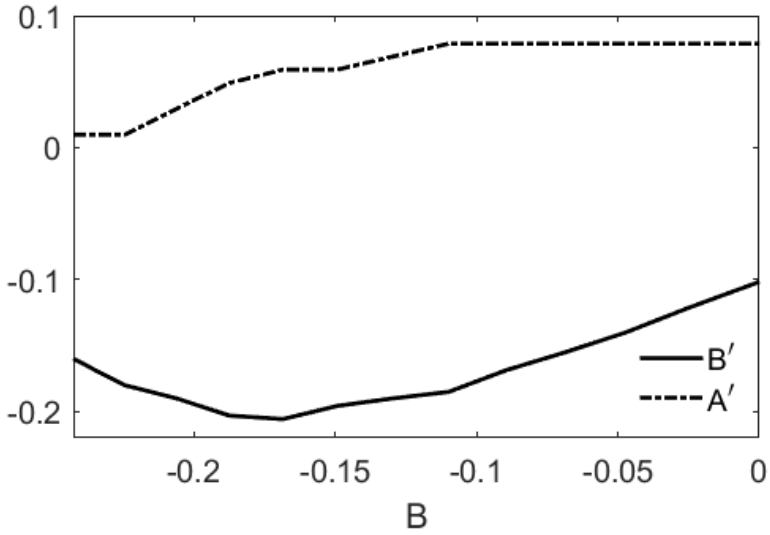


(a) Private and Public Bonds

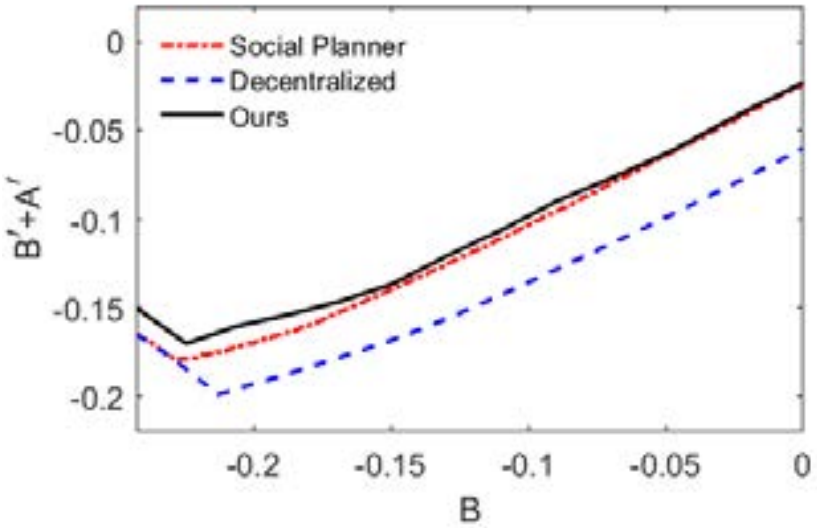


(b) p and c^T

Policy Functions



(a) Policy for A', B'

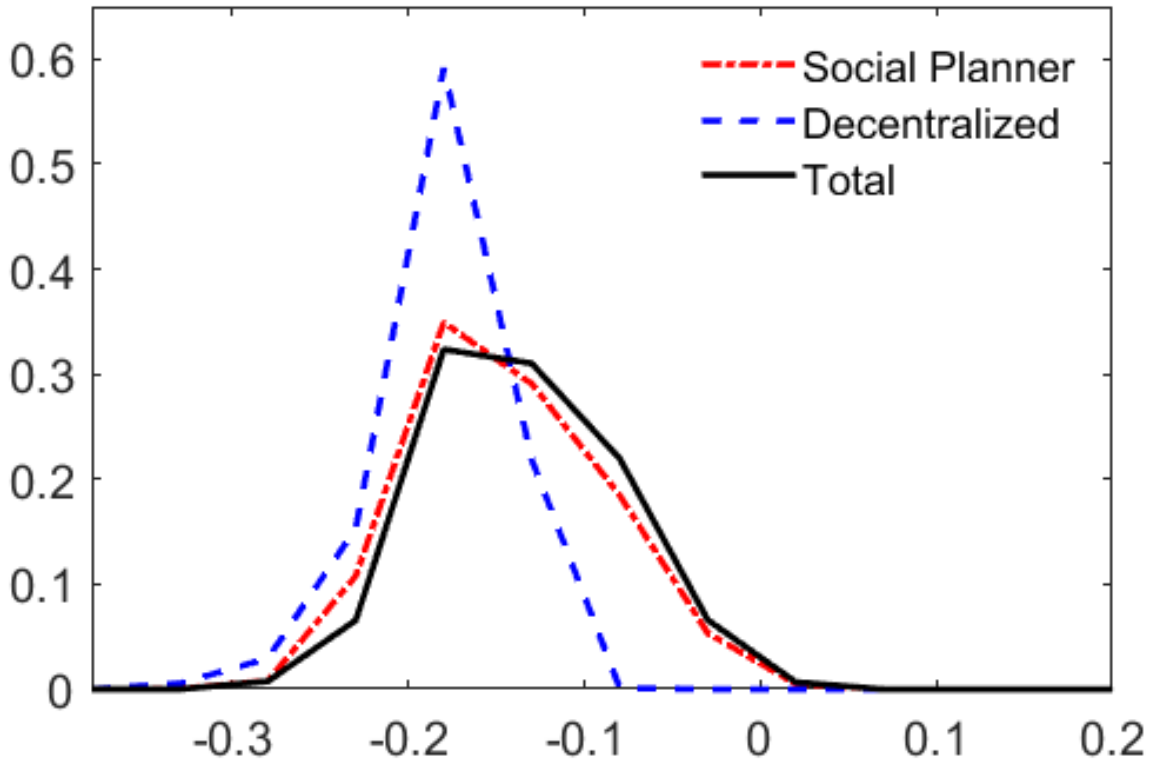


(b) Policy Comparison

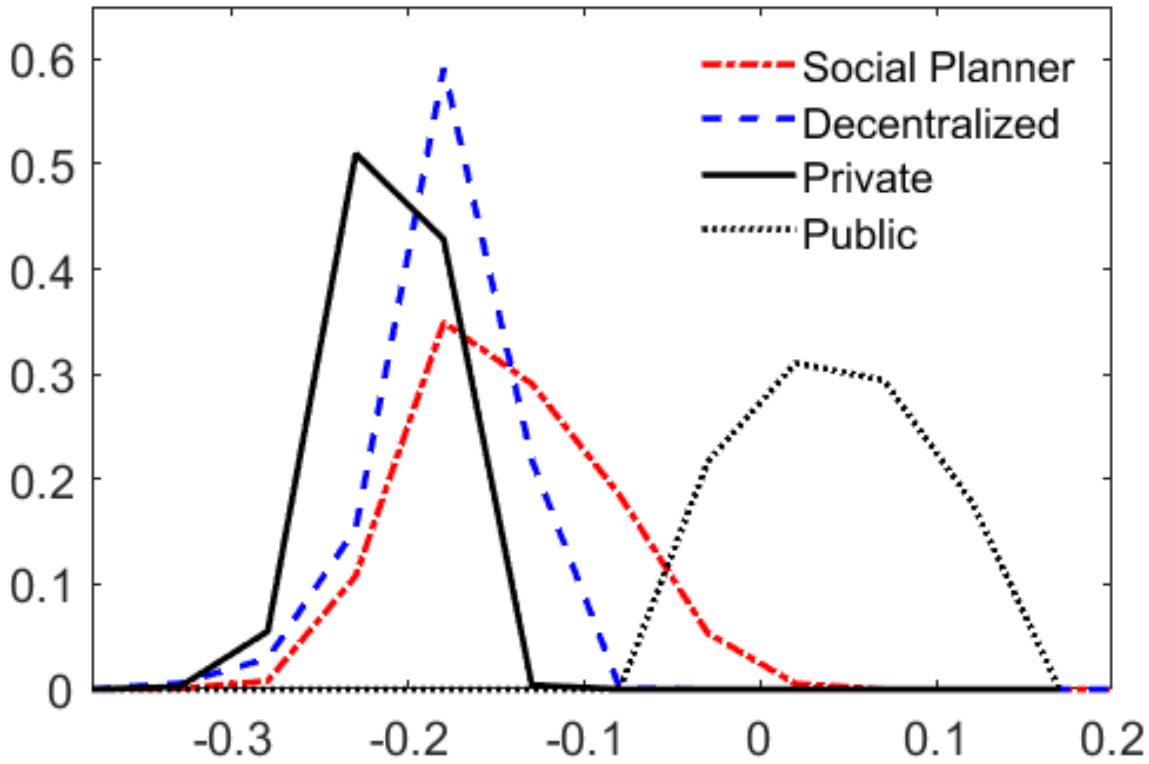
Comparison of Simulation Results

	Social Planner	Decentralized	Our Model
Bond/GDP (%)			
Total Bonds	−11.948	−16.006	−10.935
Private Bonds	–	–	−18.647
Public Bonds	–	–	7.712
Prob(BC binds for private)	0.000	0.168	0.166
Prob(BC binds for aggregate)	–	–	0.000

Debt Distribution Comparison



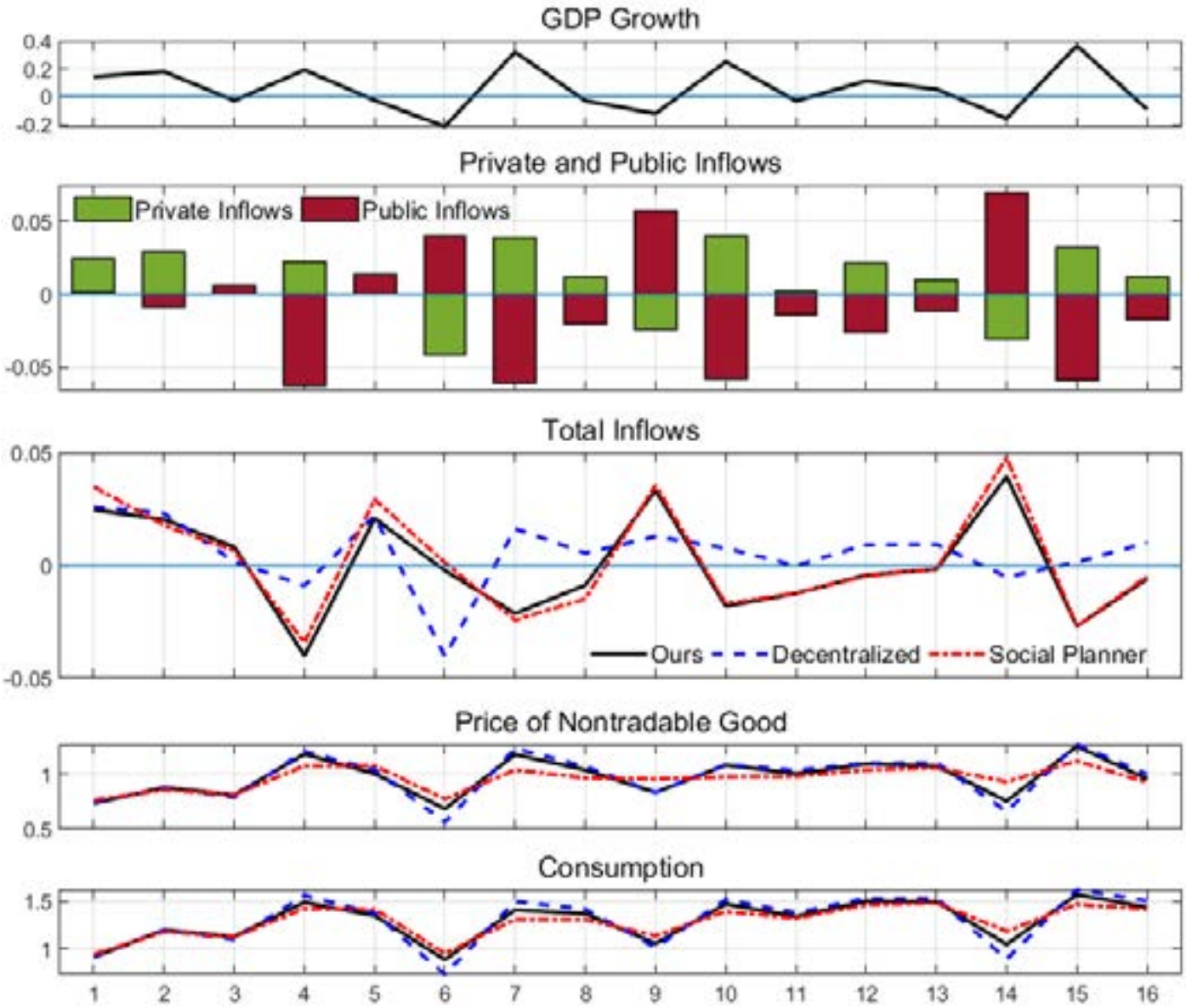
Debt Distribution Comparison



Comparison of Simulation Results

	Social Planner	Decentralized	Our Model
Correlation with Growth			
Total Inflows	−0.056	0.466	−0.163
Private Inflows	–	–	0.914
Public Inflows	–	–	−0.633
Absolute Ratios (%)			
Total Inflows	1.668	1.242	1.729
Private Inflows	–	–	1.570
Public Inflows	–	–	2.302
Standard Deviation (%)			
Total Inflows	2.027	1.320	2.097
Private Inflows	–	–	1.583
Public Inflows	–	–	2.671
GDP	5.039	5.099	5.071
Consumption	6.390	7.538	6.435
Real Exchange Rate	11.745	13.733	12.981
Welfare	1.000	0.995	0.9995

Simulation Comparison



Likelihood and Severity of a crisis

Crisis: private borrowing constraint binds and total capital inflows and GDP growth are below one standard deviation from the mean

Outcomes of Crisis Periods

	Decentralized	Our Model
Crisis Probability	0.053	0.024
Total Inflows	−4.488	−3.816
Private Inflows	−4.488	−4.560
Public Inflows	–	0.744
Consumption	−16.512	−13.340
Real Exchange Rate	−22.839	−20.126

Policy Implications

- Previous papers on private overborrowing: Bianchi(2011), Benigno et al. (2013, 2016)
  - Make a normative statement that the government should implement corrective measures such as taxes on capital flows or capital controls
- Our paper
  - Makes a positive statement that the governments have been already taking steps to alleviate negative consequences of private overborrowing by using reserve policy.
- The reserve policy is useful because capital flow taxes or capital controls are hard to implement and may be ineffective in practice.

Calibration of Developed Countries

- $\kappa = 0.25$: a more lenient borrowing constraint.
- Growth shocks less volatile; transitory shocks more persistent

Income shock		
$\mu_\gamma = 1.023$	$\rho_\gamma = 0.323$	$\sigma^2_\gamma = 0.0004$
$\mu^T_z = -0.097$	$\rho^T_z = 0.925$	$\sigma^2_T = 0.0024$
$\mu^N_z = 0.041$	$\rho^N_z = 0.909$	$\sigma^2_N = 0.0010$
Government spending shock		
$\rho_G = 0.522$	$\sigma^2_G = 0.005$	

Developing versus Developed Countries

	Model		Data	
	Developing	Developed	Developing	Developed
Stock of Bonds/GDP (%)				
Private Bonds	−18.647	−23.676	−18.028	–
Public Bonds	7.712	4.668	11.975	5.839
Absolute Ratios (%)				
Private Inflows	1.583	1.307	3.253	3.197
Public Inflows	2.671	1.582	2.933	1.814
Correlation with Growth				
Total Inflows	−0.163	0.083	−0.152	0.029
Private Inflows	0.914	0.901	0.191	0.091
Public Inflows	−0.633	−0.644	−0.319	−0.138
Corr(Private, Public)	−0.673	−0.750	−0.353	−0.706

Panel Regression on Simulated Data

$$\text{Capital Flows}_{it} = \beta\, \text{Growth}_{it} + \alpha_i + \gamma_t + \nu_{it}$$

	Developing			Developed		
	Total Inflows	Private Inflows	Public Inflows	Total Inflows	Private Inflows	Public Inflows
β	-0.028^{***}	0.120^{***}	-0.148^{***}	0.019^{***}	0.158^{***}	-0.139^{***}
	(0.003)	(0.001)	(0.003)	(0.005)	(0.002)	(0.005)
Obs	2,812	2,812	2,812	1,064	1,064	1,064
Countries	74	74	74	28	28	28

Sensitivity Analysis: Roles of Shocks

	Baseline	No G shock	No z Shock
Stock of Bonds/GDP			
Private Bonds/GDP	-18.647	-18.804	-19.020
Public Bonds/GDP	7.712	3.268	5.430
Correlation with Growth			
Total Inflows	-0.163	0.718	-0.323
Private Inflows	0.914	0.970	0.937
Public inflows	-0.633	-0.926	-0.751
Absolute Ratios			
Private Inflows	1.583	2.015	1.424
Public inflows	2.671	1.412	2.171
Standard Deviation			
Private Inflows	1.874	2.430	1.608
Public inflows	3.355	1.807	2.821
Prob(BC binds for private)	0.166	0.010	0.102
Prob(BC binds for aggregate)	0.000	0.000	0.000

Conclusion

- It is important to study both private inflows and public inflows when we examine the cyclical behavior of total capital inflows, particularly across the developed and developing countries.
- We build a quantitative model with both private and capital flows and successfully account for the features in the data.
- We find public inflows/reserves are important for alleviating the inefficient credit booms and financial crisis.