Financial Crises, Debt Maturity, and Capital Controls

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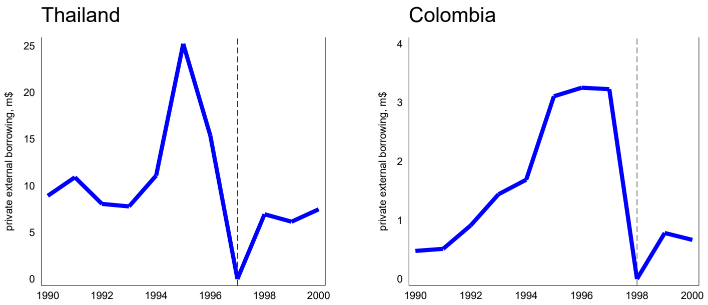
Motivation

- Growing consensus on the need for capital controls
  - Empirical evidence links capital flow surge and financial crises



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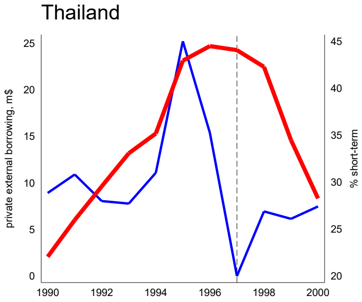

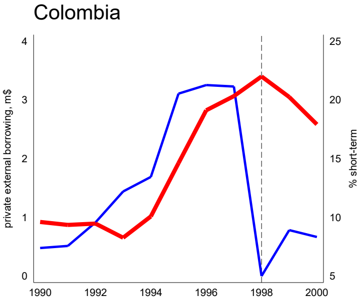

- Significant fluctuations in maturity of capital flows also observed
- Main questions:
  - How does financial friction affect the debt maturity choice?
  - What is the implication on capital control policy?

Approaches and Results

- Empirics:
  - A new index: maturity-dependent capital control changes
  - Stylized facts:
    - During financial crisis, inflow controls are tightened
    - Short-term inflow controls are tightened more than long-term
- Theory:
  - Small open economy with collateral constraint (à la Bianchi/Korinek) + multiple maturities + risk-averse international creditors
    - Inefficient debt portfolio: especially excessive short-term debt
    - Fit debt portfolio dynamics and tighter short-term controls
    - Sizable welfare improvements

Intuition

- Over-borrowing calls for capital controls
  - borrowing capacity depends on collateral values
  - high debt requires high repayment, which crowds out consumption, depresses collateral prices, tightens borrowing constraints (pecuniary externality)
  - agents do not internalize externality hence over-borrow

- Over-borrowing in short-term debt is more detrimental
  - Given borrowers in crisis now,

    $\Longrightarrow$ low output tends to continue in the near future while recover in the far future

    $\Longrightarrow$ higher spread for short-term debt than long-term

    $\Longrightarrow$ larger externality for short-term debt

Related Literature

- Empirical analysis of capital control policy:
  - Chinn and Ito (08), Klein (12), Pasricha et al. (15), Fernández et al. (16)
  - Na et al. (18), Fernández, Rebucci and Uribe (15)
  - **This paper:** capital control changes, maturity-dependence
- Systematic risk in financial crises and policy remedies:
  - Korinek (18), Jeanne and Korinek (10), Bianchi (11), Benigno et al. (13, 16), Bianchi and Mendoza (13), Devereux et al. (15), Schmitt-Grohé and Uribe (17)
  - **This paper:** debt portfolio and maturity structure
- Optimal maturity structure of debt:
  - Hatchondo and Martinez (09), Arellano and Ramanarayanan (12), Chatterjee and Eyigungor (12), Aguiar and Amador (13), Broner et al.(13)
  - **This paper:** inefficiency in maturity choice

Outline

- Empirical analysis of capital inflow controls in financial crises
- Model of debt portfolio choice and optimal capital controls
- Quantitative analysis
- Conclusion

New Facts about Capital Inflow Controls in Financial Crises

Examples of Inflow Controls in Financial Crisis

- Malaysia (1998): foreign portfolio inflows must remain in the country for a period of 12 months
- Thailand (1997): prohibition of security lending transactions by nonresidents
- Argentina (1991): reserve requirements on foreign currency demand deposits were raised from 40% to 43%
- Brazil (1994): 100% marginal reserve requirement on demand deposits
- Iceland (2017): central bank approval is required for borrowing from nonresidents with maturity of less than two years

Data Construction

A new index for capital control changes based on "Annual Report on Exchange Arrangements and Exchange Restrictions" (IMF)

- Text analysis on the policy statements of capital control changes
- Distinguish easing/tightening, short-/long-term flow
- 5-year window for each 139 financial crisis episodes (1970 – 2012)
- In total, 789 capital control changes policy statements

- Example: *"Ukraine 2008: reserve requirement on deposits and loans in foreign currency from nonresidents is increased from 4% to 20% for a term not exceeding 183 calendar days"*
  - Short-term capital inflow tightening

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Fact 1: Capital Inflow Controls Tighten in Financial Crises

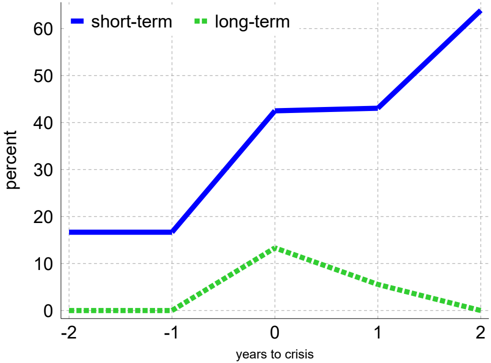
Percent of financial crisis episodes displaying tightening

Note: 139 financial crisis episodes, 1970 – 2011

- Capital inflow tightening is observed in 12.5% of financial crises, which triples the pre-crisis level.

Fact 2: Short-term Inflow Targeting

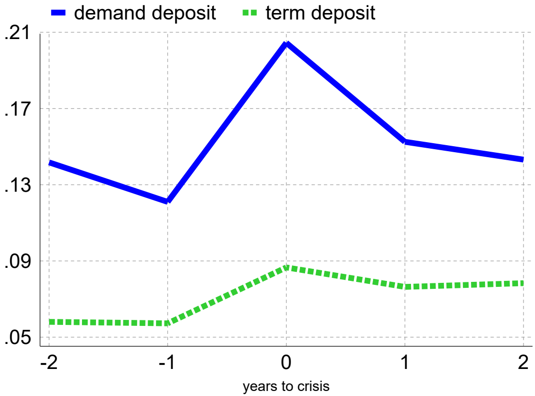
Percent of maturity-dependent tightening to total tightening



Note: 139 financial crisis episodes, 1970 – 2011

- Short-term inflows are more tightened, especially in crises.

Reserve Requirement on Foreign Currency Deposit



Note: 23 financial crisis episodes, 1995 – 2011

- Reserve requirements rise in crisis, with particularly higher increase for short-term deposit.

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The Model

Household, Tradable Goods Producer, International Creditor

Household

Household solves:

$$\max_{c_t^T, c_t^N, d_{t+1}^S, d_{t+1}^L} \quad \mathbb{E} \sum_{t=0}^{\infty} \beta^t u(c_t)$$

$$s.t. \quad c_t^T + p_t c_t^N + d_t^S + d_t^L = \pi_t + p_t y_t^N + q_t^S d_{t+1}^S + q_t^L (d_{t+1}^L - \delta d_t^L)$$

$$q_t^S d_{t+1}^S + q_t^L d_{t+1}^L \leq \kappa(\pi_t + p_t y_t^N)$$

- Perpetual debt: coupon payments decay at δ
- Total debt position can not exceed κ of present income
- Household chooses consumption c_t^T, c_t^N, repays debt d_t^S, d_t^L, issues new debt $d_{t+1}^S, (d_{t+1}^L - \delta d_t^L)$, subject to exogenous bond prices q_t^S, q_t^L, tradable sector profit π_t, and nontradable endowment y_t^N

Tradable Goods Producer

- Profit maximization under working capital constraint:
  η fraction of input purchase must be paid in advance of sales

$$\max_{f_t} \quad \pi_t = \Gamma f_t^{\gamma} - f_t - (\frac{1}{q_t^S} - 1)\eta f_t$$

- Endogenously links household income to q_t^S
- Production technology Γf_t^{γ}, intermediate input (tradable) f_t

Risk-averse International Creditor

- Stochastic discount factor $M_{t,t+1}$: a discrete-time version of one-factor term structure (Ang and Piazzesi (2003))

$$\ln M_{t,t+1} = -\phi_0 - \phi_1 x_t - \frac{1}{2}\zeta_t^2 \sigma_x^2 - \zeta_t \epsilon_{x,t+1}$$

$$\zeta_t = \phi_0^\zeta + \phi_1^\zeta x_t \qquad \text{market price of risk}$$

$$x_{t+1} = \phi_0^x + \phi_1^x x_t + \epsilon_{x,t+1} \qquad \text{macro state}$$

$$\boldsymbol{\Longrightarrow q_t^S = \mathbb{E}_t M_{t,t+1},\ \ q_t^L = \mathbb{E}_t[M_{t,t+1}(1 + \delta q_{t+1}^L)]}$$

- Generates term premium, key to short-term inflow targeting

$$tp_t = \frac{\mathbb{E}_t(1 + \delta q_{t+1}^L)}{q_t^L} - \frac{1}{q_t^S} \neq 0$$

Equilibrium Definitions

1. q_t^S, q_t^L, y_t^N are realized
2. tradable sector: π_t
   - working capital constraint, given q_t^S
3. household: $\{c_t^T, c_t^N, d_{t+1}^S, d_{t+1}^L\}$
   - budget constraint, collateral constraint, given $\{q_t^S, q_t^L, \pi_t, y_t^N, d_t^S, d_t^L\}$

Frictionless equilibrium	❶, ❷ without collateral constraint, ❸
Competitive equilibrium	❶, ❷, ❸
Ramsey equilibrium	maximize household's utility subject to ❶, and FOCs from ❷ and ❸

Quantitative Analysis

Statistics: Model and Data

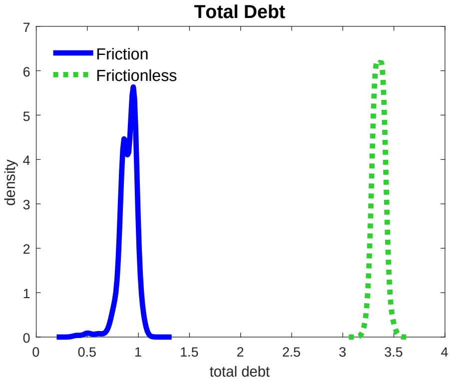
- Model captures the dynamics of debt portfolio and key macro variables

Statistics	Model	Data
Stdev total consumption	4.8	6.2
Stdev real exchange rate	4.8	8.2
Stdev trade balance to GDP	2.7	2.4
debt-to-GDP (%)	29.3	30.6
short-term debt to total debt (%)	23.2	18.3
Correlation with Y	Model	Data
total consumption	0.92	0.88
real exchange rate	0.81	0.41
trade balance to GDP	-0.74	-0.84

Optimal Debt Portfolio: 1. Inter-temporal Condition

$$\text{Euler equation:} \quad u'_{Tt} q_t^S - \boldsymbol{\mu_t} q_t^S = \beta \mathbb{E}_t u'_{Tt+1}$$

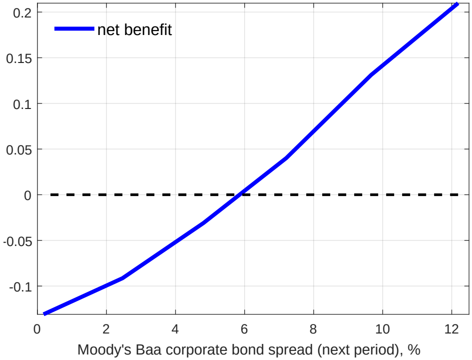
- Collateral constraint $\Longrightarrow$ precautionary saving/underborrowing



Optimal Debt Portfolio 2: Short-term vs. Long-term

- Cost benefit: short-term is cheaper to borrow
- Insurance benefit: long-term hedges future adverse shocks

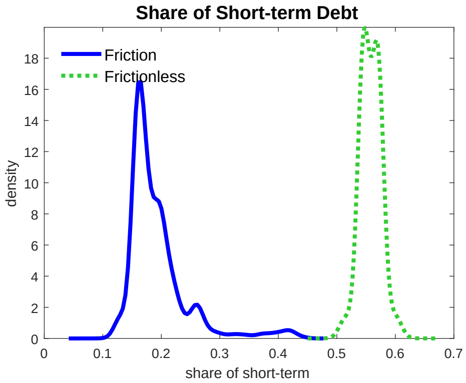
$$\text{Given } c_t, d^L_{t+1} \rightleftharpoons d^S_{t+1} : \quad \underbrace{\mathbb{E}_t(u'_{Tt+1} \cdot \frac{1}{q^S_t})}_{\text{cost benefit}} - \underbrace{\mathbb{E}_t\left[u'_{Tt+1} \cdot \frac{1+\delta q^L_{t+1}}{q^L_t}\right]}_{\text{insurance benefit}} = 0$$



Optimal Debt Portfolio

- Insurance benefit of long-term debt aligns with the precautionary saving motive

$\Longrightarrow$ more long-term debt than frictionless case



Pecuniary Externality

- Private agents undervalue repayment cost:

repayment cost by social planner: $\mathbb{E}_t(\widetilde{u}'_{Tt+1} + \underbrace{\boldsymbol{\widetilde{\mu}_{t+1}\Phi_{t+1}}}_{\text{pecuniary externality}})$

- $\Phi = \kappa y^N(\frac{\partial p^N}{\partial c}) > 0$: financial amplification of repayment cost

$$c \downarrow \Rightarrow p \downarrow \Rightarrow \text{borrowing capacity} \downarrow \Rightarrow c \downarrow$$

- $\widetilde{\mu} \geq 0$: shadow value of collateral

- Pecuniary externality peaks if collateral constraint binds today
  - High probability of entering a crisis tomorrow $\Longrightarrow \widetilde{\mu}_{t+1} \uparrow$
  - Large effect of $c \downarrow$ in decreasing collateral value $\Longrightarrow \Phi_{t+1} \uparrow$

Pecuniary Externality: Short-term versus Long-term

- Larger undervaluation of short-term debt's repayment cost

short/long trade-off by social planner:

$$\mathbb{E}_t\Big[\widetilde{u}'_{Tt+1}\big(\frac{1}{q_t^S} - \frac{1+\delta q_{t+1}^L}{q_t^L}\big)\Big] + \mathbb{E}_t\Big[\widetilde{\mu}_{t+1}\Phi_{t+1}\underbrace{\big(\tfrac{1}{q_t^S} - \tfrac{1+\delta q_{t+1}^L}{q_t^L}\big)}_{\text{term premium}}\Big] = 0$$

- Term premium $> 0 \Longrightarrow$ costly to repay short-term
  $\Longrightarrow$ larger undervaluation
- Largest term premium in crisis $\Longrightarrow$ largest undervaluation

Optimal Capital Controls: Tax on Debt

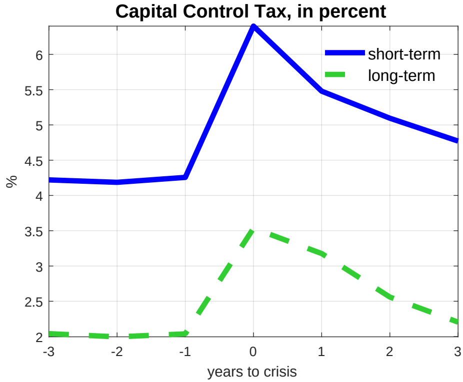
- Tax on the new issuance of debt: $\tau_t^S,\ \tau_t^L$

$$\begin{aligned} c_t^T + p_t c_t^N + d_t^S + d_t^L = & \pi_t + p_t y_t^N \\ & + (1 - \tau_t^S) q_t^S d_{t+1}^S + (1 - \tau_t^L) q_t^L (d_{t+1}^L - \delta d_t^L) \end{aligned}$$

- Higher tax $\Longrightarrow$ lower debt price
  $\Longrightarrow$ less fund raised by debt issuance
  $\Longrightarrow$ correct repayment cost undervaluation

Optimal Capital Control in Crisis Window

- Both short- and long-term inflow are tightened.
- Short-term inflow are tightened by a larger extent.

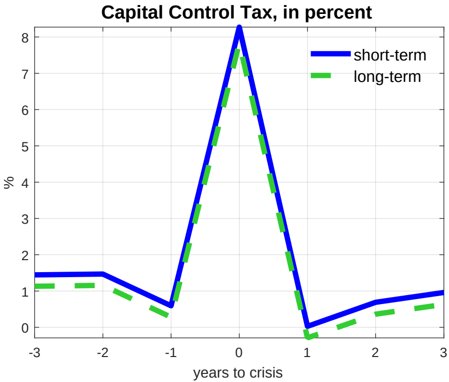


The Role of Term Premium

- If term premium is zero, pecuniary externality in maturity choice will be small.

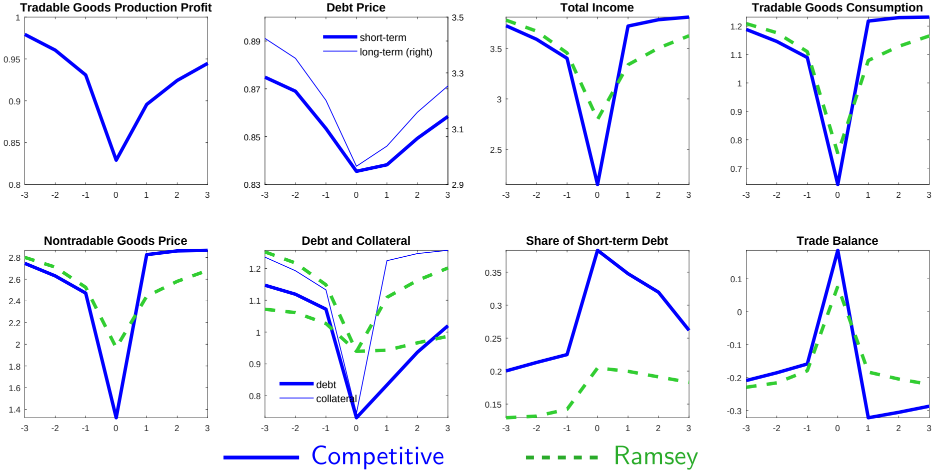
$$\mathbb{E}_t\left[\widetilde{\mu}_{t+1}\Phi_{t+1}\left(\frac{1}{q_t^S}-\frac{1+\delta q_{t+1}^L}{q_t^L}\right)\right] = Cov\left(\widetilde{\mu}_{t+1}\Phi_{t+1}, \frac{1}{q_t^S}-\frac{1+\delta q_{t+1}^L}{q_t^L}\right) \to 0$$

- No significant short-term inflow targeting.



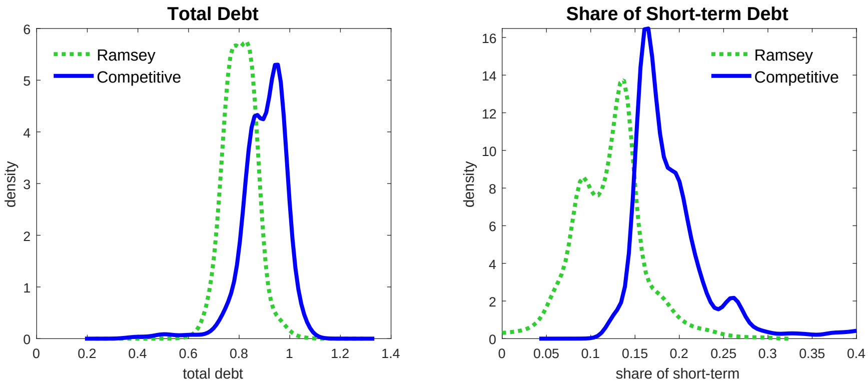
Evaluate Optimal Capital Controls – Crisis Episode

Adverse shock in international creditor's SDF



Evaluate Optimal Capital Controls – Debt Portfolio

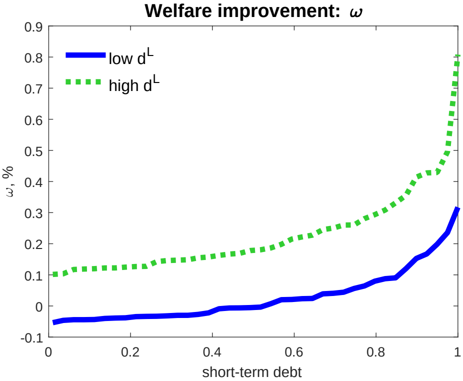
- Optimal capital controls correct overborrowing and excessive short-term debt.



Evaluate Optimal Capital Controls – Welfare Improvement

- Define the welfare gain as Δc that would make private agents indifferent between decentralized and Ramsey equilibria

$$(1+\omega(\mathbf{S}_t))^{1-\sigma} V(\mathbf{S}_t) = \widetilde{V}(\mathbf{S}_t)$$



Comparison Among Capital Control Schemes

	Competitive	Fixed	Fixed	Fixed	Fixed	Optimal
	$\tau_t^S = 0$ $\tau_t^L = 0$	$\tau_t^S = 0$ $\tau_t^L = \tau^L$	$\tau_t^S = \tau^S$ $\tau_t^L = 0$	$\tau_t^S = \tau$ $\tau_t^L = \tau$	$\tau_t^S = \tau^S$ $\tau_t^L = \tau^L$	τ_t^{S*} τ_t^{L*}
crisis freq.	11.8	13.3	15.3	16.7	19.2	26.3
welfare gain	–	0.02%	0.19%	0.23%	0.35%	0.59%
τ^S	–	–	1.83%	1.52%	2.09%	2.79%
τ^L	–	0.65%	–	1.52%	0.98%	1.71%

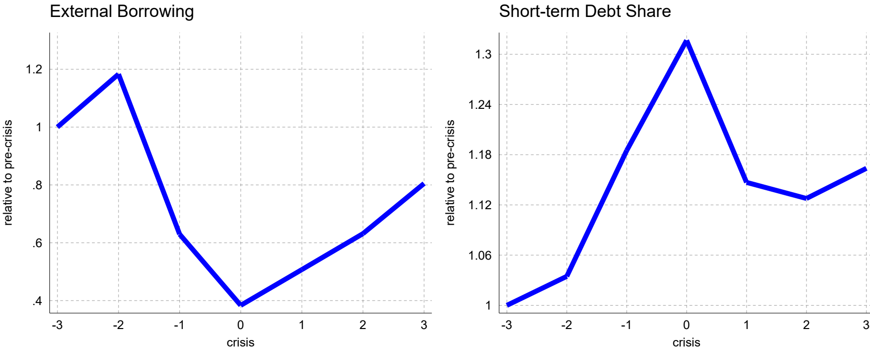
- Optimal policies prevent half of crises and increase welfare
- Maturity-dependent optimal policies yield 48% more welfare gain
- Short-term control is more effective in enhancing welfare

Conclusion

- Document new facts on capital inflow controls
  - tightened in financial crises
  - short-term inflow is tightened more
- Propose a theoretical framework for
  - debt portfolio choice
  - maturity-dependent capital controls
- Derive and evaluate optimal capital controls
  - tilting towards short maturities
  - significantly improves welfare
- Policy implication:
  - differentiate capital controls based on maturities
  - maturity-dependent reserve requirement/collateral requirement

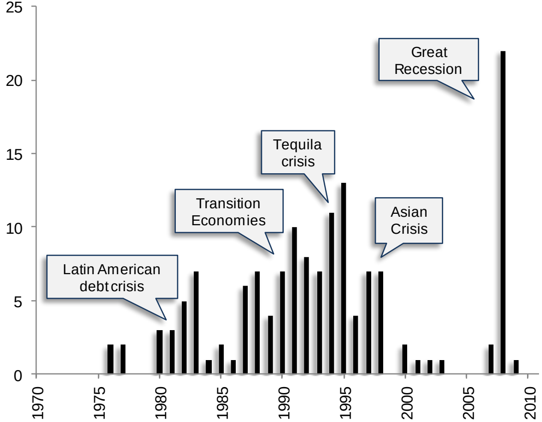
Extra

External Debt Volume and Maturity



Financial Crises Definition - Laeven and Valencia (2012)

- Significant financial distress in the banking system (as indicated by significant bank runs, losses in the banking system, and/or bank liquidations)

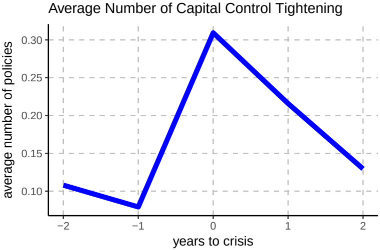


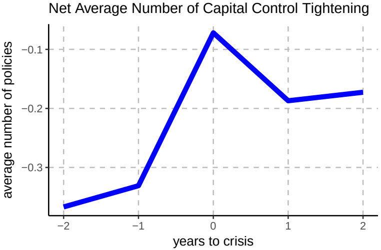
Comparison with Existing Capital Control Measures

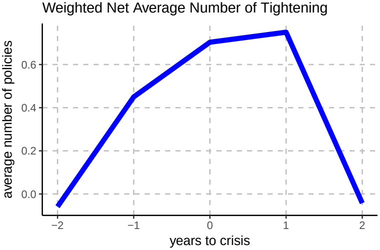
- New measure captures more variation

	Tightening Inflow	Easing Inflow	Tightening Outflow	Easing Outflow	Tightening Overall	Easing Overall
Number of changes						
New measure	30	65	27	35		
Quinn (2011)					39	15
Observation	333	333	333	333	333	333
Number of changes						
New measure	68	93	61	51		
Fernandez et al. (2016)	24	24	22	22		
Observation	217	217	217	217		

Cyclicality of Capital Inflow Control

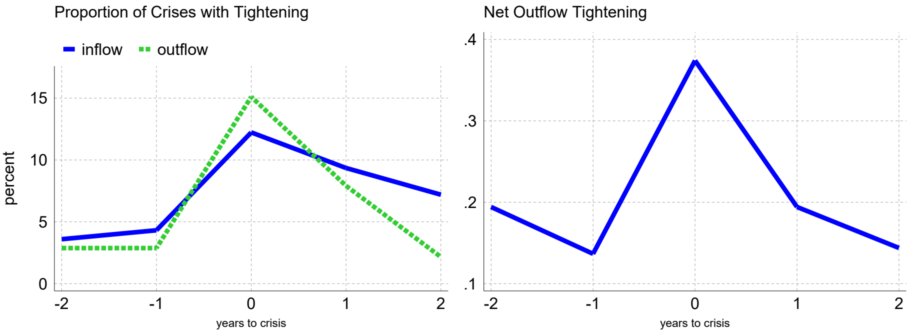






- Robustness checks: average number of capital inflow tightening, average number of capital inflow tightening (net easing), weighted average number of capital inflow tightening (net easing)

Outflow Controls



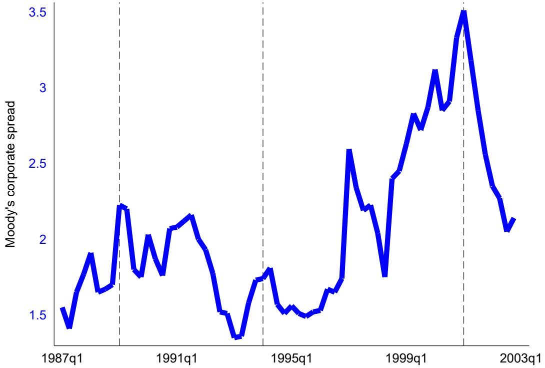
- Outflow controls are tightened in financial crises
- There is more tightening in outflow than inflow

Capital Inflow Control in Sudden Stop Episodes

	trough-peak	p-value	trough-recovery	p-value
inflowD	0.21	0.06	0.12	0.11
inflowN	0.52	0.09	0.27	0.14
inflowNnet	1.45	0.03	0.27	0.27

Calibration

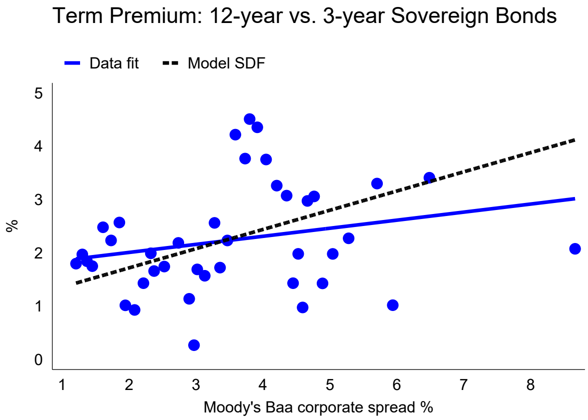
- Calibrated to Argentine data
- International creditor's stochastic discount factor
  - Moody's Baa corporate spread is the factor $x \Longrightarrow$ AR(1) of x



  - Short-term interest rate estimates risk-neutral part ϕ_0, ϕ_1
  - Risk's price $(\phi_0^\zeta, \phi_1^\zeta)$ calibrated to match average $\frac{debt}{GDP}$ and share of short-term debt

Term Premium: Calibration vs. Data

- Calibrated SDF generates term premium similar to the data.



Data source: Broner et al. (2013), Argentina sovereign bonds, 1994 – 2000

Calibration

Parameter	Description	Value
σ	Risk aversion	2
ξ	Elasticity of substitution	0.83
α	Weight on tradables in CES	0.31
β	Discount factor	0.86
κ	Collateral constraint	0.32
δ	Coupon decaying rate	0.90
Γ	Tradable goods production function	2.11
γ	Tradable goods production function	0.83
η	Working capital constraint in tradable production	0.34
$\phi_0^x, \phi_1^x, \sigma_x$	AR(1) coefficients of the factor in pricing kernel	[0.02,0.89,0.035]
$\phi_0, \phi_1, \phi_0^\zeta, \phi_1^\zeta$	international creditor SDF	[0.68,0.31, 0.97, 0.96]

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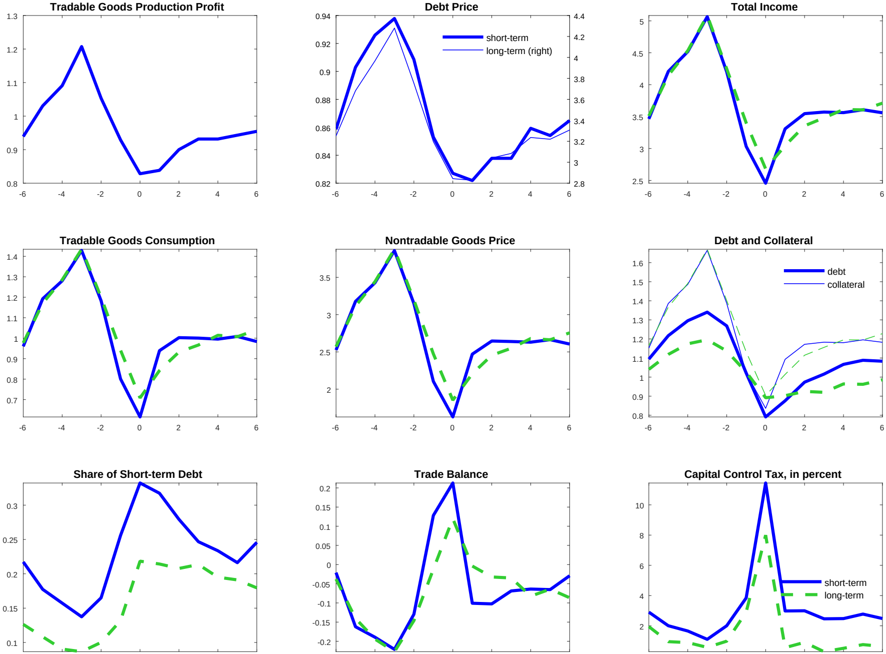
Comparison Between Competitive and Ramsey

- Fewer crises in Ramsey economy
  - every 11.8 years vs. every 26.3 years

- Less severe crises in Ramsey economy

	ΔGDP	Δc^T	depreciation
Competitive	-33.8%	-34.1%	44.0%
Ramsey	-17.6%	-17.7%	20.1%
	Δ debt	Δ tradable balance	
Competitive	-31.8%	0.33	
Ramsey	-9.5%	0.20	

Typical Sudden Stop Episode



SDF Shock and Nontradable Endowment Shock