International Reserves, Credit Constraints, and Systemic Sudden Stops

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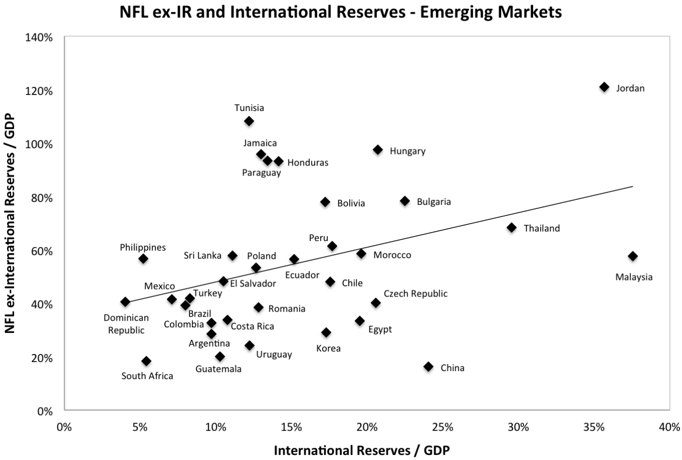
[1]The views expressed herein are solely the responsibility of the author and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or of any other person associated with the Federal Reserve System.

Facts of International Reserves Accumulation

Fact 1: EMs hold high levels of international reserves and foreign liabilities simultaneously, resulting in annual costs around 1% of GDP (Rodrik, 2006)

International Reserves and Foreign Liabilities



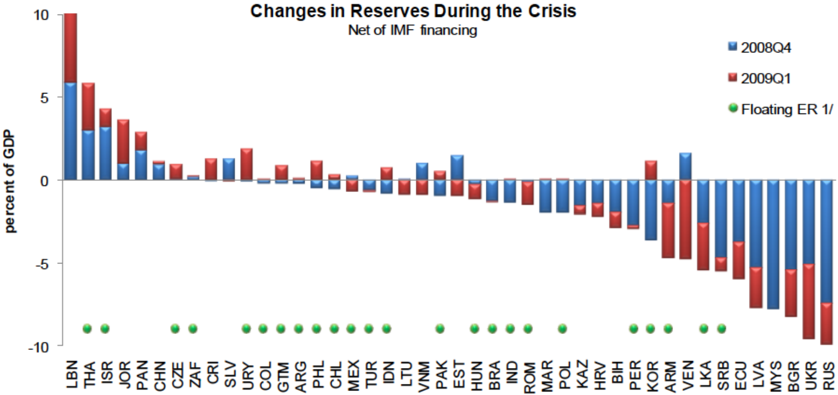
Source: Updated and extended version of the dataset in Lane and Milesi-Ferretti (2007).

Facts of International Reserves Accumulation

Fact 1: EMs hold high levels of international reserves and foreign liabilities simultaneously, resulting in annual costs around 1% of GDP (Rodrik, 2006)

Fact 2: Countries barely used international reserves during the Global Financial Crisis

Change in Reserves During the GFC (1/2)



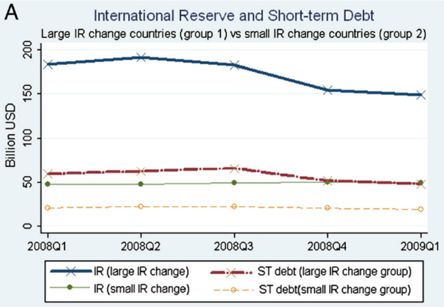
Source: WEO, AREAER and staff calculations.

1/ corresponds to the categories “floating” and “free floating” in the 2009 AREAER de facto classification.

Change in Reserves During the GFC (2/2)

"Reserves play a stabilizing role simply because they are there and not necessarily to be used.", De Gregorio (2011)

"The adjustment of EMs during the global liquidity crisis has been constrained more by their fear of losing reserves than by fear of floating.", Aizenman and Sun (2012)



Source: Aizenman and Sun (2012)

Facts of International Reserves Accumulation

Fact 1: EMs hold high levels of international reserves and foreign liabilities simultaneously, resulting in annual costs around 1% of GDP (Rodrik, 2006)

Fact 2: Countries barely used international reserves during the Global Financial Crisis

$\Rightarrow$ Current models and traditional rules of thumb cannot reconcile these two facts

Related Literature

- **Precautionary savings:** insurance against sudden stops and deleveraging crises (Bianchi et al (2013), Alfaro and Kanczuk (2009, 2013), Jeanne and Ranciere (2011), Obstfeld et al (2010), Aizenman and Lee (2007), Salomao (2013))

- **Neo-mercantilism:** strategy of export promotion and the consequent "desire" of a depreciated currency (Dooley et al (2004a and 2004b), Korinek and Serven (2011))

My contribution: Both strands of the literature cannot explain high simultaneous holdings of reserves and debt when we have endogenous short-term debt.

This Paper

Introduces a new motive for reserve accumulation, namely its role as implicit collateral for external borrowing

- SOE 2 sector endowment economy: tradables (y_t^T) and non-tradables (y_t^N)
- Incomplete markets:
  - Access only to 1 period non-state contingent bonds (b_{t+1})
  - Additional asset: International Reserves (IR)
  - Collateral constraint: international borrowing limited to a fraction of tradable output (κ_t^T) and a multiple of international reserves (κ^{ir})
- Main results:
  - IR levels are close to the average of 1991-2012
  - Optimal behaviour imply an accumulation before crises and a small depletion during them, with results close to a policy of constant IR

Theoretical Framework

Model Setup

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

$$U(c) = \frac{c^{1-\sigma} - 1}{1 - \sigma}$$

subject to

$$c_t \equiv A(c_t^T, c_t^N) = [\omega(c_t^T)^{-\eta} + (1-\omega)(c_t^N)^{-\eta}]^{-\frac{1}{\eta}}$$

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

$$\tau_{t+1} = IR_{t+1} - IR_t$$

$$b_{t+1} \geq -[\kappa_t^T y_t^T + \kappa^{ir} IR_t]$$

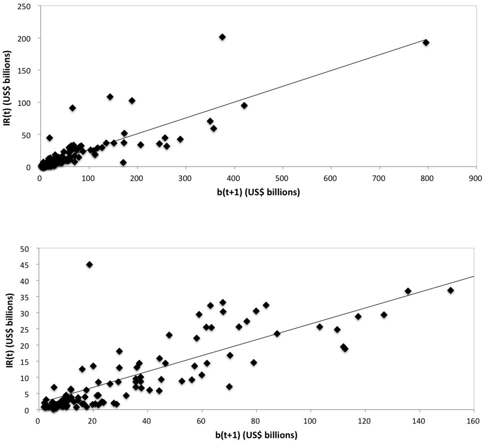
where $\kappa_t^T = \{\kappa^{T,L}, \kappa^{T,H}\}$, $r_t = \{r^L, r^H\}$, y_t^T and y_t^N are exogenous stochastic variables

Can International Reserves Serve as Collateral?

- Usual criticism: international reserves cannot be used as collateral because central bank assets are legally protected against attachment by creditors[2]
- Main idea: strong reputational effects if default happens in the presence of international reserves
  - *"An economy which maintains an adequate level of reserves gives the rest of the world the assurance that it will honor its commitments in exceptional situations."* - Banco Central de Chile (2011)
  - *"Foreign investors minimize risks by offering only short-term loans (...) through local banks, so that if banks cannot repay, the government will be drawn into supporting them to avoid widespread economic damage. Thus, foreign investors get an implicit government guarantee."* - Rajan (2010)

[2] See Panizza, Sturzenegger and Zettelmeyer (2009).

Do International Reserves Serve as Collateral?



Note: Each point represents data for a specific country during an international crisis episode.
Source: Updated and extended version of the dataset in Lane and Milesi-Ferretti (2007)

Quantitative Analysis

Business Cycle Moments (% of GDP) - Latin America

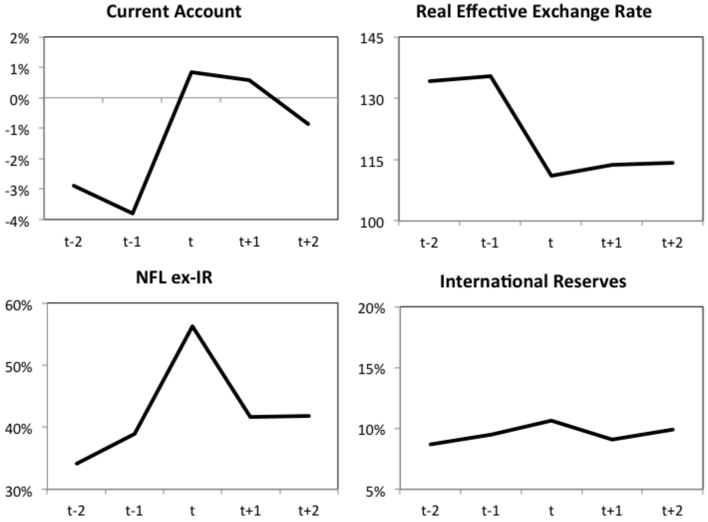
	Average	Std	Autocorr.	Correl(y)
International Reserves	9.9%	2.1%	0.55	0.07
Net Foreign Liabilities ex-IR	36.0%	11.9%	0.66	-0.31
Current Account	-1.6%	2.5%	0.68	-0.40

Source: World Bank World Development Indicators and updated and extended version of the dataset in Lane and Milesi-Ferretti (2007) complemented by the updated international capital flows database constructed by Alfaro, Kalemli-Ozcan, and Volosovych (2014). The data are sampled annually from 1991 to 2015.

Systemic Sudden Stops Episodes

- Two step process: first identify periods of global financial stress and then Sudden Stops episodes
- Periods of global financial stress: periods where there is a spike in the EMBI Global spread with respect to its 2 year moving average (1995, 1999, 2002 and 2009)
- Sudden Stops episodes: periods where the country experiences a one standard deviation reversal in the current account in a state of global financial stress

Systemic Sudden Stops Episodes



Calibration Strategy

- Endowment process: detrend the series and estimate a VAR(1) for each country and use their average
- General parameters of the model $\{\sigma, \eta, \omega\}$: standard values
- Using target moments: $\{\beta, \kappa^{ir}, \kappa^{T,H}, \kappa^{T,L}, \pi, \psi\}$
  - 2 states of international risk aversion: normal and crisis
  - Target moments:
    - Average NFL ex-IR-GDP ratio = 36.0%
    - Collateral constraint never binds in normal times
    - Frequency of sudden stops: 6.4%
    - CA standard deviation: 2.5%
    - CA reversal: 3.9% of GDP
    - CA recovery: 1.4% of GDP

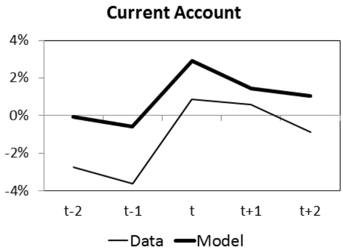
  Results: $\beta = 0.93$, $\kappa^{ir} = 2.87$, $\kappa^{T,L} = 0.2$, $\pi = 20\%$, $\psi = 40\%$
- Interest rate: $r = \{3\%, 8\%\}$ - sample average

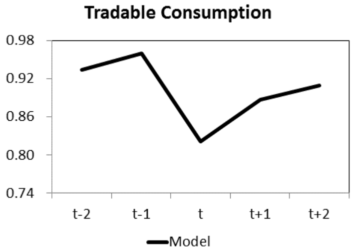
Model Simulations

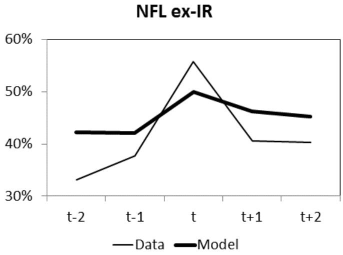
Targeted Moments	Model	Data
Average NFL ex-Reserves-to-GDP ratio	36.0%	36.0%
Frequency of Sudden Stops	6.4%	6.4%
σ(CA/Y)	2.4%	2.5%
Reversal	3.1%	3.9%
Recovery	1.8%	1.4%

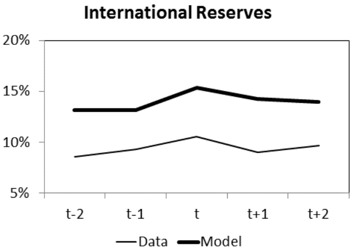
Non-Targeted Moments	Model	Data
Average Reserves-to-GDP ratio	10.8%	9.9%
σ(IR/Y)	10.8%	2.1%
σ(NFL ex-IR/Y)	30.3%	11.9%
ρ(y,IR/Y)	-0.64	0.07
ρ(y,-b/Y)	-0.66	-0.31
ρ(y,CA/Y)	-0.42	-0.40
ρ(y,REER)	0.77	0.30

Systemic Sudden Stops Experiments

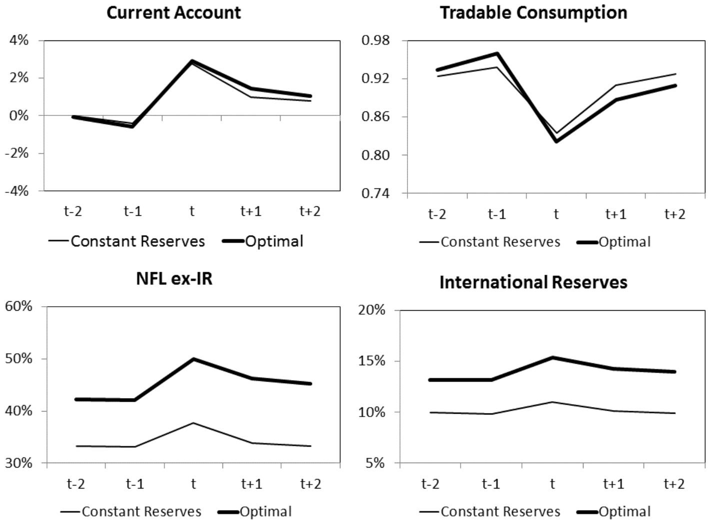




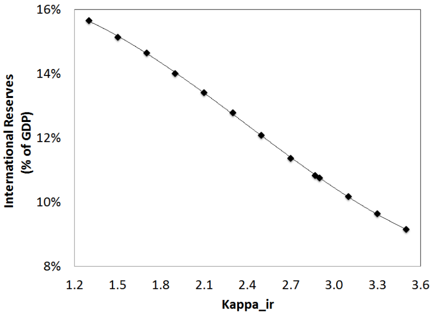


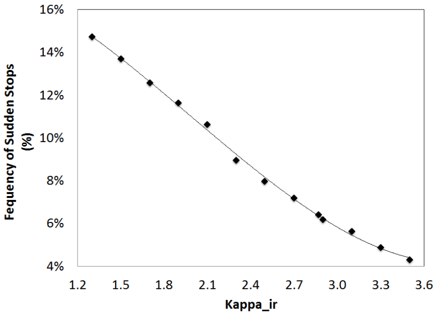


Alternative Policy - Constant International Reserves



Can the Model Explain Any Level of Reserves?





Conclusions

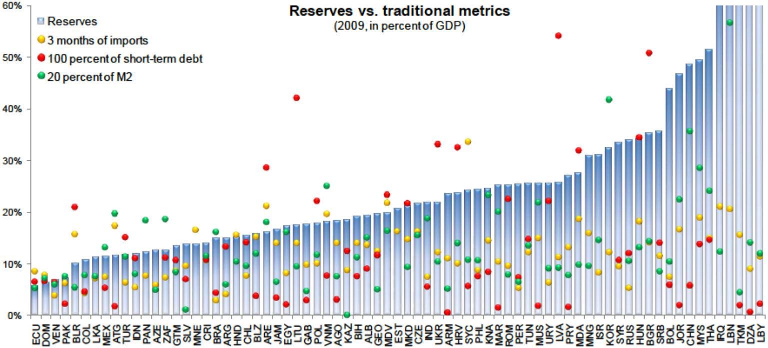
I introduce a new motive for reserve accumulation, namely its role as collateral for external borrowing in a SOE, and am able to get:

- High levels of international reserves and external debt simultaneously, reaching values close to the data
- Optimal behaviour that implies reserve accumulation before crises and a small depletion during them
- The results are close to those of a policy of constant reserves, shedding light on the "fear of losing reserves" during the GFC
- Results are robust to changes in the "value" of international reserves as collateral (κ^{ir}) and other parameters of the model

Thank you!

Appendix

Traditional Rules of Thumb



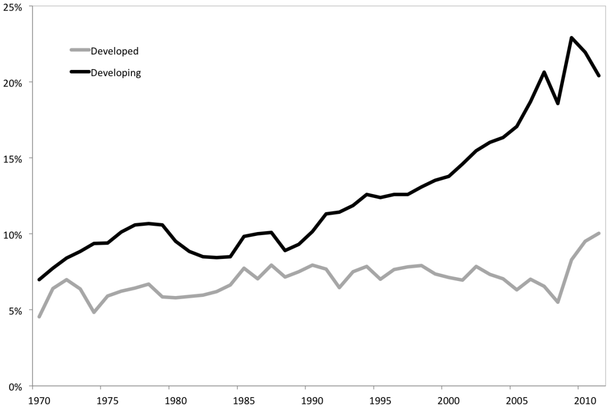
Source: WEO, IFS and staff calculations.

Related Literature

The current literature cannot explain these high simultaneous holdings when we have endogenous short-term debt.

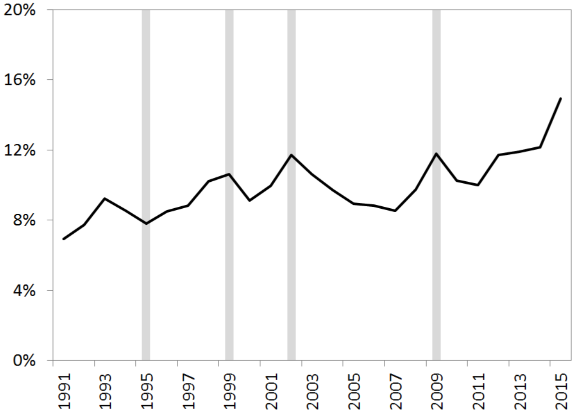
	Methodology	Results
BHM (2013)	Model of optimal reserves in the presence of rollover risk & default	Optimal IR = 7.5% of GDP LT debt crucial for results
AK (2009)	DSGE with choice of debt & IR with symmetric default costs	Optimal IR = 0% of GDP
Salomao (2013)	DSGE with choice of debt & IR with asymmetric default costs	Optimal IR = 4% of GDP
AK (2013)	Optimal exchange-rate regime with borrowing in local currency	Higher IR are always better
JR (2011)	SOE seeking insurance against SS in capital flows	Optimal IR = 9.1% of GDP Debt level is exogenous

International Reserves (% of GDP)



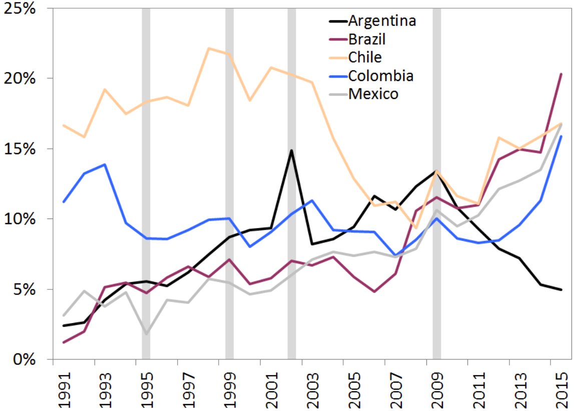
Source: World Bank World Development Indicators

International Reserves (% of GDP) - Latin America



Source: World Bank World Development Indicators

International Reserves (% of GDP) - Latin America

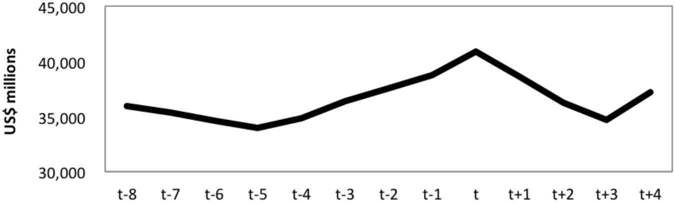


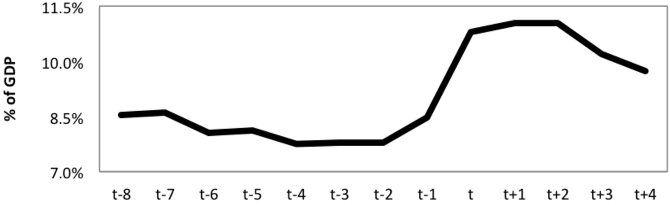
Source: World Bank World Development Indicators

Sudden Stops Episodes

Country	Years of Sudden Stops
Argentina	1995, 2002
Brazil	2002
Chile	1999, 2009
Colombia	1999
Mexico	1995, 2009

International Reserves During Crises - Quarterly

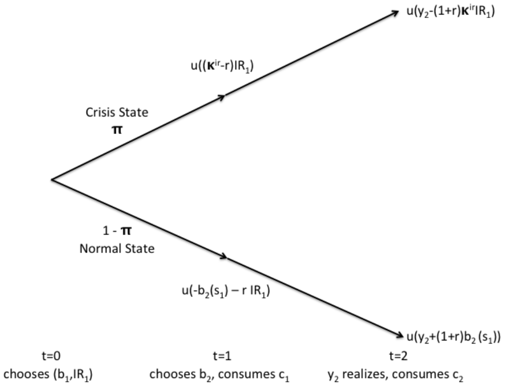




Illustrating the Mechanism

- Economy lasts for 3 periods: t=0,1,2
- Deterministic endowment sequence: $y_0 = y_1 = 0$ and $y_2 > 0$
- Objective function: $E_0\{ln(c_1) + \beta ln(c_2)\}$, $\beta(1+r) = 1$
- Economy is subject to a sudden stop shock in period 1:
  - A sudden stop occurs with probability $\pi\epsilon[0,1]$.
  - If the shock materializes: $b_2 \geq -\kappa^{ir} IR_1$
- With $\pi = 0$, constant consumption: $c_1^* = c_2^* = y_2/(2+r)$
- International reserves accumulation trade-off: pay ”carrying” cost of rIR_1 to increase c_1 by $\kappa^{ir} IR_1$ if shock materializes

Illustrating the Mechanism



$$IR_1 = K(r, \pi, \kappa^{ir})y_2 \qquad K\epsilon(0, 1/2) \qquad K_r < 0, K_\pi > 0, K_{\kappa^{ir}} < 0$$

Competitive Equilbrium

- Defining $G(c_t^T, c_t^N) \equiv U'(c_t)A_1(c_t^T, c_t^N)$, first-order conditions are:

$$G(c_t^T, c_t^N) = \lambda_t$$

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

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

$$\mu_t \geq 0, \qquad \mu_t[b_{t+1} + \kappa_t^T y_t^T + \kappa^{ir} IR_t] = 0$$

- Market clearing condition:

$$c_t^N = y_t^N$$

Social Planner's Problem

$$V(IR, b, \mathbf{y}) = \max_{IR', b', c^T} u(c(c^T, y^N)) + \beta E_{y'|y} V(IR', b', \mathbf{y'})$$

subject to

$$c^T + b' + IR' = y^T + b(1+r) + IR$$

$$b' \geq -\left[\kappa^T y_t^T + \kappa^{ir} IR\right]$$

Optimal International Reserves Policy

- The first order conditions are:

$$G(c_t^T, y_t^N) = \beta(1+r)E_t G(c_{t+1}^T, y_{t+1}^N) + \mu_t$$

$$G(c_t^T, y_t^N) = \beta E_t \{G(c_{t+1}^T, y_{t+1}^N) + \mu_{t+1}\kappa_{ir}\}$$

$$\mu_t \geq 0, \quad \mu_t \left[b_{t+1} + \kappa_t^T y_t^T + \kappa^{ir} IR_t \right] = 0$$

- The first equation is exactly the same Euler Equation that we get in the decentralized equilibrium

- The second equation determines the optimal International Reserves accumulation policy

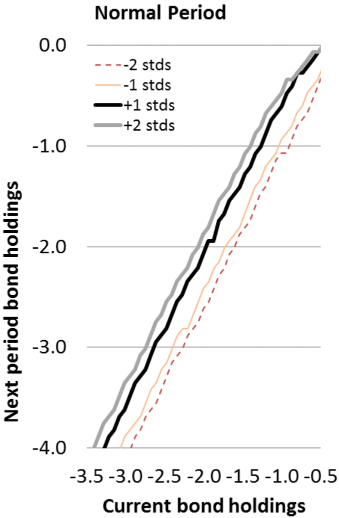
Calibration

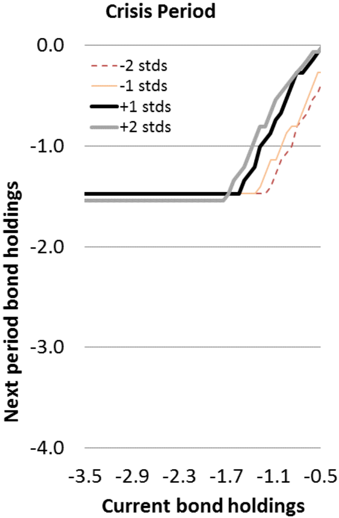
$$log(\mathbf{y_t}) = \rho log(\mathbf{y_{t-1}}) + \epsilon_t, \quad \epsilon_t \sim N(0, V)$$

$$\rho = \begin{bmatrix} 0.920 & -0.314 \\ 0.277 & 0.573 \end{bmatrix} \qquad V = \begin{bmatrix} 0.00248 & 0.00142 \\ 0.00142 & 0.00143 \end{bmatrix}$$

Interest rate in normal times	$r^N = 0.03$
Interest rate in financial distress	$r^C = 0.08$
Risk aversion	$\sigma = 2$
Atemporal elasticity of substitution	$1/(1+\eta) = 0.8$
Weight on tradables in CES	$\omega = 0.23$
Discount factor	$\beta = 0.932$
Probability of entering financial distress	$\pi = 0.2$
Probability of going back to normal times	$\psi = 0.4$
y^T credit coefficient in financial distress	$\kappa^{T,L} = 0.2$
IR credit coefficient	$\kappa^{ir} = 2.87$

Bond Policy Functions - $IR_t = 0.40$





IR Policy Functions - $IR_t = 0.40$