Sovereign Local Currency Debt and Original Sin Redux

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Sovereign Debt and Original Sin

- **Original sin** $\rightarrow$ Inability to borrow abroad in local currency (LC)
  (Eichengreen, Hausmann and Panizza, 2007)

$$\text{Original Sin} \rightarrow \begin{array}{c}\text{Currency}\\ \text{Mismatches}\end{array} \rightarrow \begin{array}{c}\text{Debt Intolerance} \Uparrow\\ \text{External Vulnerability} \Uparrow\end{array}$$

  - Currency mismatch: assets in LC (peso) and liabilities in FC (dollar)
  - Debt intolerance: default risks vs external debt.
  - External vulnerability: default risk vs global financial conditions

Sovereign Debt and Original Sin

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  (Eichengreen, Hausmann and Panizza, 2007)

$$\text{Original Sin} \rightarrow \begin{matrix}\text{Currency} \\ \text{Mismatches}\end{matrix} \rightarrow \begin{matrix}\text{Debt Intolerance} \Uparrow \\ \text{External Vulnerability} \Uparrow\end{matrix}$$

- Since mid-2000, foreign currency (FC) external debt $\Downarrow$: 85% $\rightarrow$ 50%
  - Foreign investors participation $\Uparrow$: $\approx$ 0% $\rightarrow$ 20%

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- **Original sin redux**: High external vulnerability even with LC external debt
  (Carstens and Shin, 2019)
  - Heavy reliance on foreign capital
  - Low developed financial market

Original Sin Redux: Foreign Investors' Currency Mismatch

- Foreign investor have large unhedged FX exposures (Cantú & Chui, 2020)

	Government		Foreign Investor	
	Asset	Liability	Asset	Liability
Foreign Currency (FC)	LC	FC	FC	FC
	Currency Mismatch		No Currency Mismatch	
Local Currency (LC)	LC	LC	LC	FC
	No currency Mismatch		Currency Mismatch	

- Negative feedback loop:

Global Financial Shocks $\rightarrow$ Local Currency Depreciation $\rightarrow$ Foreign Inv. Asset Sales (Capital Ouflows) $\rightarrow$ Bond Price $\Downarrow$

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Question:

Low financial development amplifies the negative feedback loop?

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What I Do

1. Document empirical patterns of “original sin redux" based on cross-country difference.

$$\text{Financial Development} \Downarrow \rightarrow \text{Credit Channel Vulnerability} \Uparrow \rightarrow \text{Default Risk} \Uparrow \text{External Vulnerability} \Uparrow$$

   - Credit channel vulnerability: Sensitivity of private credit to capital outflows

2. Provide theoretical explanations behind cross-country difference:

   - With an emphasis on domestic financial sector.
   - Based on sovereign default model with
     - Endogenously determined foreign investment for LC sovereign bond
     - Domestic financial sector (Gertler and Kiyotaki, 2010)

Related Literature and Contribution

- Related literature
  - Sovereign risk related with the banking sector's fragility:
    Gennaioli, Martin, Rossi (2014), Perez (2015), Sosa-Padilla (2018), Farhi & Tirole (2018), Arellano, Bai, Bocola (2017)
  - EMEs issuing sovereign debts internationally in local currency:
    Ottonello & Perez (2019), Du & Schreger (2016), Ho (2019), Hofmann, Shim, Shin (2020)
  - EMEs external vulnerability:
    Di Giovanni, Kalemli-Ozcan, Ulu & Baskaya (2017), Iacoviello & Navarro (2019), Gonzalez-Aguado (2018)

- My work contributes to the literature:
  - Empirically by documenting "original sin redux" and cross-country difference.
  - Theoretically by providing explanation behind the cross-country difference.

Data: 11 EMEs 07Q1 $\sim$ 20Q2

EMEs: Brazil, Colombia, Hungary, Indonesia, Malaysia, Mexico, Philippines, Poland, South Africa, Thailand, Turkey

- **LC bond default risk** (Du & Schreger, 2016)

$$\text{Default Risk}_t = \underbrace{y_t^{LC}}_{\text{LC bond yield}} - \underbrace{y_t^*}_{\text{US treasury yield}} - \underbrace{\rho_t}_{\text{currency risk}}$$

  - Currency risk: Compensation for the risk of local currency depreciation
  - Default risk: Compensation for the risk of sovereign default

- **Share of LC sovereign bonds held by foreign investors** (Arslanalp & Tsuda 2014, IIF)

- **Ratio of liquid liabilities to GDP**: Financial development indicator (World Bank)

Credit Channel Vulnerability

Credit channel vulnerability: Sensitivity of private credit to foreign investment

$$\Delta\text{Private Credit}_t = \gamma \Delta\text{Foreign Holding}_t + \beta_l \text{X}_{t-1} + \beta_g \text{Global}_t + \epsilon_t \quad (1)$$

- ΔPrivate Credit$_t$: banks private credit growth rate - total claim growth rate
- ΔForeign Holding$_t$: changes in the foreign holdings of LC bond
- X_t: local factor
- Global$_t$: global factor

Financial Development & Credit Channel Vulnerability

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- **Problem**: Financial development is related with debt to GDP.
  - Higher debt to GDP in a country with more developed financial market

	Low debt	High debt
Low financial development	Colombia, Indonesia, Mexico, Turkey	South Africa
High financial development	Thailand	Brazil, Hungary, Malaysia

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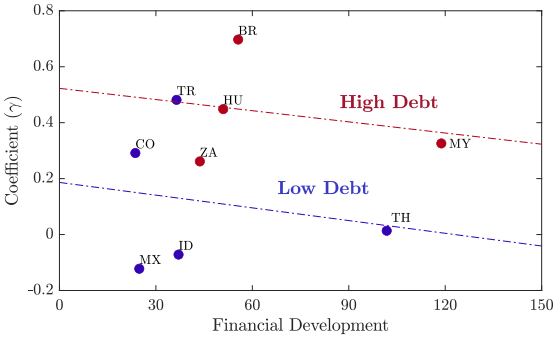
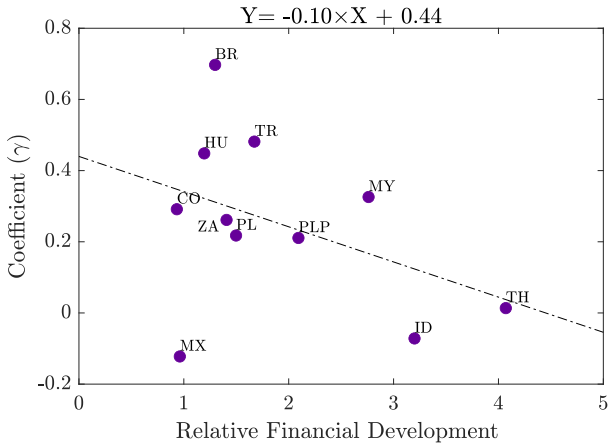


Financial Development & Credit Channel Vulnerability

- **Purpose**: Relationship of financial development with credit channel vulnerability
- **Problem**: Financial development is related with debt to GDP.
  - Higher debt to GDP in a country with more developed financial market
- **Solution**: Financial Development Relative to Debt to GDP
  - High financial development & high debt $\leftrightarrow$ Gov't crowds out the development with high debt.

Financial development relative to debt to GDP & Credit Channel Vulnerability

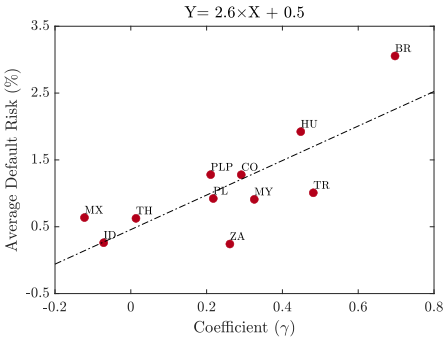
Relative Financial Development $\Downarrow$ $\rightarrow$ Credit Channel Vulnerability $\Uparrow$



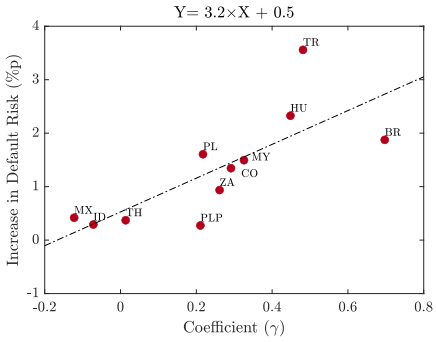
Credit Channel Vulnerability, Default Risks, External Vulnerability

- Banks ability to supply private credit when capital outflows (⇓ Credit channel vulnerability)
  $\rightarrow \downarrow$ Default risk & $\downarrow$ External vulnerability (Sensitivity to global financial conditions)

(a) Default risk

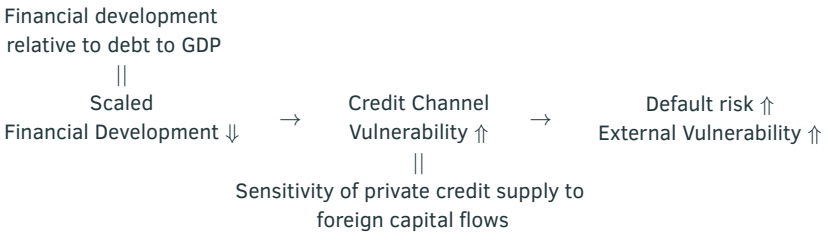


(b) External vulnerability



Summary of what I found

Relationship of default risk and external vulnerability with banks' capability.



Model Summary

- A three-period sovereign default model with financial intermediaries (Gertler and Kiyotaki, 2010)
- Small open economy:
  - Household: members randomly switch between workers and bankers
    - Workers: save, consume, supply labor, pay labor income tax.
    - Bankers: buy the government bond and rent capital to firms.
  - Firms: produce consumption goods.
  - Foreign investors: buy the government bond.
  - Government: issues debts only in local currency to finance its expenditure.
- The LC bond held both by banks and foreign investors.
  (Erce and Mallucci, 2018, Gonzalez-Aguado, 2018)

Model Features Generating “Original Sin Redux"

1. Foreign investors’ decisions are endogenous.
2. Different losses (haircuts) from the government’s default by bond holder.
   - Domestic banks vs foreign investors
3. Collateral constraint of domestic banks
4. Global financial states: normal times vs high risk times
   - High risk times: $\downarrow$ productivity and EM’s currency depreciation

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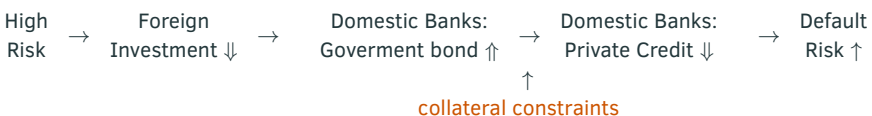

Model: Exogenous State

In the model, the exogenous state is given by $\Lambda_t = (z_t, S_t, x_t)$.

- z_t: total factor productivity, S_t: nominal exchange rate.
- x_t : indicator of global financial states
  - $x_t = 0$: a normal time, $x_t = 1$: a high risk time.
  - Follows a two-state Markov process.

$$Pr(x_{t+1} = 1 \mid x_t = 0) = \pi_{01},\ \pi_{11} > \pi_{01} \tag{2}$$

- In high risk times ($x_t = 1$),
  - decline in productivity ($\phi_z > 0$)

$$\log(z_t) = \mu_z + \rho_z \log(z_{t-1}) + \varepsilon_{z,t} - \phi_z x_t, \epsilon_{z,t} \sim N(0, \sigma_z^2) \tag{3}$$

  - currency depreciation ($\phi_S > 0$) with higher volatility ($\eta > 0$)

$$\log(S_t) = \mu_s + \rho_S \log(S_{t-1}) + \varepsilon_{S,t} + \phi_S x_t, \epsilon_{S,t} \sim N(0, (\sigma_S(1 + \eta x_t))^2) \tag{4}$$

Model: Government

Maximizes the utility from its public goods net of default disutility cost v,

$$\max_{G_1, G_2, D} U(\bar{g}) + \beta_g \mathbb{E}_0[U(G_1) + \beta_g(U(G_2) - Dv)] \tag{5}$$

$$\begin{aligned} \text{s.t.} \quad & \bar{g} = q_0 B_1 \\ & G_1 = q_1 B_2 - B_1 + \tau w_1 n_1 \\ & G_2 = \tau w_2 n_2 - (1 - D) B_2 - D(b_2^* \psi + b_2 \psi_d) + W_2 \end{aligned} \tag{6}$$

- period 0 : Finances $\bar{g}$ with default free LC bonds.
- period 1 : Finances G_1 with labor income tax (τ), defaultable bonds.
- period 2 : Finances G_2 with labor income tax (τ) and decides on default.
  - Default disutility costs v: logistic distribution (Arellano, Bai and Mihalache, 2020)
  - Productivity penalty.

Model: Firms

- A representative firm operates in period 1, 2.

$$\max_{k_t, l_t} z_t k_t^{\alpha} l_t^{1-\alpha} - r_{k,t} k_t - w_t l_t \tag{7}$$

  - Rents capital from banks at rate $r_{k,t}$
  - Hires workers at wage w_t.

Model: Household

Representative household composed of a measure 1 of workers and bankers.

- period 0: Starts with workers endowed with $\overline{n}_0^h$ and bankers with N_0.
- period 1:
  - λ of workers become new bankers
  - λ of bankers cease to operate and become workers
  - workers transfer $\overline{N}$ to newly born bankers
  - exiting bankers transfer the net worth (N_1) to household
- period 2: Bankers pay out the accumulated net worth (N_2) to household.

Model: Household

- Linearity of preference over consumption: $q^a(\text{price of deposit}) = \beta$
- Collateral constrained bankers: capital (k) vs government bond (b)

$$\underbrace{k_{t+1} + q_t b_{t+1}}_{\text{asset}} = \underbrace{N_t}_{\text{equity}} + \underbrace{\beta\chi N_t}_{\text{liability } (q^a a_{t+1})} \tag{8}$$

- Risk neutral bankers: Two assets' expected returns are equal.

$$\mathbb{E}_1(R_{k,2}) = \frac{\mathbb{E}_1((1-D) + D\psi_d)}{q_1} \tag{9}$$

$$\mathbb{E}_0[W(\Lambda_1)R_{k,1}] = \frac{\mathbb{E}_0[W(\Lambda_1)]}{q_0} \tag{10}$$

where, $W(\Lambda_1)$ is the marginal value of an additional unit of net worth,

$$W(\Lambda_1) = \lambda + (1-\lambda)(\beta\mathbb{E}_1\left[R_{k,2}\right] + \beta\chi(\mathbb{E}_1\left[R_{k,2}\right]\beta - 1)). \tag{11}$$

Model: Foreign investors

In period 0 and 1, a unit mass of foreign investors labeled by $i \in [0, 1]$

$$\max_{b^*_{i,t}} E_t(\tilde{r}_{i,t}) b^*_{i,t} - \frac{\Gamma}{2} \mathrm{Var}_t(\tilde{r}_{i,t}) b^{*2}_{i,t} \tag{12}$$

where, $b^*_{i,t}$: i's investment in government bond, $\tilde{r}_{i,t}$: log return

- Heterogeneous participation costs, i per dollar invested.
  (Alvarez, Atkeson and Kehoe, 2009, Fanelli and Straub, 2020)
- Access to an international risk free asset at r^*.

Model: Foreign investors

- $\tilde{R}_{i,t}$: Investor i's dollar return on the local currency bond in period t

$$1 + \tilde{R}_{i,t} \equiv \frac{1}{(1 + r^*)} \frac{\left[(1 - D_{t+1}) + D_{t+1}\psi\right] / S_{t+1}}{q_t(1 + i)/S_t} \tag{13}$$

- $\tilde{r}_i \equiv \ln(1 + \tilde{R}_i)$: Log return

$$\tilde{r}_{i,t} = \underbrace{\ln((1 - D_{t+1}) + D_{t+1}\psi) + \ln(S_t) - \ln(S_{t+1}) - \ln(q_t) - r^*}_{\tilde{r}_t} - i \tag{14}$$

$$\Rightarrow \quad E_t(\tilde{r}_{i,t}) = E_t(\tilde{r}_t) - i$$

$$\mathrm{Var}_t(\tilde{r}_{i,t}) = \mathrm{Var}_t(\tilde{r}_t)$$

Model: Foreign investors

- The investor i's bond holding then satisfies:

$$b^*_{i,t} = \frac{E_t(\tilde{r}_t) - i}{\Gamma \operatorname{Var}_t(\tilde{r}_t)} \tag{15}$$

- $\hat{i}_t$ is the marginal foreign investors purchasing the bond:

$$\hat{i}_t = E_t(\tilde{r}_t). \tag{16}$$

- Foreign holdings of the government bonds b^*_t:

$$\underbrace{\int_{i=0}^{i=\hat{i}_t} b^*_{i,t} di}_{b^*_t} = \frac{1}{\Gamma \operatorname{Var}_t(\tilde{r}_t)} \int_{i=0}^{i=\hat{i}_t} (E_t(\tilde{r}_t) - i)\ di = \frac{E_t(\tilde{r}_t)^2}{2\Gamma \operatorname{Var}_t(\tilde{r}_t)} \tag{17}$$

Model: Foreign investors

- **Expectation**: default risk, currency risk, compensation for these risks:

$$E_t(\tilde{r}_t) = \overbrace{\ln(\psi)\Delta_{t+1} - \ln(\Delta_{t+1}\psi_D + (1-\Delta_{t+1}))}^{\text{Default risk}} + \underbrace{(1-\rho_s)\ln S_t - \phi_s E_t(x_{t+1})}_{\text{Currency risk}} + \underbrace{\mathbb{E}_t(R_{k,t+1} - 1) - r^*}_{\text{Compensation for risk}} \tag{18}$$

  where $\Delta_{t+1} = Pr(D_{t+1} = 1)$

- **Variance**: uncertainty related to currency and default risk:

$$\mathrm{Var}_t(\tilde{r}_t) = \overbrace{\sigma_s^2(1 + \eta E_t(x_{t+1})) + \phi_s^2 E_t(x_{t+1})(1 - E_t(x_{t+1}))}^{\text{Uncertainty related with currency risk}} + \underbrace{(\ln(\psi))^2 \Delta_{t+1}(1-\Delta_{t+1})}_{\text{Uncertainty related with default risk}} \tag{19}$$

Model: Foreign investors

All else equal, foreign investors hold more local currency bond when:

1. default probability Δ_{t+1} is low.
2. compensation rate for holding defaulted debt ψ is high.
3. less likely to be high risk periods, low $E_t(x_{t+1})$.
4. the expected return of banks' capital investment $E_t(R_{k,t+1})$ is high.

Model Mechanism : Incentives to issue debt in period 1

- Rewriting the government expenditure with (B,f),
  where $f = \frac{b^*}{B}$: share of government debt held by foreign investors

$$
\begin{aligned}
G_1 &= q_1 B_2 - B_1 + \tau w_1 n_1 \\
G_2 &= \tau w_2 n_2 - (1 - D) B_2 - D(B_2 f_2 \psi + B_2 (1 - f_2) \psi_d) + W_2
\end{aligned}
\tag{20}
$$

- The F.O.C with respect to the debt issuance in period 1, (B_2)

$$
\begin{aligned}
&\overbrace{\left[q_1 + \frac{\partial q_1}{\partial B_2} B_2\right]}^{\text{revenue effect}} U'(G_1) + \beta_g \mathbb{E}_1 [U'(G_2) \overbrace{\left(\frac{\partial TR_2}{\partial B_2}\right)}^{\text{crowding-out}}] \\
&= \beta_g \underbrace{\mathbb{E}_1 \left[U'(G_2) \mid D = 0\right]}_{\text{mg. cost in repayment states}} + \beta_g \underbrace{\mathbb{E}_1 \left[U'(G_2) \left(\psi_d - (\psi_d - \psi) \left(f_2 + B_2 \frac{\partial f_2}{\partial B_2}\right)\right) \mid D = 1\right]}_{\text{mg. cost in default states}}
\end{aligned}
\tag{21}
$$

Model mechanism: Incentives to issue debt in period 1

- Revenue effect relative to crowding-out effect

- When the banks' collateral constraint binds, the government's debt issuance crowds out banks' capital investment. (collateral constraint)

$$-\frac{\partial k_2}{\partial B_2} = \frac{\partial(q_1 B_2(1-f_2))}{\partial B_2} = q_1(1-f_2)\left[1 + \frac{B_2}{q_1}\frac{\partial q_1}{\partial B_2} + \frac{B_2}{(1-f_2)}\frac{\partial(1-f_2)}{\partial B_2}\right] \tag{22}$$

- Impacts of debt issuance (B_2) on capital (k_2) via foreign holdings (f_2):
  - $f_2 = \frac{b_2^*}{B_2} \Downarrow \rightarrow k_2 \Downarrow$
  - Expected return on capital, $E(R_{k_2}) \Uparrow \rightarrow f_2 \Uparrow \rightarrow k_2 \Uparrow$
  - Default risk, $\Delta \Uparrow \rightarrow f_2 \Downarrow \rightarrow k_2 \Downarrow$

Model mechanism : Default risk conditional on global states

Realization of “high risk" changes default risk (Δ) dependent on (B_2, f_2, k_2, Λ_1): “high risk": ($x_1 = 1$)

1. foreign holding (f_2) $\Downarrow \rightarrow \Delta \Downarrow$
   - More likely to be "high risk" in next period ($\because \pi_{11} > \pi_{01}$)
     $\rightarrow$ expected loss from currency depreciation $\uparrow$
2. capital (k_2) $\Downarrow \rightarrow \Delta \Uparrow$: crowding-out effect $\Uparrow$
   - Government rely more on banks for debt issuance ($\frac{B_2}{(1-f_2)} \frac{\partial(1-f_2)}{\partial B_2} \Uparrow$)
3. crowding-out effect $\Uparrow \rightarrow$ less incentive to issue debt, $B_2 \Downarrow \rightarrow \Delta \Downarrow$

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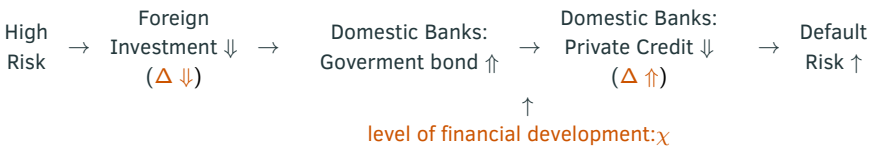


Parameterization

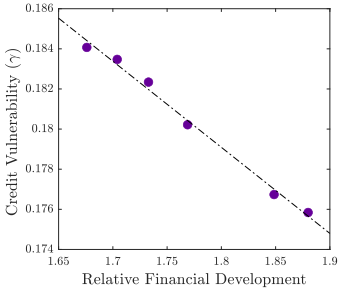
- The first subset of parameter values:
  - Pinned down from the data and the literature with some values assigned.
- The second set of parameters $\{\chi, \Gamma, \lambda_d, \overline{g}\}$:
  - Chosen to match four key moments of sample EMEs. (Parameters)

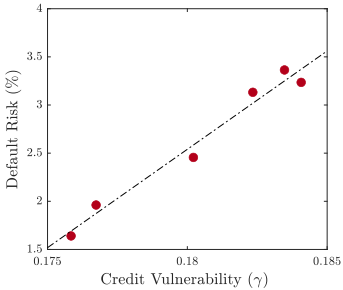
Model Fit

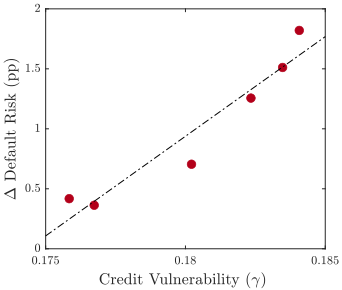
	Data	Model
mean (LC debt/y, %)	29.0	29.1
mean (foreign holding, %)	20.8	20.8
mean (default risk, %)	1.1	3.1
mean (increase in default risk, %p)	1.3	1.3

Financial development and vulnerability to global shocks

- Vary the value of χ and compare the selected moments of the economy
  - χ: the level of financial development







- Consistent with data : Financial development with default risk & external vulnerability

Conclusion

- Study “original sin redux” focusing on the role of domestic financial sector.
  - EMEs externally vulnerable even with significant share of LC external debt.
- Document empirical patterns based on cross-country difference:
  - Level of financial development $\Rightarrow$ Degree of external vulnerability
- Present a model that can account for the empirical feature on relationship:
  - Capability to provide private credits during periods of capital outflows
  - Default risk
  - External vulnerability

THANK YOU!

Credit Channel Vulnerability: List of Explanatory Variables

$$\Delta\text{Private Credit}_t = \gamma\Delta\text{Foreign Holding}_t + \beta_l X_{t-1} + \beta_g \text{Global}_t + \epsilon_t$$

- ΔPrivate Credit$_t$: banks private credit growth rate - total claim growth rate
- ΔForeignholding$_t$: changes in the foreign holdings of LC bond
- X_t: local factor
  change in nominal exchange rate, change in exchange rate volatility, debt to GDP,
  banks government claims as the share of total claim, inflation rate, real growth rate
- Global$_t$: global factor
  VIX, BBB-Treasury spread, 10-Year Treasury yield, TED spread, US Federal Funds Rate

(Back to main)

Credit Channel Vulnerability: Estimates of γ

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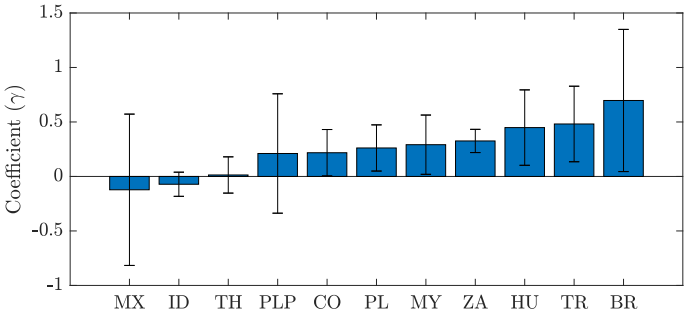

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Model: Workers in Household

The lifetime utility of workers in households is

$$\max_{[c_{t=0,1,2}, l_{t=1,2}, a_{t=1,2}]} c_0 + \mathbb{E}_0 \left[\sum_{t=1}^{t=2} \beta^t \left(c_t - \frac{l_t^{1+\frac{1}{\zeta}}}{1+\frac{1}{\zeta}} \right) \right] \tag{23}$$

$$\begin{aligned} \text{s.t.} \quad & c_0 + q_0^a a_1 = \overline{n}_0^h \\ & c_1 + q_1^a a_2 = (1-\tau) w_1 l_1 + a_1 + \lambda(N_1 - \overline{N}) \\ & c_2 = (1-\tau) w_2 l_2 + a_2 + N_2. \end{aligned} \tag{24}$$

In equilibrium,

- $q_t^a = \beta$
- $(1-\tau) w_t = l_t^{\frac{1}{\zeta}}$

(Back to main)

Model: Bankers problem in period 1

The value of bankers in period 1

$$V_1^B(N_1) = \max_{[a_2, k_2, b_2]} \beta \mathbb{E}_1 [N_2] \tag{25}$$

s.t

$$N_2 = \underbrace{(r_{k,2} + (1-\delta))}_{R_{k,2}} k_2 + b_2(1 - D_2) + b_2 \psi_d D_2 - a_2. \tag{26}$$

$$k_2 + q_1 b_2 \leq N_1 + q_1^a a_2 \tag{27}$$

$$a_2 \leq \chi N_1 \tag{28}$$

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Model: Bankers problem in period 0

The value of bankers in period 0

$$V_0^B(N_0) = \max_{[a_1,k_1,b_1]} \beta \mathbb{E}_0 \left[\lambda N_1 + (1-\lambda) V_1^B(N_1) \right] \tag{29}$$

s.t

$$N_1 = R_{k,1} k_1 + b_1 - a_1. \tag{30}$$

$$k_1 + q_0 b_1 \leq N_0 + q_0^a a_1 \tag{31}$$

$$a_1 \leq \chi N_0 \tag{32}$$

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Parameters	Description	Value
Parameters from the data		
ρ_z, σ_z	Process of TFP	0.93, 0.025
ρ_s, σ_s	Process of nominal exchange rate	0.95, 0.06
π_{01}, π_{10}	Transition probability	0.045, 0.78
Parameters assigned		
σ	Risk aversion	2.0
α, δ	Capital share, depreciation rate	0.33, 0.1
ζ	Frisch elasticity	0.33
β, β_g	Private, government discount rate	0.96, 0.92
r^*	Risk free rate	0.005
τ	Tax rate on labor income	0.28
W_2	Government endowment in t=2	0.42
ϕ_z	Productivity decline	0.03
ϕ_s	Nominal exchange rate increase	0.1
η	increase in std.dev of nominal exchange rate shocks	0.1
λ_0, λ_1	Productivity in default	-0.17, 0.21
ψ_D, ψ	Compensation rate for domestic banks and foreign investors	0.1, 0.05
σ_D	Enforcement shock	0.01
Parameters from moment matching		
χ	Leverage constraint	0.352
Γ	Preference parameter of foreign investors	5.85
λ_d	Disutility cost of default	1.247
$\overline{g}$	exogenous government spending	0.205