Macro-Financial Implications of the Surging Global Demand (and Supply) of International Reserves

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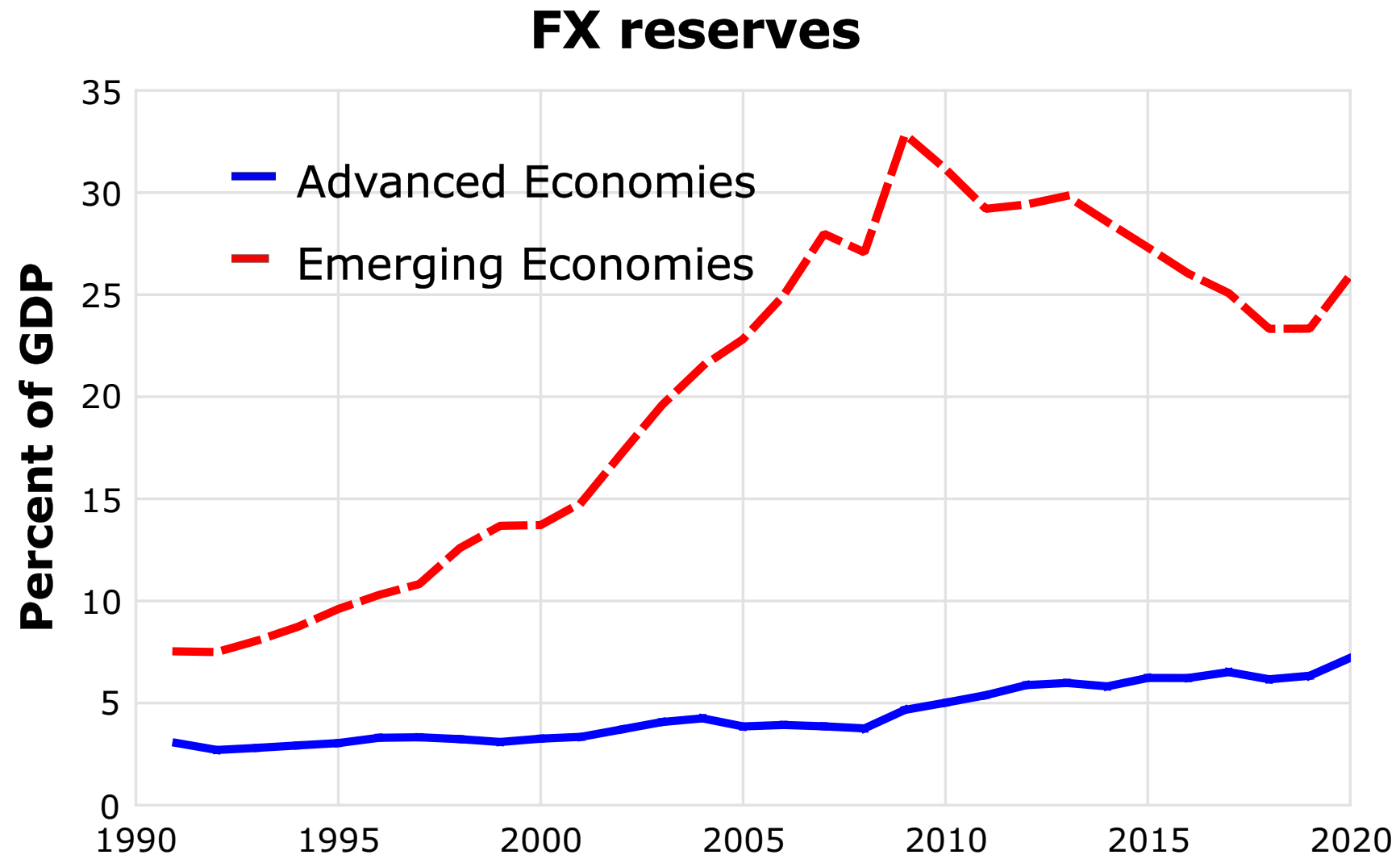*University of Pennsylvania*
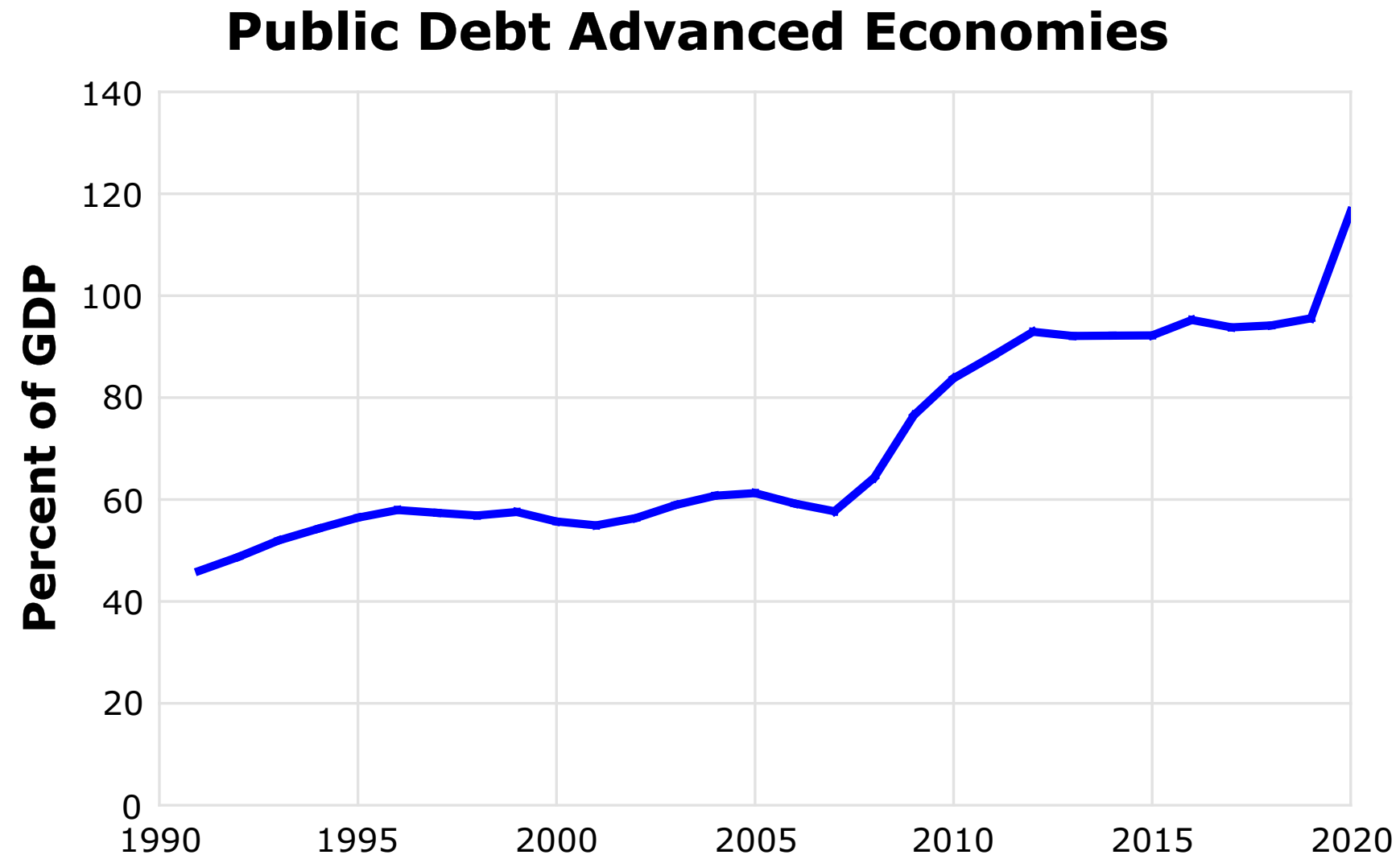*and NBER*

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FACT 1: Surge in EMEs' reserves since 1990s

FX reserves

FACT 2: Surge in AEs' public debt since 2008

Public Debt Advanced Economies

Questions

1. What are the implications for credit markets?

   - interest rates
   - private-sector credit
   - leverage
   - financial stability, etc.

2. What are the macroeconomic implications?

   - global imbalances
   - frequency and severity of crises (volatility)
   - international externalities
   - governments' ability to respond to crises
   - benefits of FX accumulation, etc.

Methodology & findings

We analyze a model in which private debt is **(a)** defaultable and **(b)** akin to inside money (has productive use or convenience yield), and find that:

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   • Lower world interest rate.
   • Higher private leverage.
   • Higher macroeconomic volatility in both AEs and EMEs (reserves externality).

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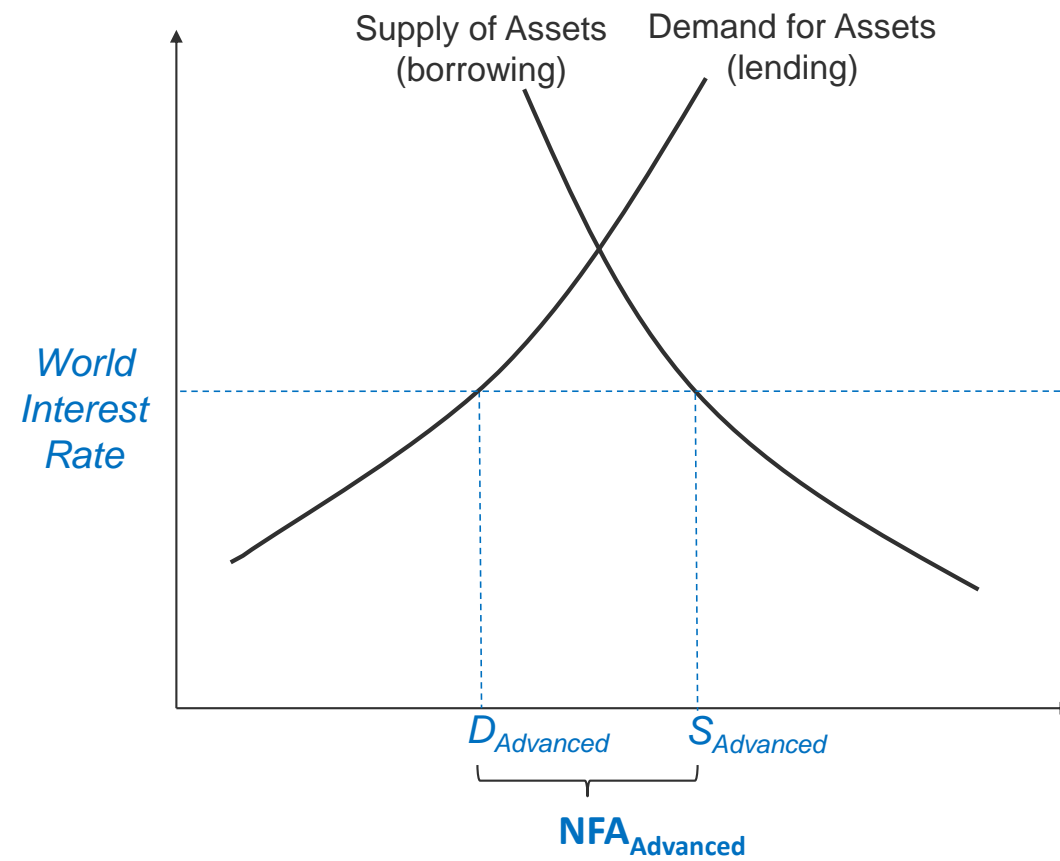   - Higher macroeconomic volatility in both AEs and EMEs (reserves externality).

2. Surge in **AEs public debt** causes:

   - Higher world interest rate.
   - Lower private leverage.
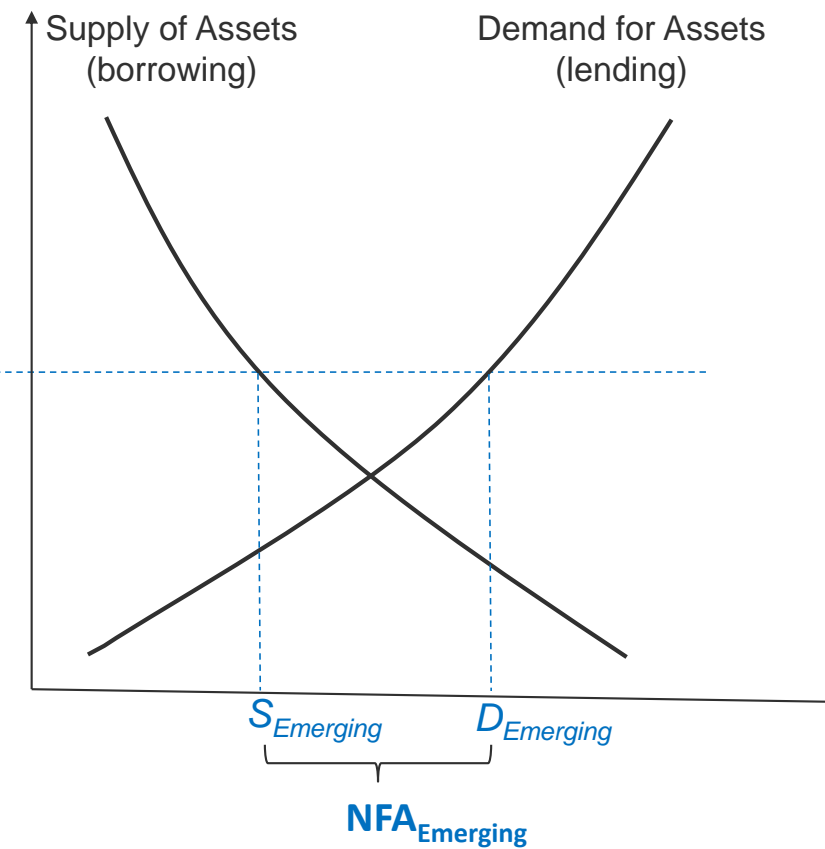   - Lower macroeconomic volatility in both AEs and EMEs (debt externality).

A TWO-REGION MELTZER DIAGRAM INTUITION

Global asset market equilibrium

Advanced Economies

Supply of Assets (borrowing)

Demand for Assets (lending)

World Interest Rate

$D_{Advanced}$ $S_{Advanced}$

NFA$_{Advanced}$

Emerging Economies

Supply of Assets (borrowing)

Demand for Assets (lending)

$S_{Emerging}$ $D_{Emerging}$

NFA$_{Emerging}$

Effects of higher FX in EMEs: NFA & interest rate

Advanced Economies

Supply of Assets (borrowing)   Demand for Assets (lending)

World Interest Rate

$D_{Advanced}$ $S_{Advanced}$

NFA$_{Advanced}$

Emerging Economies

Supply of Assets (borrowing)   Demand for Assets (lending)
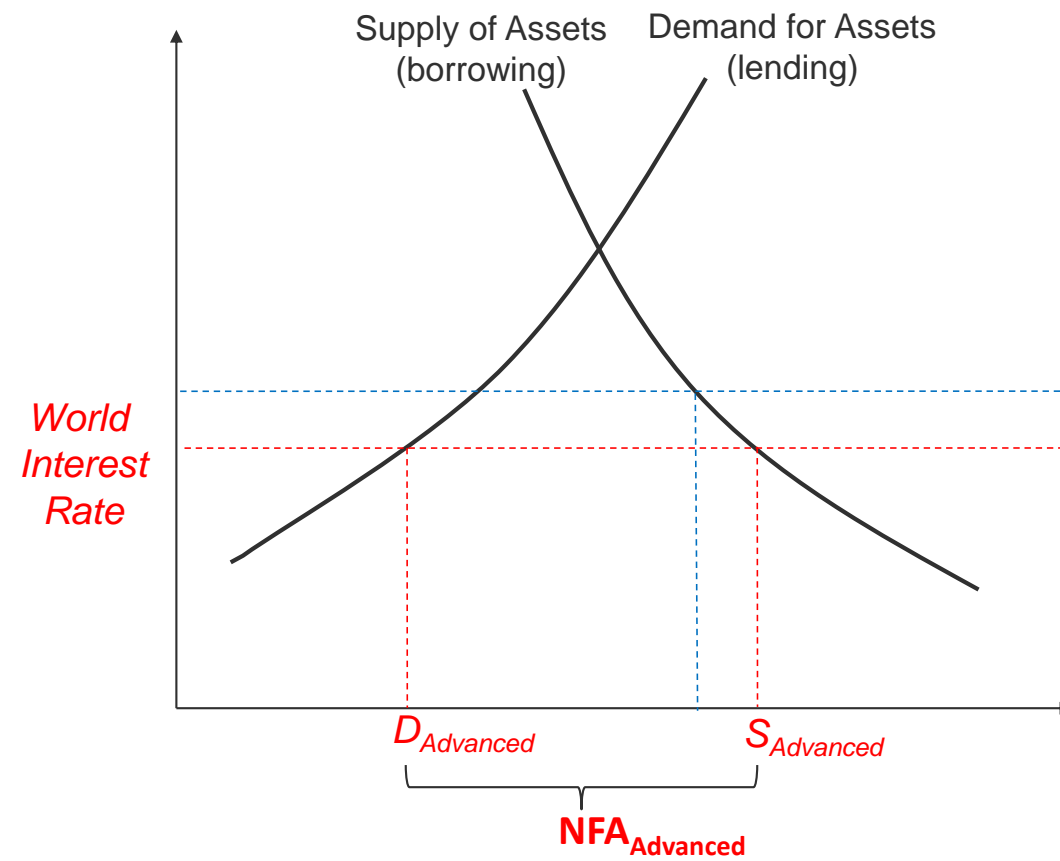
$S_{Emerging}$ $D_{Emerging}$

NFA$_{Emerging}$
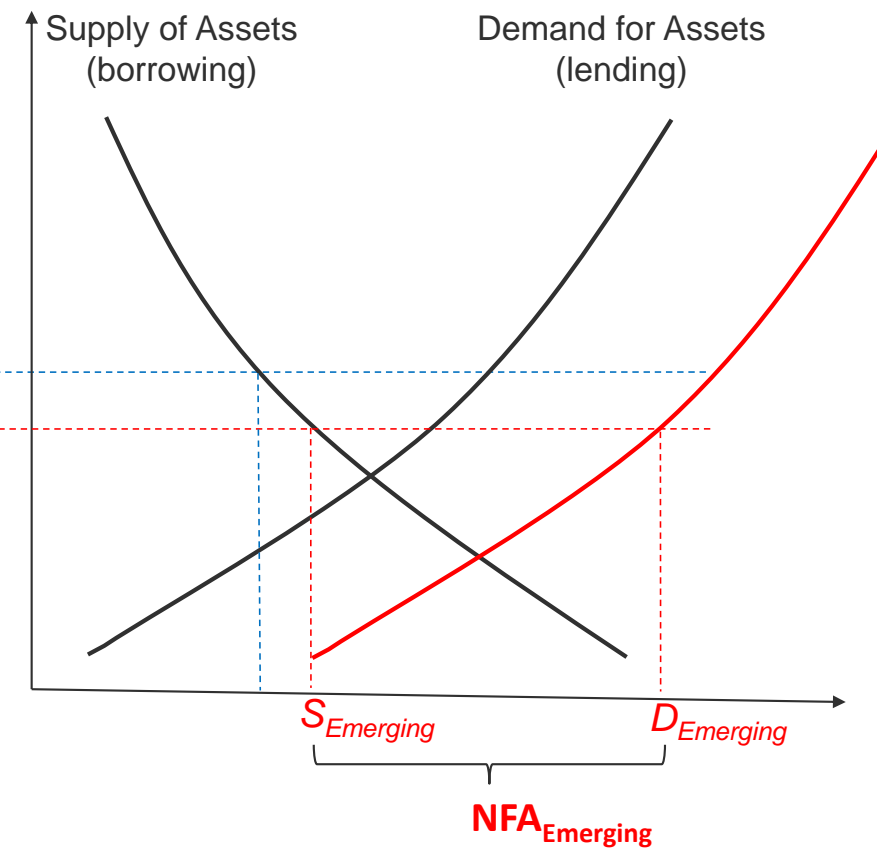
Effects of higher FX in EMEs: Private-sector leverage

Advanced Economies

Supply of Assets (borrowing)   Demand for Assets (lending)

World Interest Rate

Advanced economies issue more debt

$D_{Advanced}$ $S_{Advanced}$

NFA$_{Advanced}$

Emerging Economies

Supply of Assets (borrowing)   Demand for Assets (lending)

Emerging economies issue more debt

$S_{Emerging}$ $D_{Emerging}$
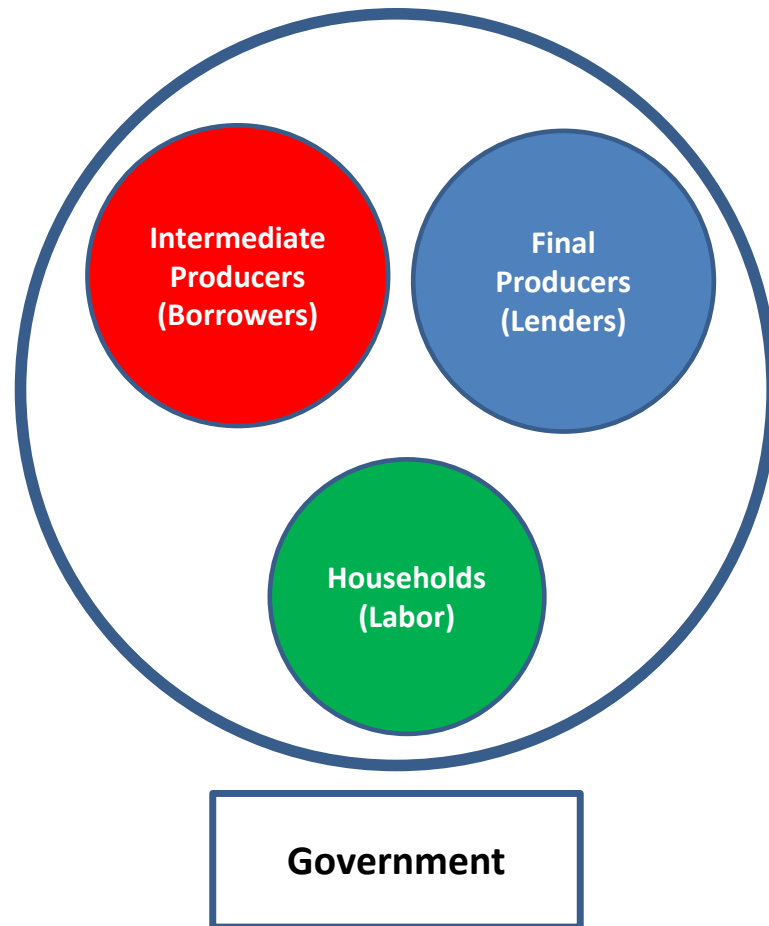
NFA$_{Emerging}$
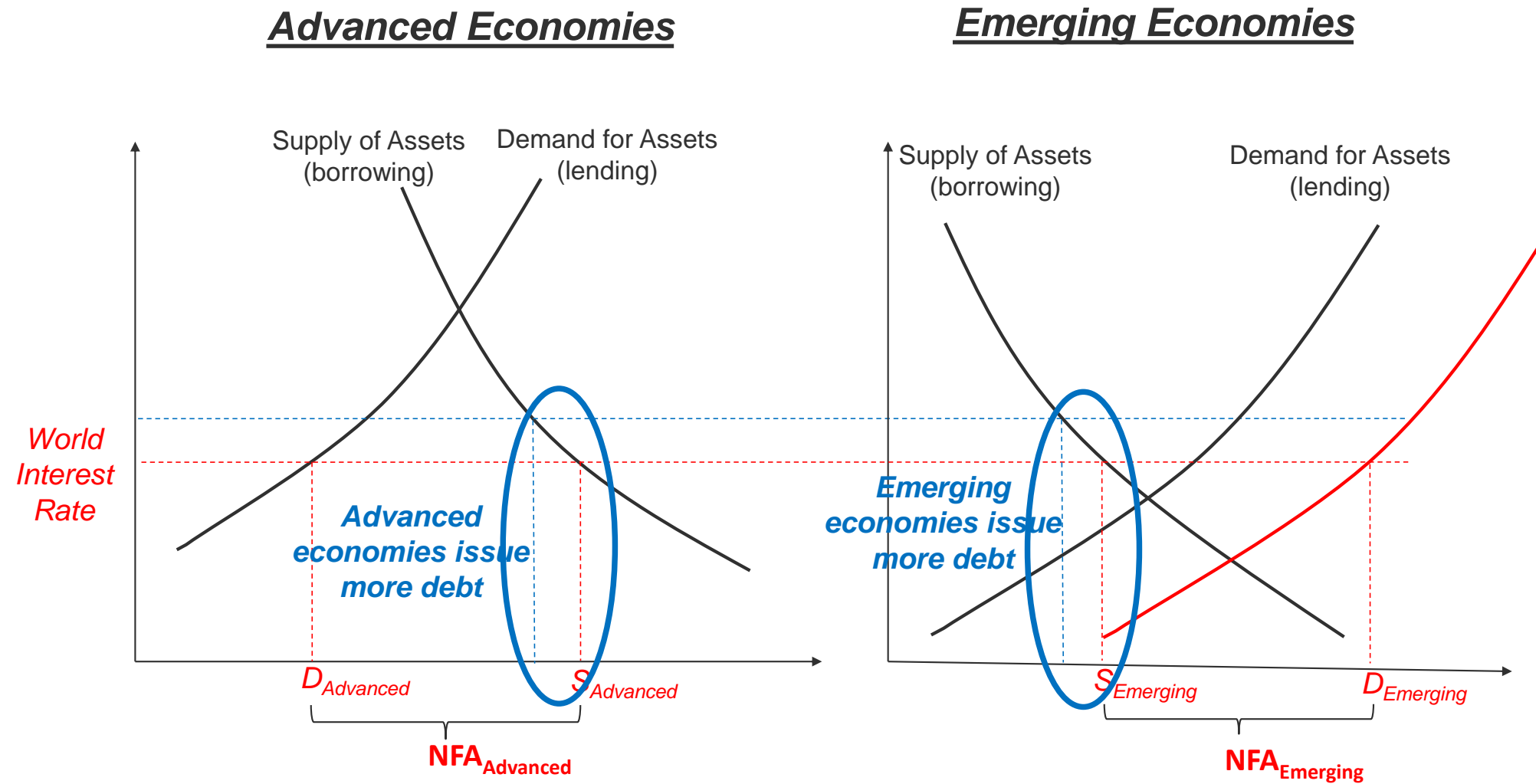
Why does higher leverage increase output volatility?

- Borrowers default when debt exceeds liquidation value of capital (high leverage)

- Liquidation price is stochastic (self-fulfilling equilibrium)

- Higher leverage thus makes private default larger and more likely

- Larger default causes larger redistribution from lenders to borrowers

- Because debt has a productive use for lenders, larger redistribution causes deeper recessions.

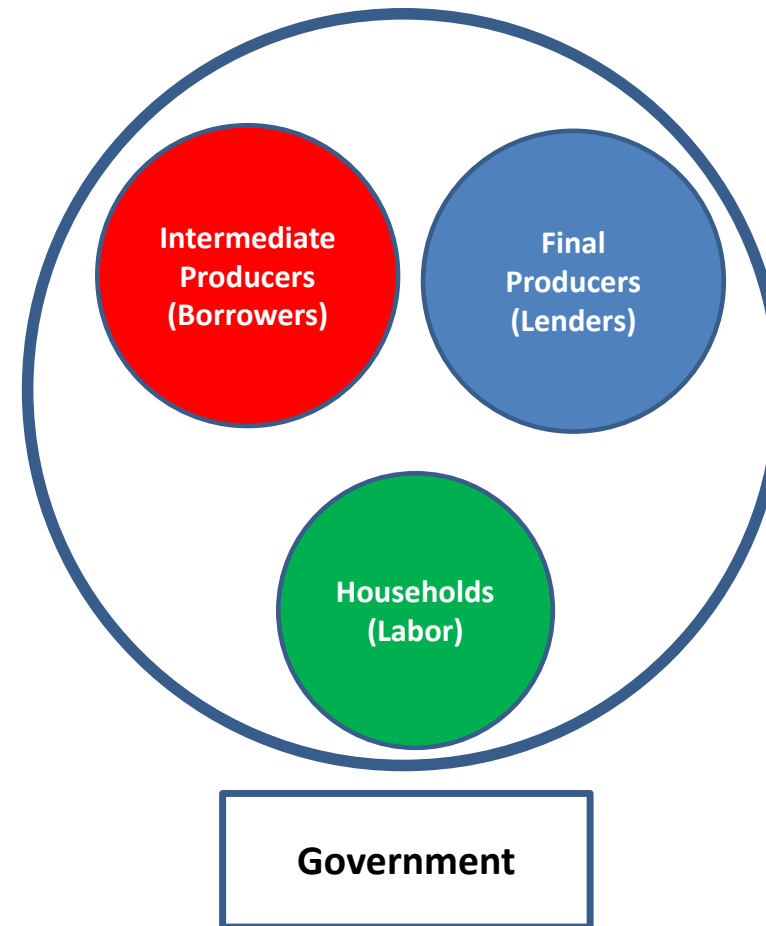- International spillovers occur because of cross-border debt holdings
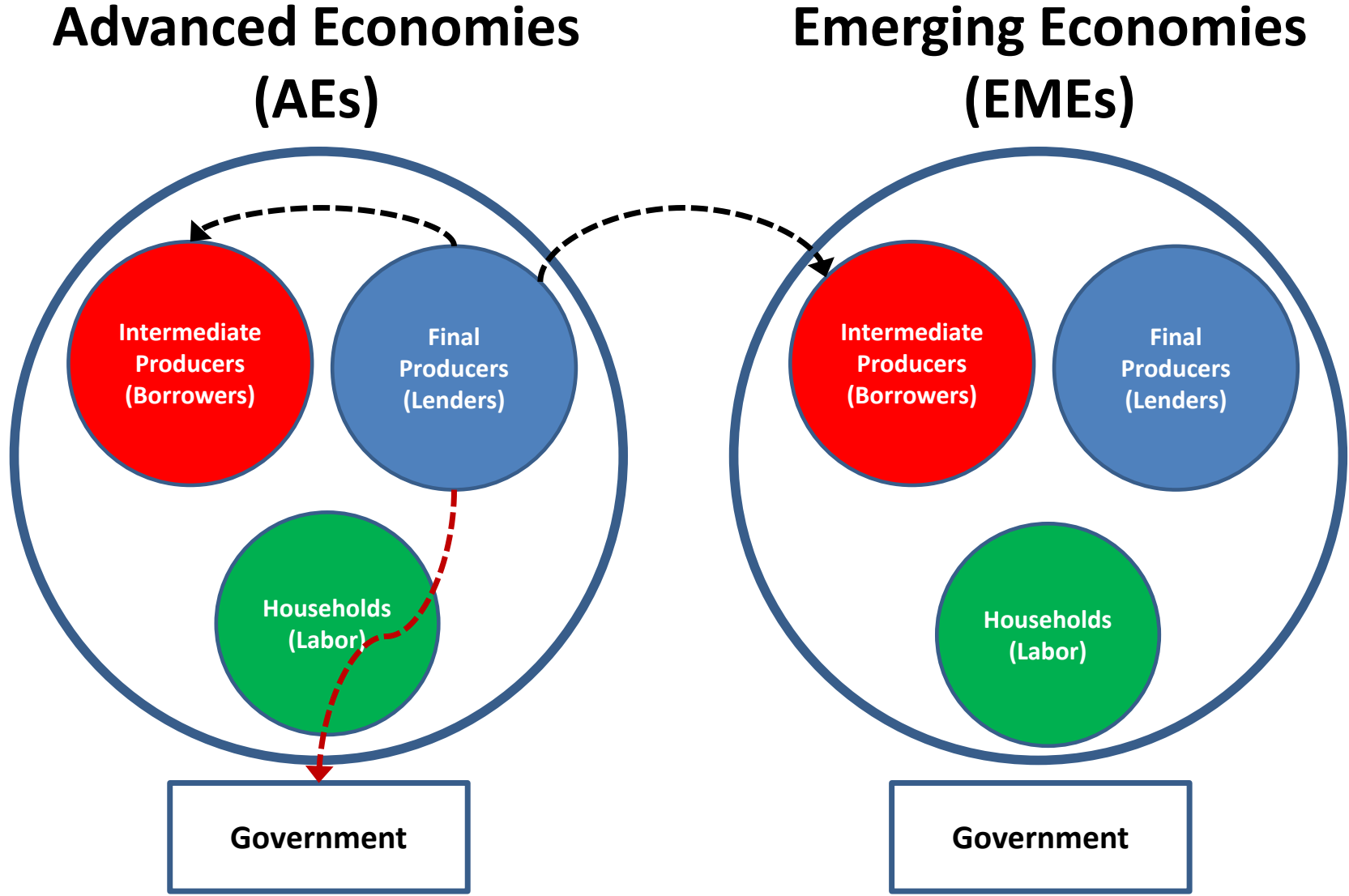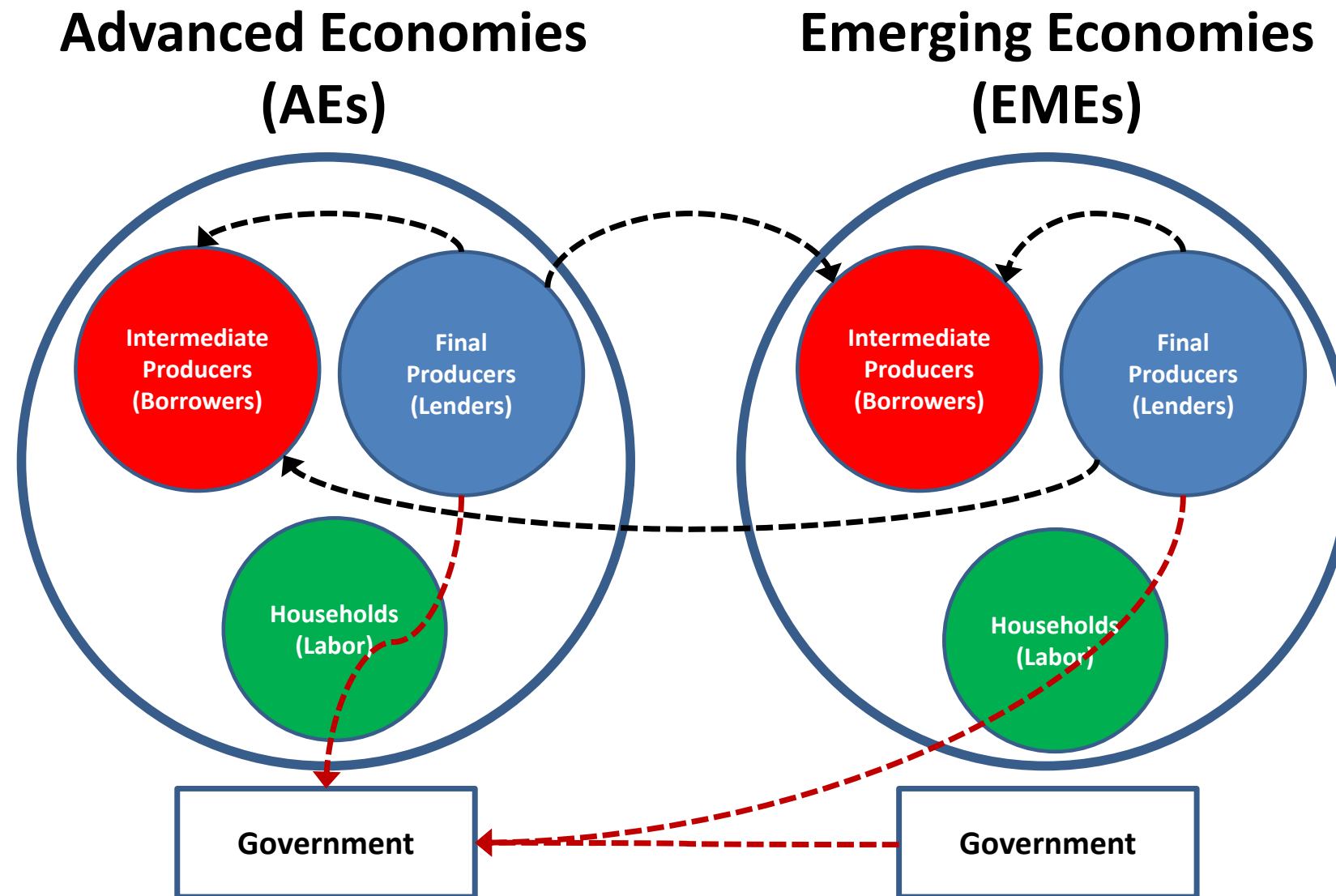
MODEL DESIGN

Two-region world economy

Financial asset purchases from AEs lenders

Financial asset purchases from EMEs lenders

Intermediate goods producers
(Net borrowers)

Technology & profits

- Continuum of firms produce intermediate goods with C-D technology

$$x_t = l_t^\gamma k_t^{1-\gamma}$$

l_t = Labor

k_t = Capital (grows exogenusly, depreciates at rate τ)

- Operating profits

$$p_t x_t - w_t l_t$$

p_t = Price of intermediate goods

w_t = Wage rate

Default, leverage & crises

- Borrow $q_{t-1}d_t$ at $t-1$ promising to repay d_t at t, but actual repayment is $\delta_t d_t$.

- Default and renegotiation occur when debt exceeds liquidation value of capital: $d_t > \ell_t k_t$

- Liquidation price is stochastic (model's only shock):

$$
\ell_t = \begin{cases} 1 & \text{with prob. } 1-\lambda \\\\ \kappa < 1 & \text{with prob. } \lambda \end{cases}
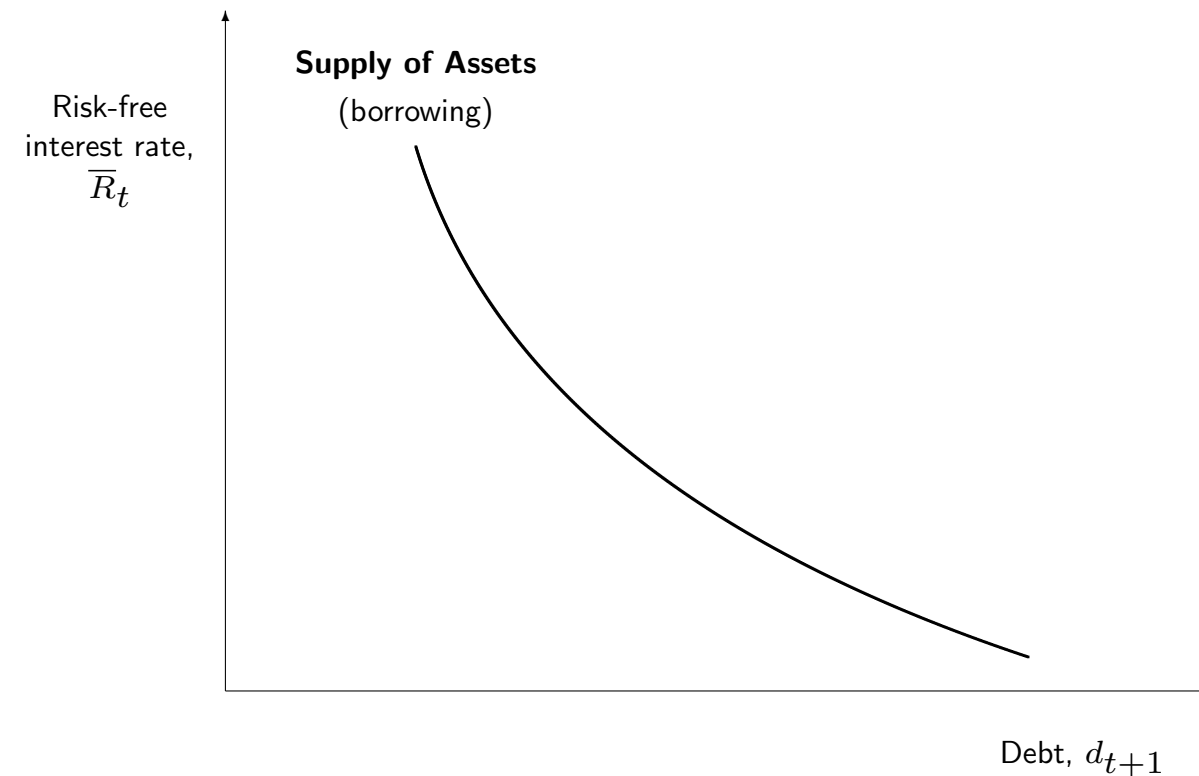$$

  − κ is a country-specific parameter (debt supply shifter).

- A financial crisis occurs when $d_t > \ell_t k_t$ **and** $\ell_t = \kappa$

Convex borrowing cost & supply of assets

$$\varphi\left(d_{t+1}, \textcolor{red}{\kappa}k_{t+1}\right) = \eta \left[\frac{\max\{\,0\,,\,d_{t+1}-\textcolor{red}{\kappa}k_{t+1}\,\}}{d_{t+1}}\right]^2 d_{t+1},$$

$$\overline{R}_t^{\,-1} = \beta + \Phi\left(\frac{d_{t+1}}{\textcolor{red}{\kappa}k_{t+1}}\right), \qquad\qquad \text{with } \Phi'(\cdot) \geq 0$$

Supply of Assets
(borrowing)

Risk-free
interest rate,
$\overline{R}_t$

Debt, d_{t+1}

Final goods producers (entrepreneurs) (Net lenders)

Utility, technology & working capital

- Expected log utility: $\quad E_0 \sum_{t=0}^{\infty} \beta^t \ln(c_t^e)$

- Linear production function: $\quad y_t = z x_t$

  $x_t =$ inputs purchased at price p_t
  $z =$ country-specific productivity

- Profits: $\quad \pi_t = z x_t - p_t x_t$

- Working capital constraint (wkc): $\quad m_t \geq \phi p_t x_t \quad$ (w. multiplier $\hat{\xi}_t$)

  $m_t =$ financial wealth (post-default)
  $\phi =$ country-specific wk parameter (debt demand shifter)

Entrepreneurs' wealth & convenience yield

- Composition of post-default financial wealth:

$$m_t = \delta_{1,t} b_{1,t} + \delta_{2,t} b_{2,t} + b_{p,t},$$

$b_{p,t}$ = holdings of AEs govt. bonds chosen at $t-1$
$b_{i,t}$ = holdings of private bonds issued by region i chosen at $t-1$
$\delta_{i,t}$ = fraction repaid by borrowers in region i at t

- Convenience yield: if $\hat{\xi}_t > 0$, reduced demand for x_t implies

$$p_t < z, \qquad \pi_t = \frac{1}{\phi}\left(\frac{z}{p_t} - 1\right) m_t > 0$$

  – Default redistributes wealth causing recession (larger drops in x_t and p_t)

Demand for assets & intermediate goods

$$z_t = (1 + \hat{\xi}_t \phi) p_t \implies x_t = m_t / \phi p_t \quad \text{if } \hat{\xi}_t > 0$$

$$c_t^e = (1 - \beta) a_t,$$

$$q_{1,t} b_{1,t+1} = \theta_{1,t} \beta a_t,$$

$$q_{2,t} b_{2,t+1} = \theta_{2,t} \beta a_t,$$

$$q_{p,t} b_{p,t+1} = (1 - \theta_{1,t} - \theta_{2,t}) \beta a_t.$$

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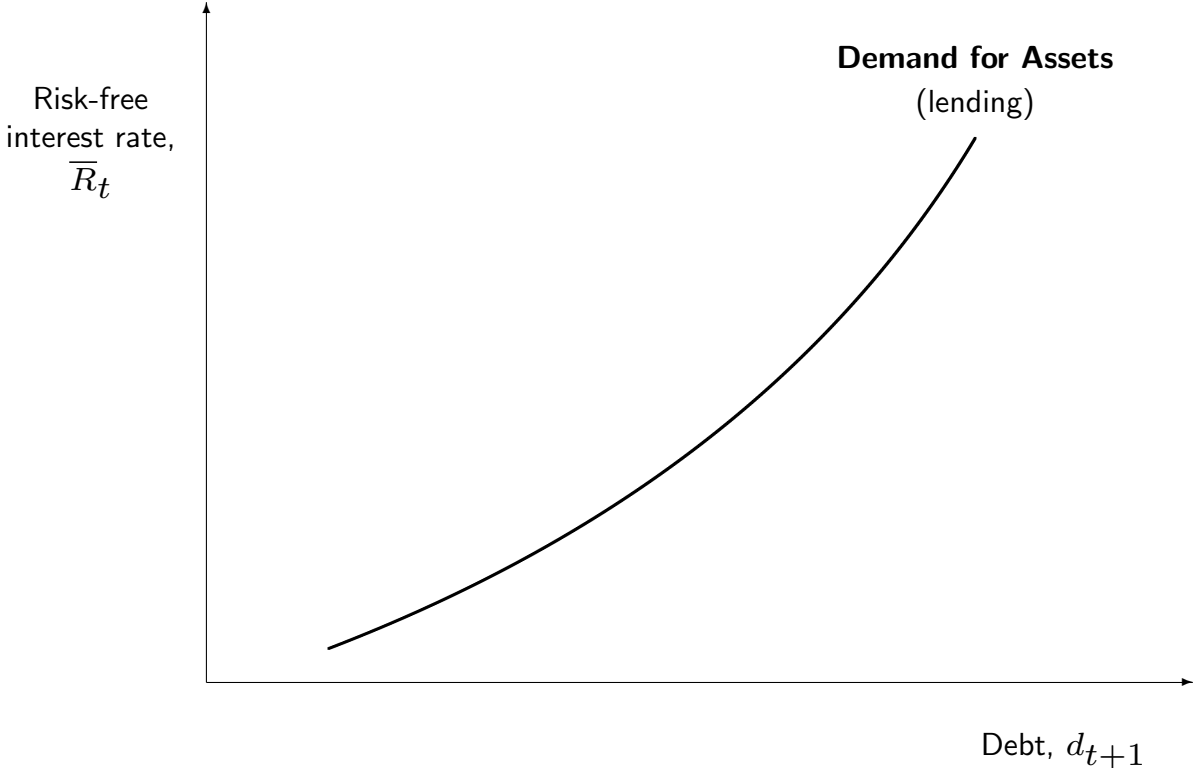$$q_{2,t} b_{2,t+1} = \theta_{2,t} \beta a_t,$$

$$q_{p,t} b_{p,t+1} = (1 - \theta_{1,t} - \theta_{2,t}) \beta a_t.$$

$\theta_{1,t}$ and $\theta_{2,t}$ same across countries, solve

$$\mathbb{E}_t \left\{ \frac{\frac{\delta_{1,t+1}}{q_{1,t}}}{\theta_{1,t} \frac{\delta_{1,t+1}}{q_{1,t}} + \theta_{2,t} \frac{\delta_{2,t+1}}{q_{2,t}} + (1 - \theta_{1,t} - \theta_{2,t}) \frac{1}{q_{p,t}}} \right\} = 1,$$

$$\mathbb{E}_t \left\{ \frac{\frac{\delta_{2,t+1}}{q_{2,t}}}{\theta_{1,t} \frac{\delta_{1,t+1}}{q_{1,t}} + \theta_{2,t} \frac{\delta_{2,t+1}}{q_{2,t}} + (1 - \theta_{1,t} - \theta_{2,t}) \frac{1}{q_{p,t}}} \right\} = 1.$$

Demand for Assets

Households & Government

Households

- Continuum of households with utility

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(c_t - z^{\frac{1}{\gamma}} \frac{h_t^{1+\frac{1}{\nu}}}{1+\frac{1}{\nu}} \right).$$

- Budget constraint

$$c_t = w_t h_t + \text{div}_t + T_t$$

$\text{div}_t = $ dividends from intermediate goods producers
$T_t = $ transfers/taxes from home government

- Labor supply condition

$$z^{\frac{1}{\gamma}} h_t^{\frac{1}{\nu}} = w_t$$

Government budget constraints

- Reserves ($FX_{i,t}$) and AE's public debt ($D_{p,t}$) are time-varying but exogenous, taxes ($T_{i,t}$) balance the budget

- Government budget constraints:

  – Advanced Economies:

$$FX_{1,t} + q_{p,t}D_{p,t+1} = q_{p,t}FX_{1,t+1} + D_{p,t} + T_{1,t}$$

  – Emerging Economies:

$$FX_{2,t} = q_{p,t}FX_{2,t+1} + T_{2,t}$$
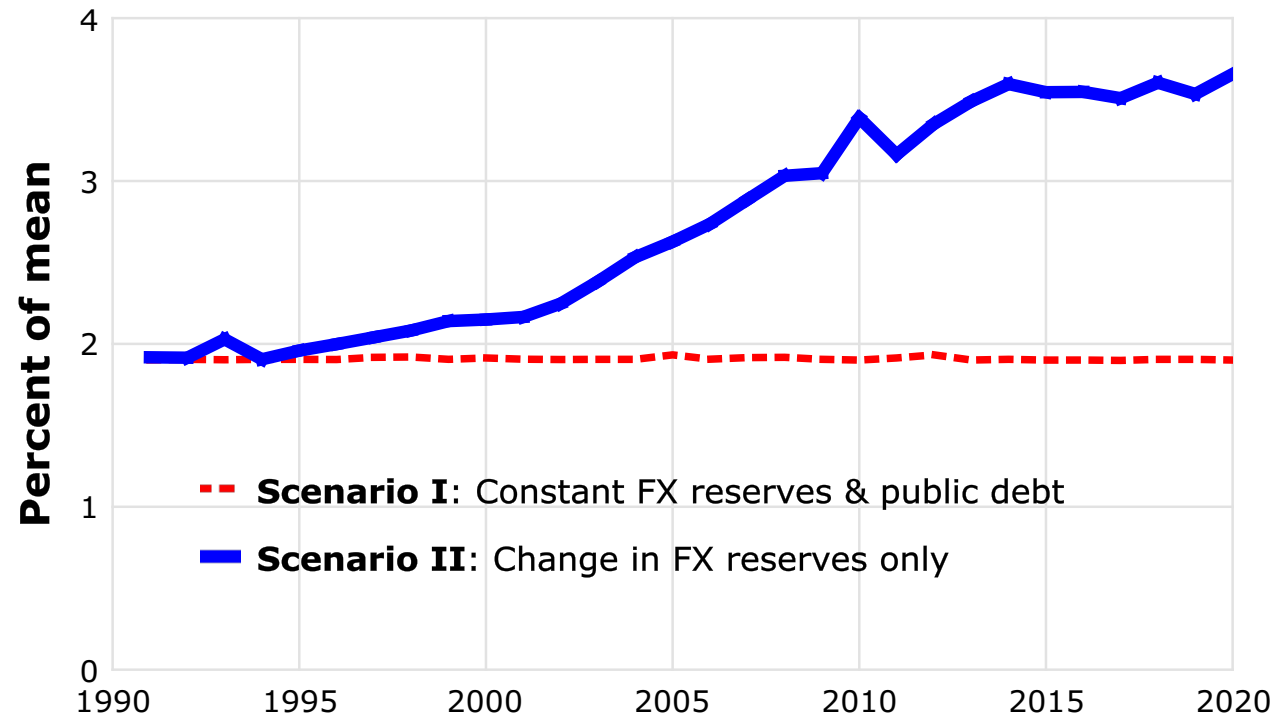
QUANTITATIVE ANALYSIS

Methodology

- **Goal**: Quantify effects of reserves on macro dynamics & output volatility (in the paper also public debt and both reserves and debt)

- **Counterfactual comparisons**:
  Scenario I: Detrended $FX_{i,t}$ and $D_{p,t}$ **constant** (at 1991 ratios to GDP).
  Scenario II: Detrended $FX_{i,t}$ take **observed** values & $D_{p,t}$ constant at 1991 GDP ratio

- **Simulations:** 10k 130-year simulations (random ℓ_t draws), last 30 years represent 1991-2020

- **Calibration:** Common parameters $(\beta, \gamma, \tau, \nu, \lambda, \eta, g)$ set to standard values or data averages; country-specific parameters (z_j, κ_j, ϕ_j) set so that simulated 1991 cross-sectional averages match 1991 data targets (GDP, private credit, NFA in AEs and U.S. real interest rate)

- **Output volatility:** Diff. between 95th and 5th percentile of each year's GDP in the cross section of 10k simulations (in percent of each cross-sectional mean)

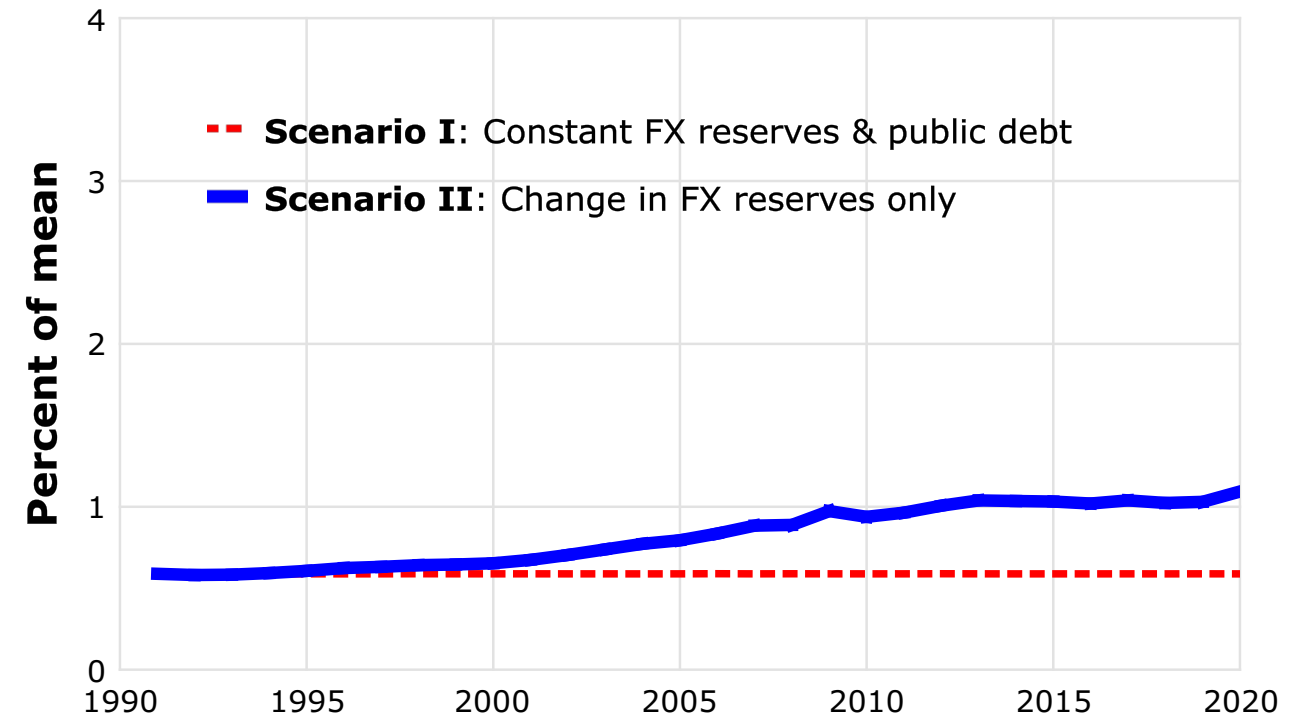# Counterfactual simulation: Effect of surge in reserves

(actual reserves v. reserves constant at 1991 GDP ratio, AE's debt constant)

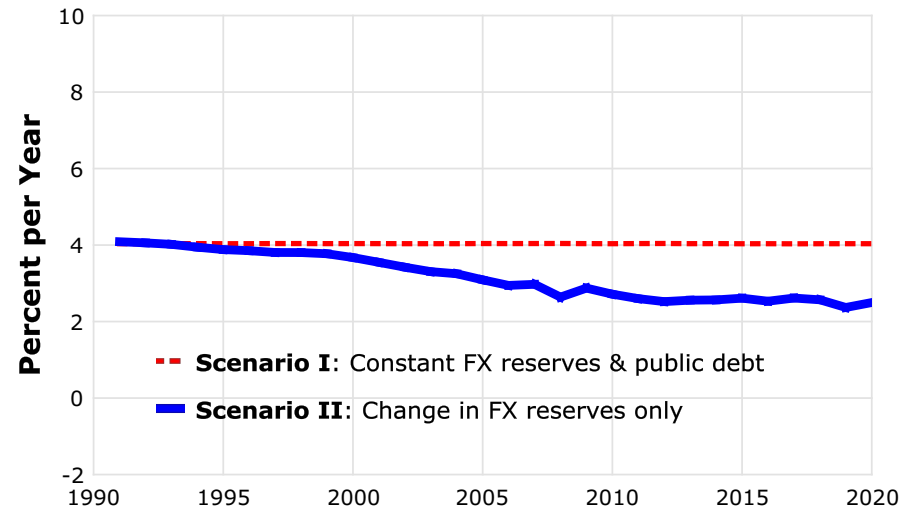# Surge in EMEs reserves increased volatility everywhere
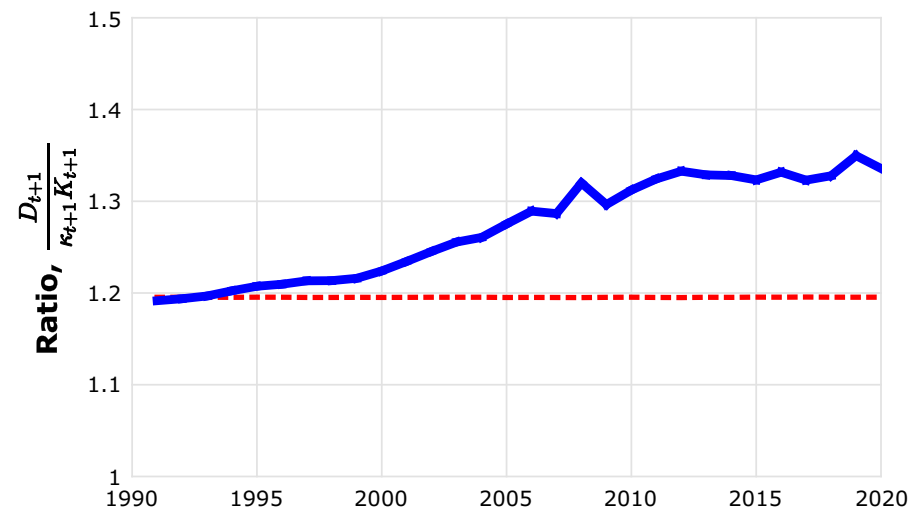
(a) Volatility AEs

(b) Volatility EMEs

Scenario I: Constant FX reserves & public debt

Scenario II: Change in FX reserves only

Why did the surge in EMEs reserves increase volatility?

(a) Real Interest Rate

Legend:
- **Scenario I**: Constant FX reserves & public debt
- **Scenario II**: Change in FX reserves only

Y-axis: Percent per Year
X-axis: 1990 to 2020

(b) Effective Leverage AEs

Y-axis: Ratio, $\frac{D_{t+1}}{\kappa_{t+1} K_{t+1}}$
X-axis: 1990 to 2020

(c) Effective Leverage EMEs

Y-axis: Ratio, $\frac{D_{t+1}}{\kappa_{t+1} K_{t+1}}$
X-axis: 1990 to 2020
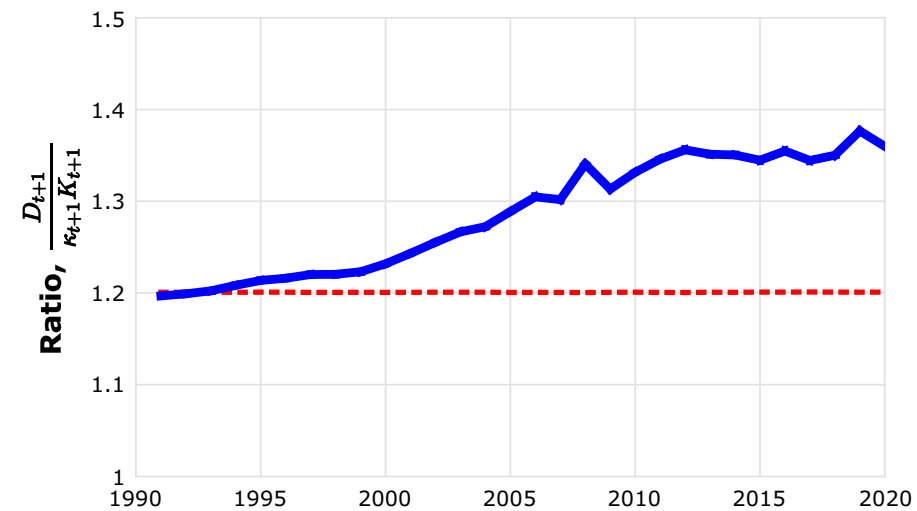
Welfare effects of surge in EMEs reserves

	AEs		EMEs	
	Hous.	*Entr.*	*Hous.*	*Entr.*
Impact FX Reserves	0.34	-1.82	-0.71	0.10
Actual Res.-Constant Debt v. Constant Res.-Constant Debt				

- **Advanced economies**:
  - *Households gain:* lower interest rate induces lower taxes to service public debt
  - *Entrepreneurs lose:* reduced bond income and higher volatility offset higher profits

- **Emerging economies**:
  - *Households lose:* FX akin to forced savings paid with taxes
  - *Entrepreneurs gain:* higher profits offset reduced bond income and higher volatility (lower m than in AEs).

EXTENSION
The stabilizing role of reserves

(why individual EMEs would like to accumulate reserves)

Using reserves to bailout entrepreneurs

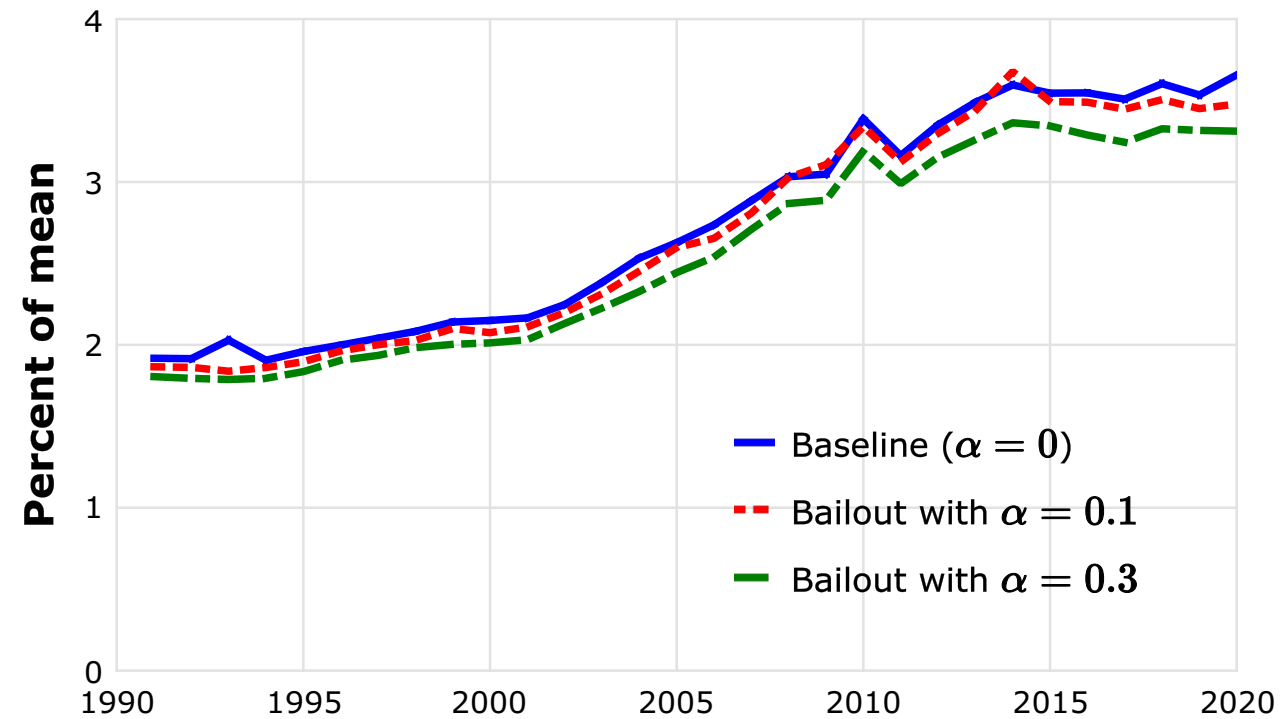- Entrepreneurs' losses in a financial crisis

$$Loss_{j,t} = (1 - \delta_{1,t})B_{1,j,t} + (1 - \delta_{2,t})B_{2,j,t}.$$

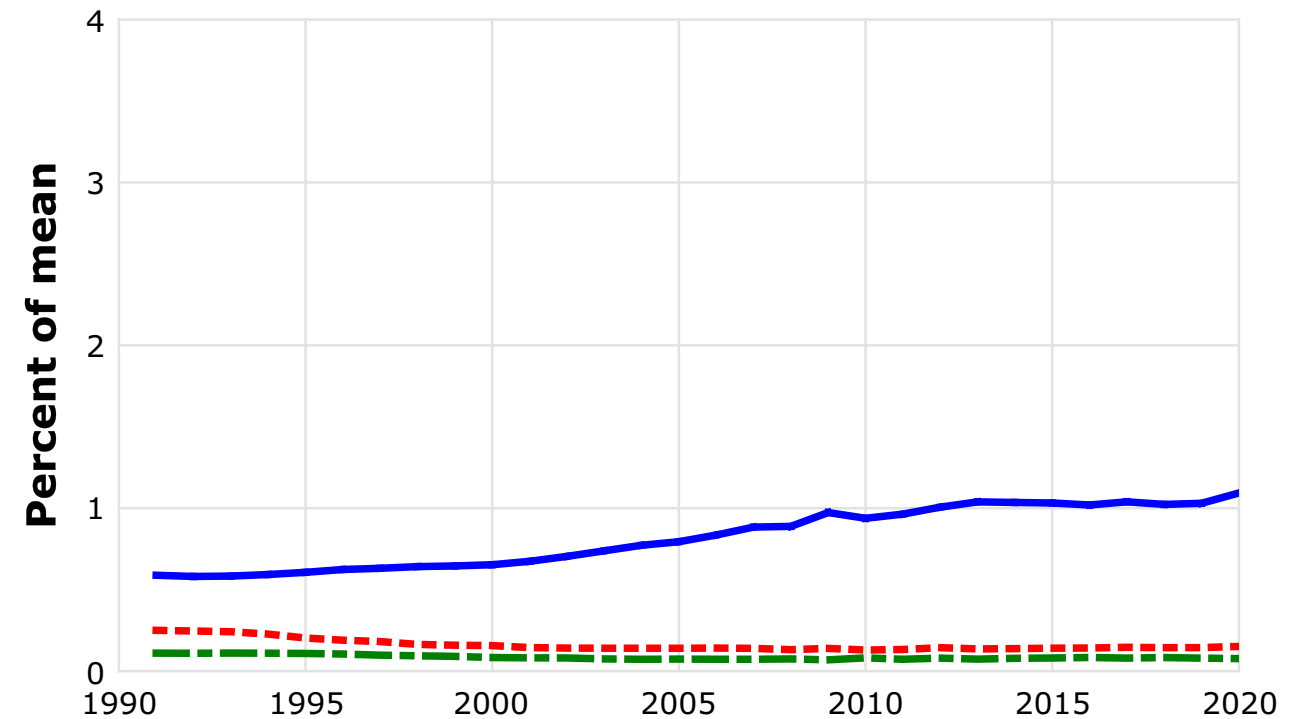- Reserves pay for transfers to entrepreneurs for a fraction of their losses

$$Bail_{j,t} = Loss_{j,t} \cdot \left[1 - e^{-\alpha\left(\frac{FX_{j,t}}{Loss_{j,t}}\right)}\right].$$

Using reserves for bailouts reduces output volatility

(a) Volatility AEs - Actual FX reserves

(b) Volatility EMEs - Actual FX reserves

Legend:
- Baseline ($\alpha = 0$)
- Bailout with $\alpha = 0.1$
- Bailout with $\alpha = 0.3$

CONCLUDING REMARKS

Concluding remarks: Surge in EMEs reserves

- **Reserves global externality**:

  – EMEs do not internalize that reserves reduce the world interest rate resulting in higher leverage and volatility (over-accumulation of reserves).

  – Similar to externality under currency mis-match (Das, Gopinath, Hall, Kim, Stein (23))

- **Is the surge in EMEs reserves desirable for the world economy?**

  – Reserves externality lowers interest rate and increases macro instability,

  – ...but also increases supply of assets (liquidity), improving efficiency in good times

  – Accordingly, welfare effects on households and entrepreneurs differ

  – Answer requires quantitative cost/benefit analysis.

- **Argument for global coordination of liquidity provision (CLAAF's EMF proposal)**

Concluding remarks: Surge in AEs Public Debt

- **AEs public debt global externality**:

  – AEs do not internalize that their public debt provides liquidity to EMEs and increases efficiency (under-issuance of public debt).
  – Higher liquidity also reduces leverage and instability
  – Similar to Azzimonti, de Francisco, Quadrini (14).

- **Is increase in AEs public debt desirable?**

  – Similar question and logic (in opposite direction) as for reserves
  – ...but not all AEs debt are equal in terms of liquidity (exorbitant privilege)
  – ...and debt sustainability and efficiency/distributional costs of taxation need to be considered (see D'Erasmo, Mendoza & Zhang (16))
  – Answer requires quantitative cost/benefit analysis.

Common parameters

Description	Parameter	Value	Target
Discount factor	β	0.930	std. value
Share of labor in production	γ	0.600	std. value
Depreciation rate	τ	0.080	std. value
Elasticity of labor supply	ν	1.000	std. value
Probability of crises ($\varepsilon_{j,t} = 0$)	λ	0.040	freq. of fin. crises
Borrowing cost	η	0.100	initial value
Long-run productivity growth	g	0.010	mean prod. growth AEs

In the long-run, productivity grows at rate g in both regions, and the implied long-run growth rate of capital and output is $(1+g)^{1/\gamma} - 1$.

Country-specific parameters

Model Parameters

Productivity $\qquad\qquad\qquad\qquad\qquad$ $z_1 = 0.474,\ z_2 = 0.205$

Working capital coeffs. $\qquad\qquad\qquad$ $\phi_1 = 1.658,\ \phi_2 = 0.543$

Crash liq. prices $\qquad\qquad\qquad\qquad$ $\kappa_1 = 0.422,\ \kappa_2 = 0.184$

Targeted 1991 Data Moments

Gross Domestic Product AEs & EMEs

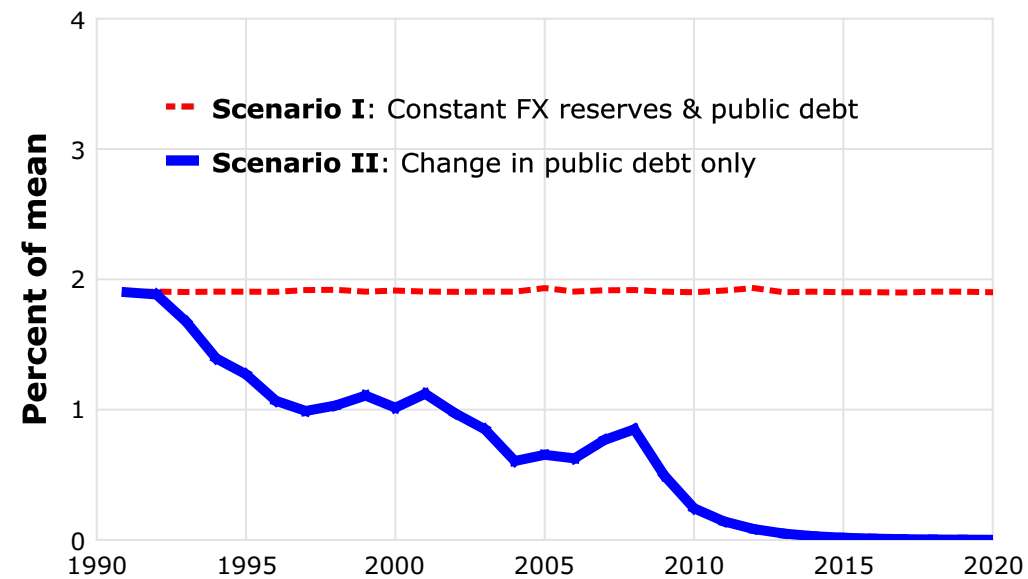Private Domestic Credit AEs & EMEs

Net Foreign Asset position AEs

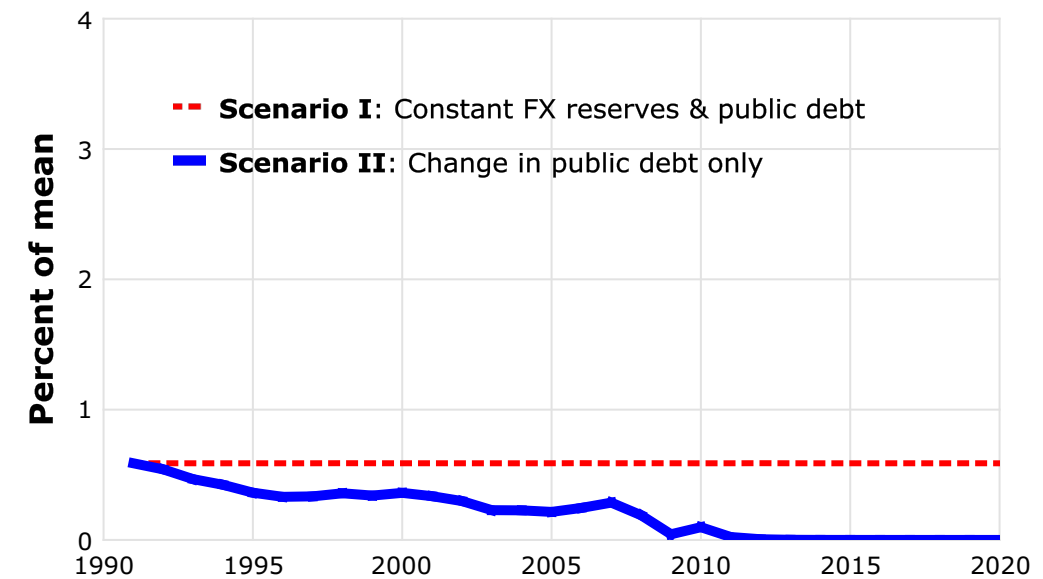US Real Interest Rate

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Counterfactual simulation
Public debt $D_{p,t}$ remains constant

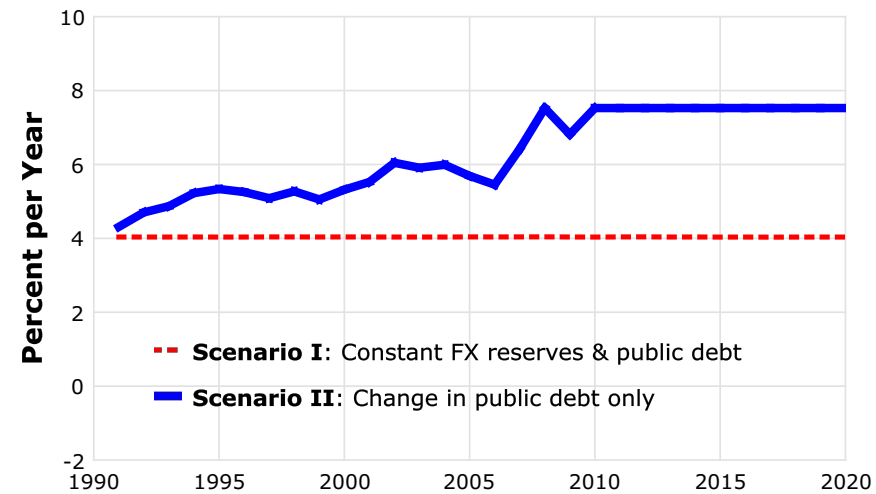# Public debt issuance by AEs reduced volatility
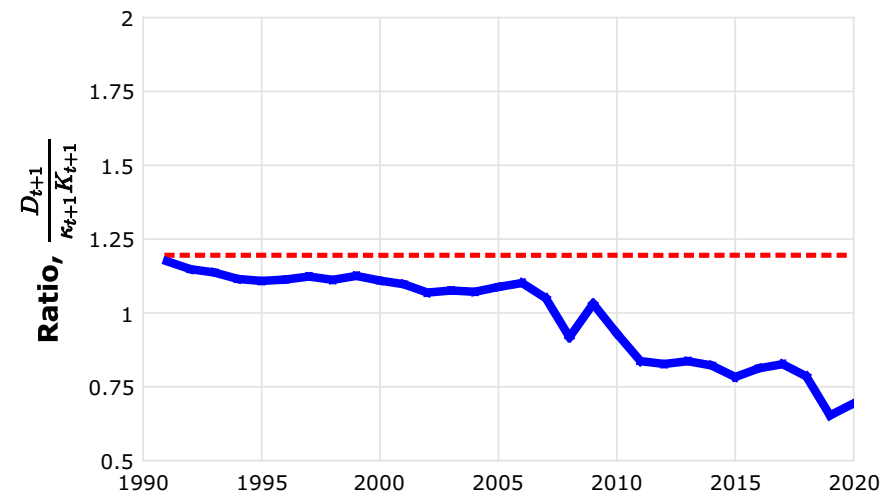
(c) Volatility AEs

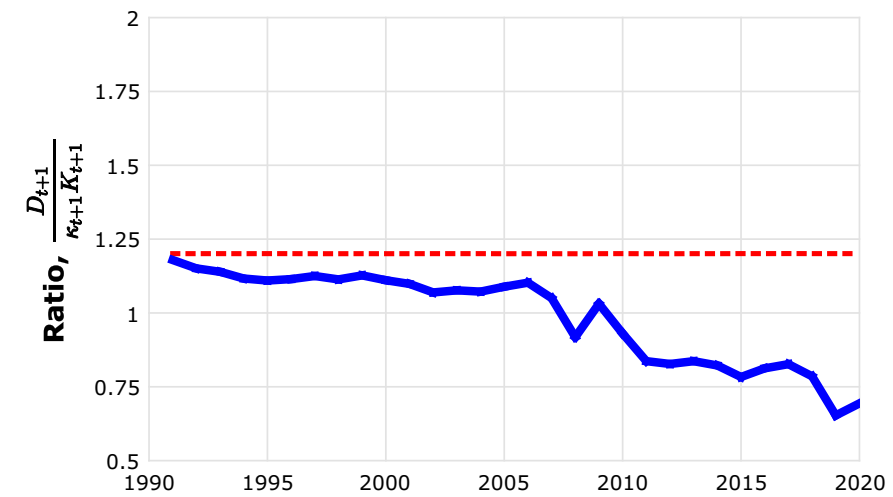**(d) Volatility EMEs**

Why did public debt reduce volatility?

(a) Real Interest Rate

Scenario I: Constant FX reserves & public debt

Scenario II: Change in public debt only

(b) Effective Leverage AEs

(c) Effective Leverage EMEs

Counterfactual simulation

Reserves $FX_{1,t}$, $FX_{2,t}$, and Public debt $D_{p,t}$

remain constant

Combined effects of reserves & public debt reduce volatility

(e) Volatility AEs

Scenario I: Constant FX reserves & public debt
Scenario II: Change in FX reserves & public debt

(f) Volatility EMEs

Scenario I: Constant FX reserves & public debt
Scenario II: Change in FX reserves & public debt