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

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Central Bank Reserves: Implications for Monetary Policy, Financial Stability & Regulation
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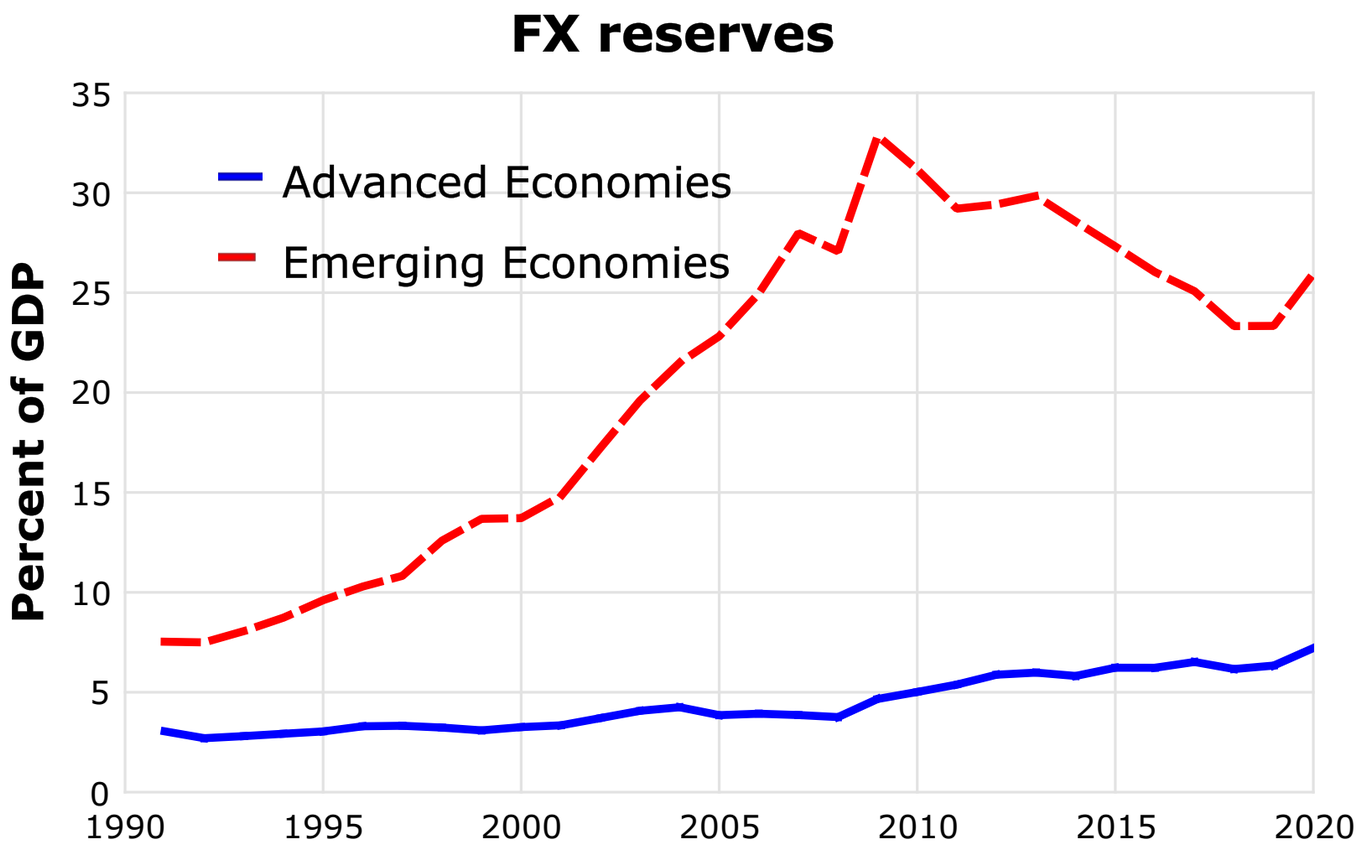
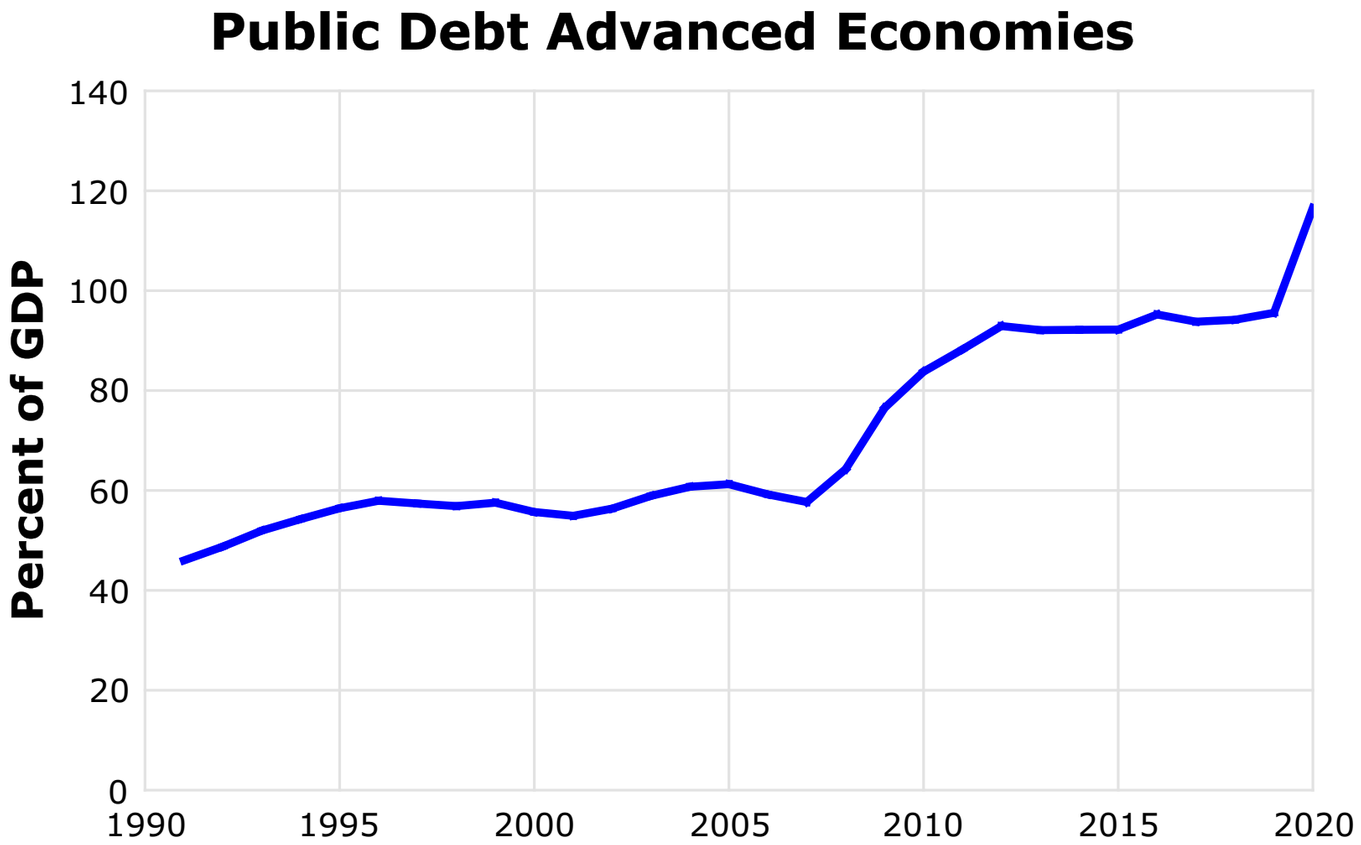
FACT 1: Surge in EMEs' reserves since 1990s



FACT 2: Surge in AEs' public debt since 2008



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
   - government responses to crises
   - benefits of FX accumulation, etc.

What we do in the paper

1. Propose two-region model of demand & supply of liquid assets that are **(a) defaultable** and **(b) akin to inside money** (productive use or convenience yield for holder)
   - Two complementary productive sectors (borrowers and lenders)
   - Exogenous supply of govt. debt (AEs) & demand for reserves (AEs, EMEs)
   - Fully integrated asset and final goods markets

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2. Counterfactual experiments show that surge in **EMEs FX reserves**:
   - Reduced world interest rate
   - Increased private leverage
   - Worsened macroeconomic volatility in both AEs and EMEs (reserves externality)
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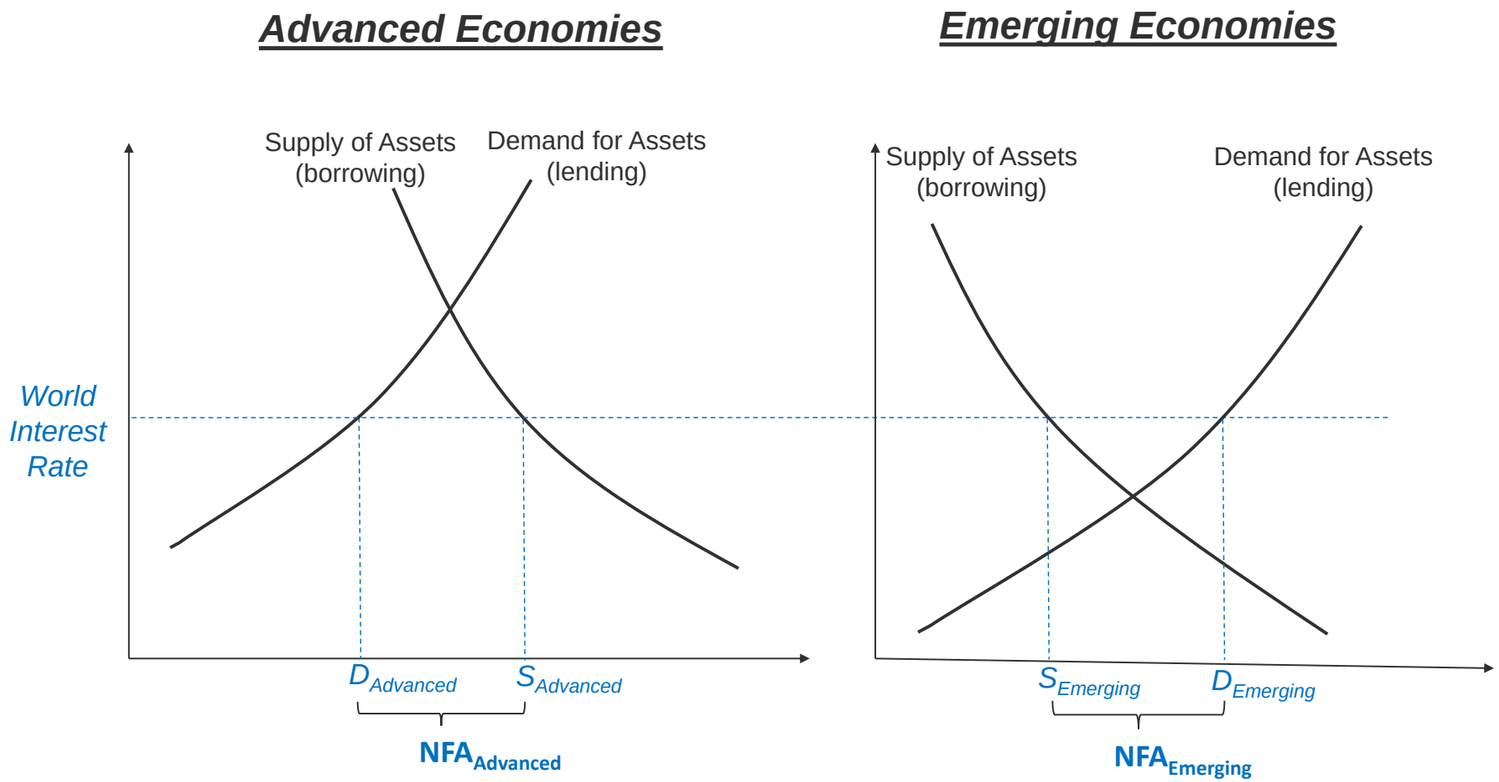
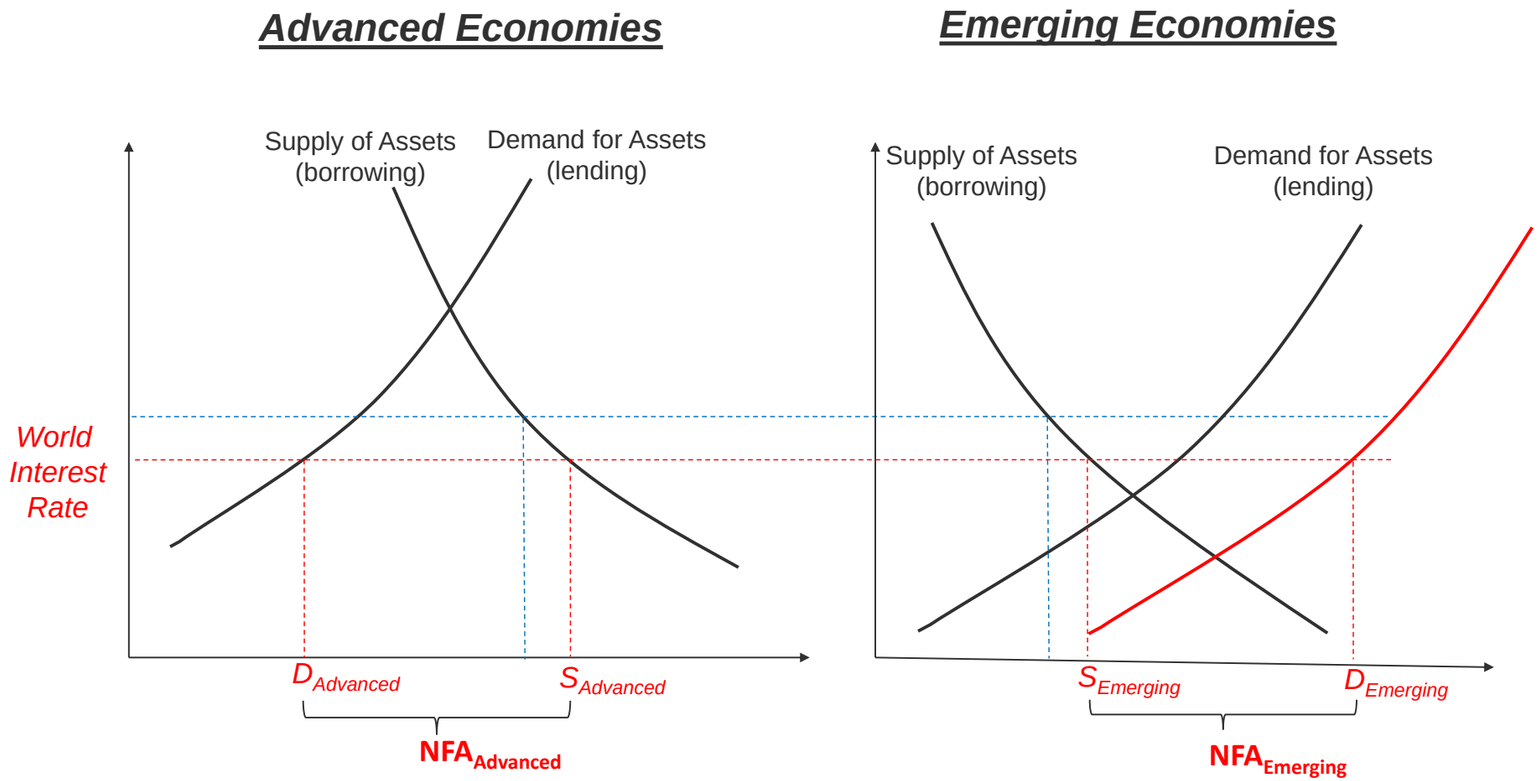
3. Counterfactuals for surge in **AEs public debt** yields analogous results in opposite direction

A TWO-REGION MELTZER DIAGRAM INTUITION

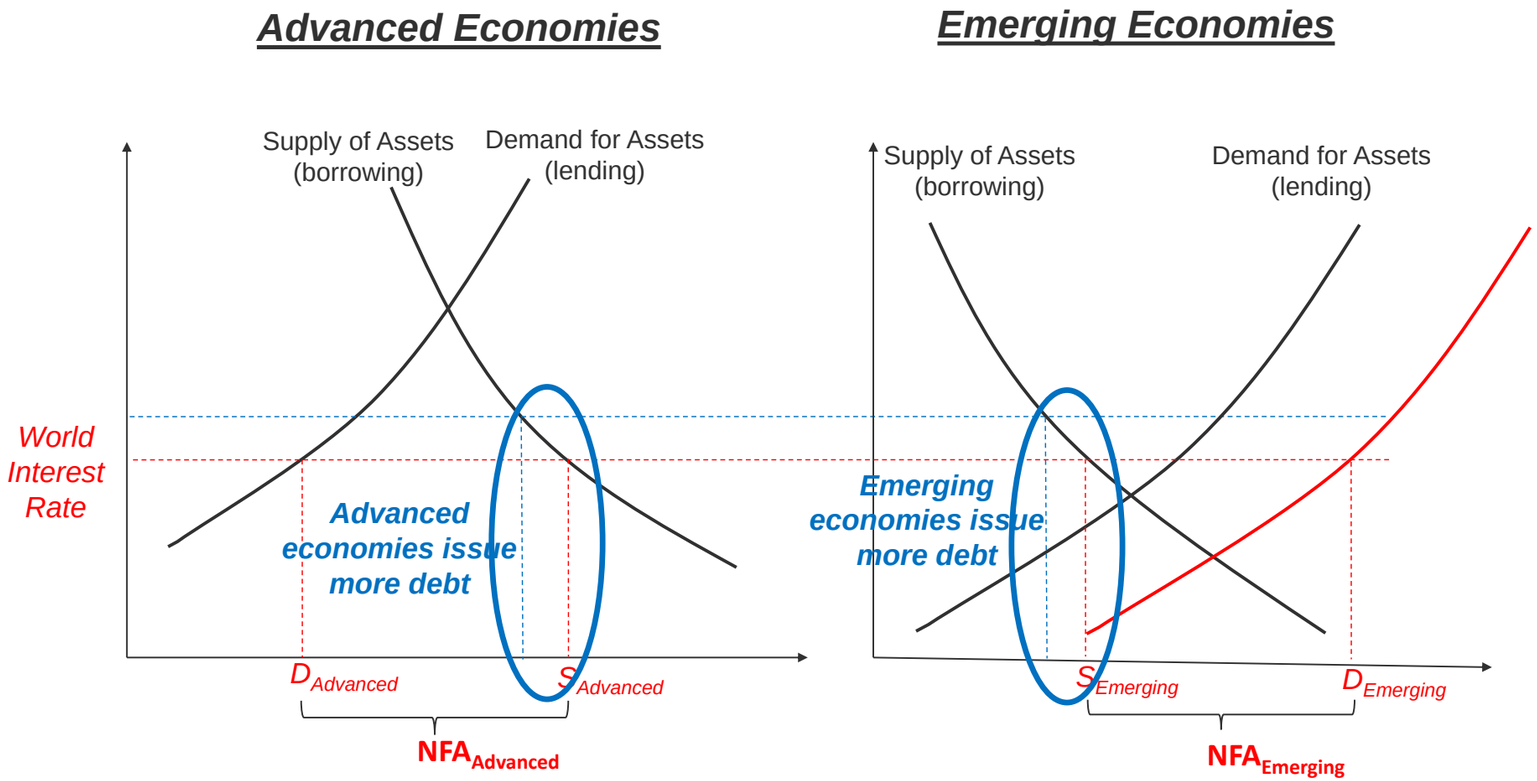
Global asset market equilibrium



Effects of higher FX in EMEs: NFA & interest rate



Effects of higher FX in EMEs: Private-sector leverage



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
- Cross-border holdings induce contagion (international spillovers)

BORROWERS & 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 $t-1$ contracting to repay d_t at t

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- Liquidation price of capital is stochastic (model's only shock):
  - $\ell_t = 1 \quad (\varepsilon_t = 1) \quad$ w. prob. $\quad 1-\lambda$
  - $\ell_t = \kappa_t < 1 \quad (\varepsilon_t = 0) \quad$ w. prob. $\quad \lambda \quad$ (κ_t is a country-specific shifter of debt supply)

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- If $d_t > \ell_t k_t$, repayment is renegotiated to $\ell_t k_t$, so repayment is $\tilde{d}(d_t, \ell_t k_t) = \min\left\{d_t,\ \ell_t k_t\right\}$

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- Convex cost for issuing **new** debt: $\varphi\left(d_{t+1}, \kappa_{t+1}k_{t+1}\right) = \eta\left[\frac{\max\{\,0\ ,\ d_{t+1}-\kappa_{t+1}k_{t+1}\,\}}{d_{t+1}}\right]^2 d_{t+1}$

Optimization problem, labor demand & supply of debt

$$V(d_t, k_t) = \max_{d_{t+1}} \{\mathsf{div}_t + \beta \mathbb{E} V(d_{t+1}, k_{t+1})\}$$

s.t.

$$k_{t+1} - (1-\tau)k_t + \mathsf{div}_t + \tilde{d}(d_t, \ell_t k_t) + \varphi(d_{t+1}, \kappa_{t+1} k_t) = p_t l_t^{\gamma} k_t^{1-\gamma} - w_t l_t + \frac{1}{\overline{R}_t} \mathbb{E}\tilde{d}(d_{t+1}, \ell_{t+1} k_{t+1})$$

- **Labor demand**

$$\gamma p_t l_t^{\gamma-1} k_t^{1-\gamma} = w_t$$

- **Debt supply** (Euler eq.)

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

Final goods producers (entrepreneurs)
(Net lenders)

Utility, technology & working capital

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

- Linear production function: $y_t = z_t x_t$

  x_t = inputs purchased at price p_t
  z_t = country-specific productivity

- Profits: $\pi_t = z_t x_t - p_t x_t$

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

  m_t = financial wealth post-default
  ϕ_t is a country-specific shifter of debt demand

Entrepreneurs' wealth & convenience yield

- 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

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

$$p_t < z_t, \qquad \pi_t = (1/\phi_t)\,[z_t/p_t - 1] m_t > 0$$

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- Budget constraint: $c_t + q_{1,t} b_{1,t+1} + q_{2,t} b_{2,t+1} + q_{p,t} b_{p,t+1} = m_t + z_t x_t - p_t x_t \equiv a_t$

Demand for assets & intermediate goods

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

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

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

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$\theta_{1,t}$, $\theta_{2,t}$ same across countries, solve no-arbitrage conditions:

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

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

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

  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

- 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

Counterfactual experiments

- **Goal**: Assess how surge in reserves affected macro dynamics & volatility

1. Calibrate model's parameters

2. Keep $z_{j,t}, \phi_{j,t}, \kappa_{j,t}$ constant at 1991 values, and $D_{p,t}$ constant at 1991 AEs public debt ratio

3. MC simulations: 10k runs of 130 years w. random draws of $\varepsilon_{j,t}$, last 30 years represent 1991-2020 (volatility measured as diff. between 95th and 5th percentiles in percent of mean)

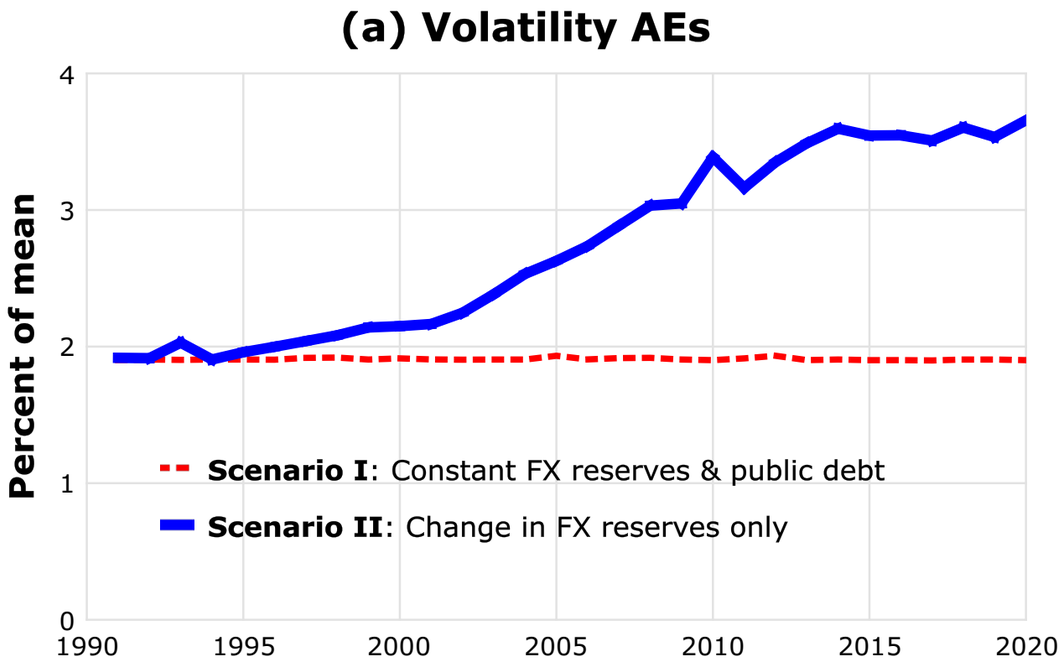
4. Compare two scenarios

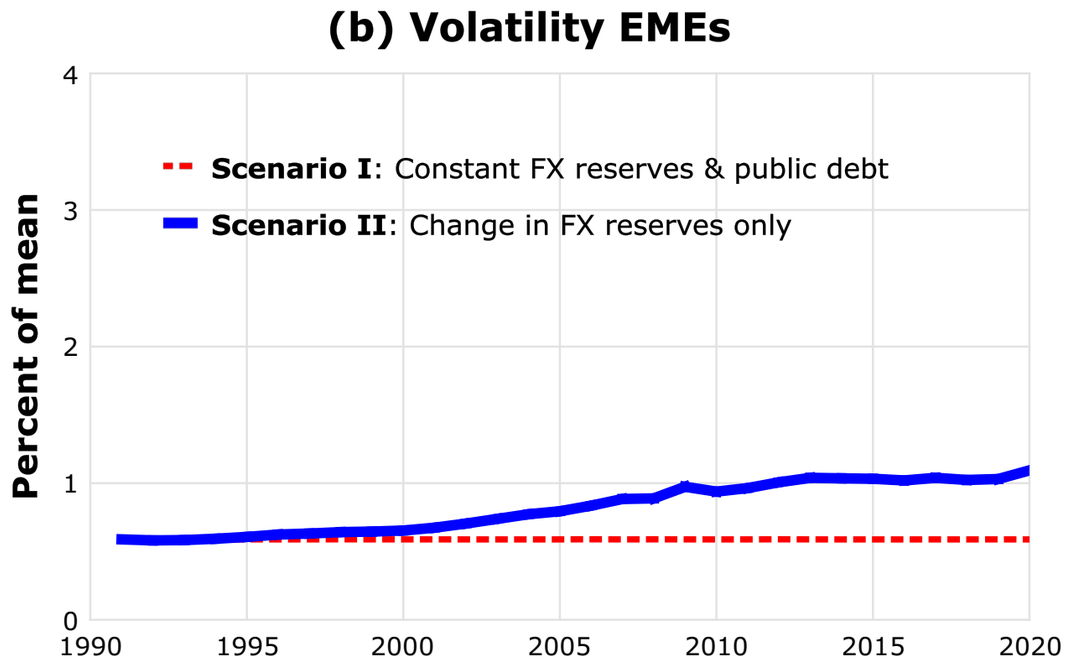
   Scenario I: (detrended) FX constant at 1991 values
   Scenario II: (detrended) FX take 1991-2020 values

Counterfactual simulation: Effect of surge in reserves

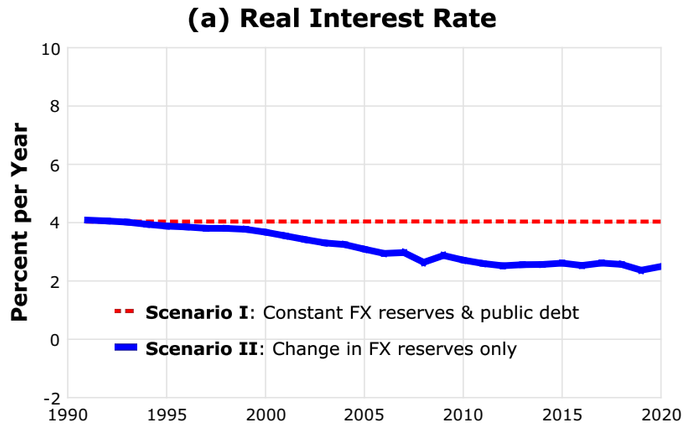
(actual reserves v. reserves constant at 1991 GDP ratio, AE's debt constant)

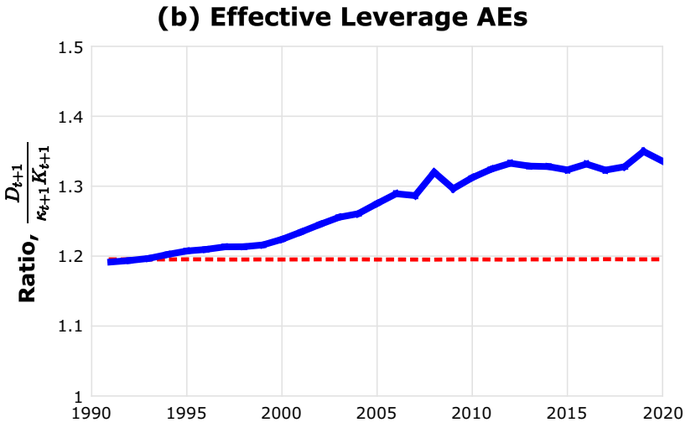
Surge in EMEs reserves increased volatility everywhere

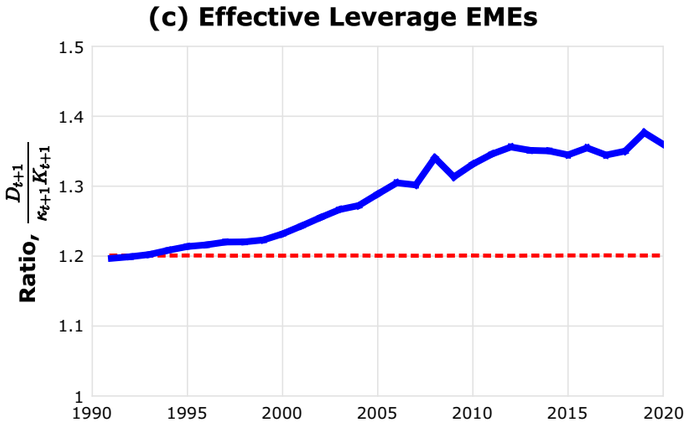




Why did the surge in EMEs reserves increase volatility?







A STABILIZING ROLE FOR RESERVES

(why individual EMEs would like to accumulate reserves)

Using reserves to bailout entrepreneurs

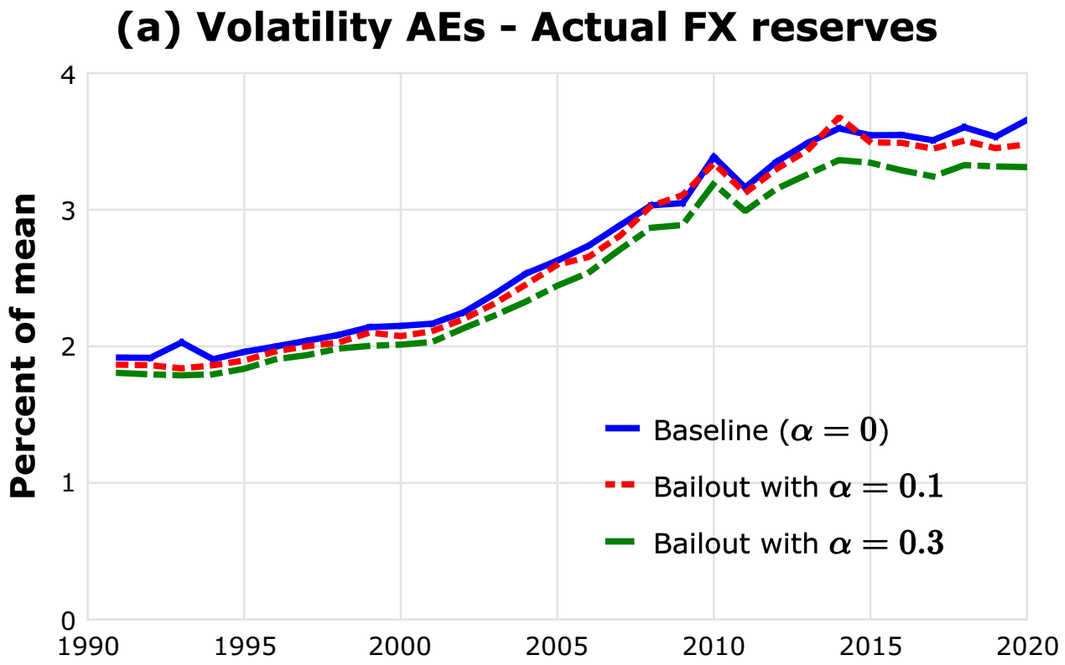
- Entrepreneurs' losses in a financial crisis

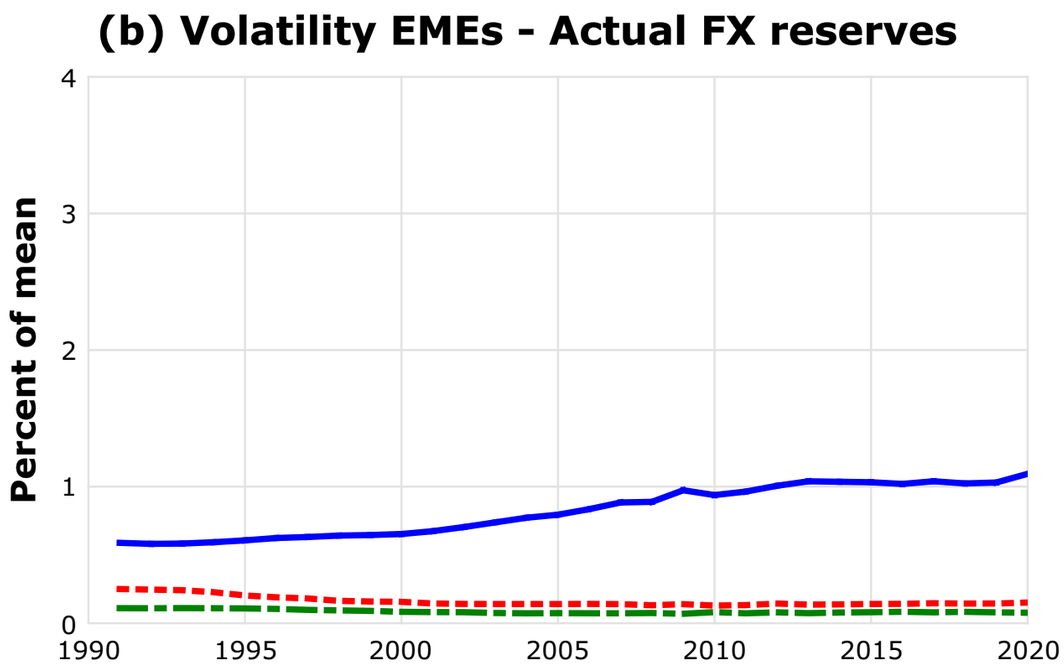
$$Loss_{j,t} = (1 - \delta_{1,t})B_{1,j,t} + (1 - \delta_{2,t})B_{2,j,t}.$$

- 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





CONCLUDING REMARKS

Concluding remarks

- **Global externality of reserves**:
  - EMEs do not internalize effects on interest rate & volatility (FX over-accumulation)
  - Argument for global coordination of liquidity provision (e.g., CLAAF's EMF proposal)

- **Is the surge in EMEs reserves desirable for the world economy?**
  - Tradeoff of reserves externality and higher volatility v. increased supply of private assets that improves efficiency in good times
  - Accordingly, welfare effects on households and entrepreneurs differ
  - Answer requires quantitative cost/benefit analysis

- **Similar arguments (in opposite direction) apply to AE's public debt,** with two caveats
  - Not all AEs debt are equal in terms of liquidity (exorbitant privilege)
  - Sustainability & efficiency/distributional costs of taxation (D'Erasmo et al. (16))

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 $(1+g)^{1/\gamma}-1$.

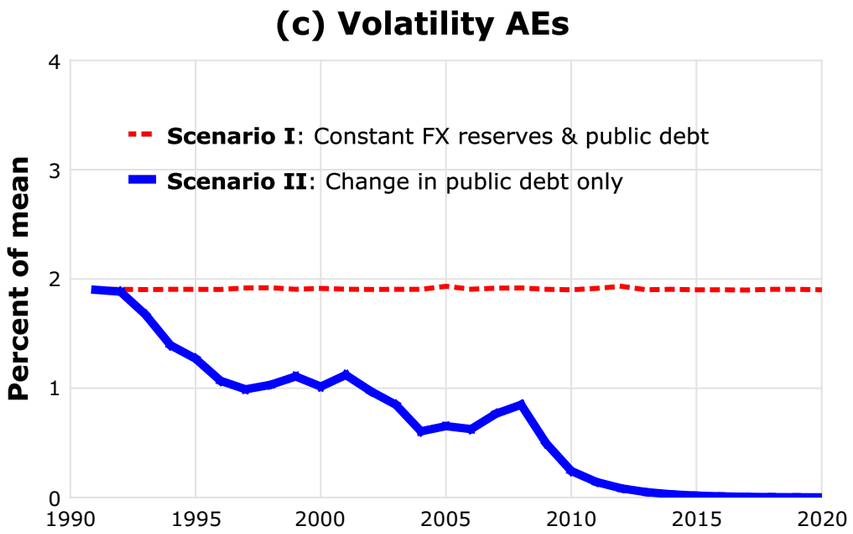
Country-specific parameters

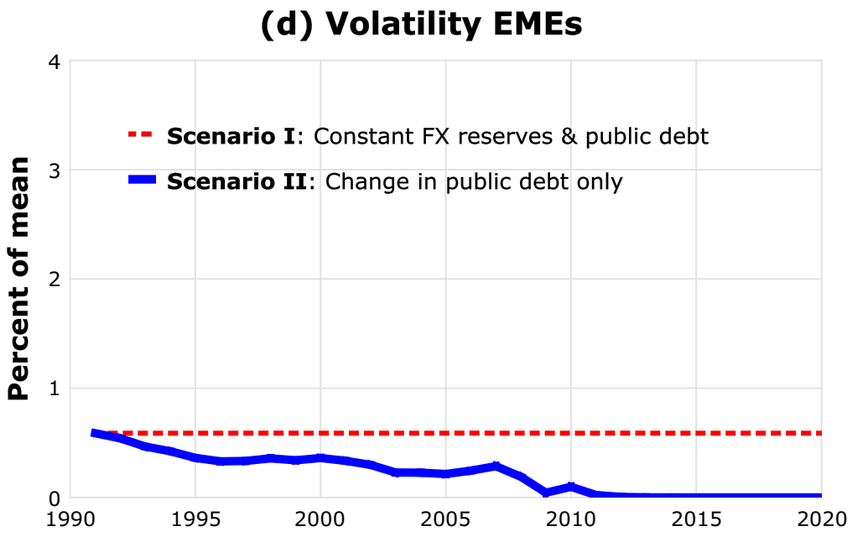
Model Parameters	
Productivity	$z_1 = 0.474,\ z_2 = 0.205$
Working capital coeffs.	$\phi_1 = 1.658,\ \phi_2 = 0.543$
Crash liq. prices	$\kappa_1 = 0.422,\ \kappa_2 = 0.184$
Targeted 1991 Data Moments	
Gross Domestic Product AEs & EMEs	
Private Domestic Credit AEs & EMEs	
Net Foreign Asset position AEs	
US Real Interest Rate	

Counterfactual simulation

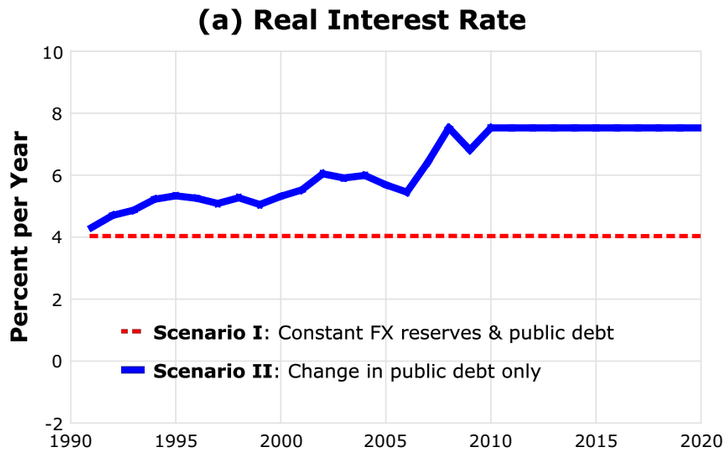
Public debt $D_{p,t}$ remains constant

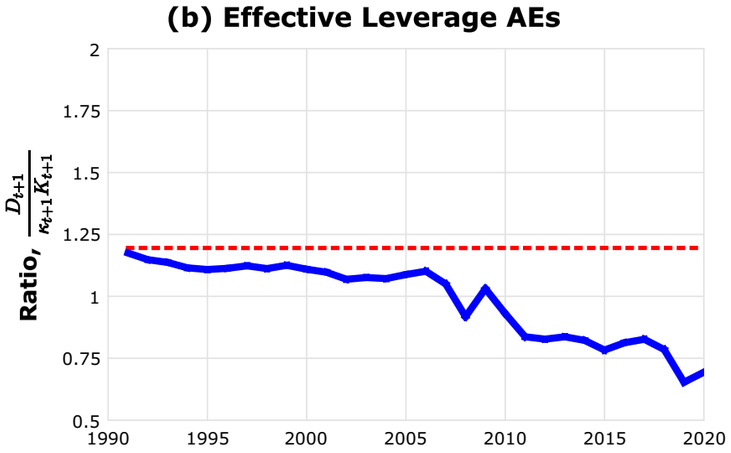
Public debt issuance by AEs reduced volatility

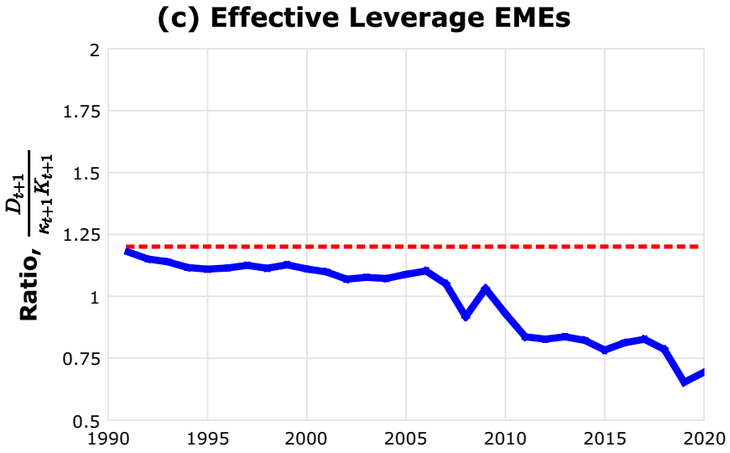




Why did public debt reduce volatility?


(a) Real Interest Rate
Percent per Year
10
8
6
4
2
0
-2
1990
1995
2000
2005
2010
2015
2020
Scenario I: Constant FX reserves & public debt
Scenario II: Change in public debt only


(b) Effective Leverage AEs
Ratio, $\frac{D_{t+1}}{\kappa_{t+1}K_{t+1}}$
2
1.75
1.5
1.25
1
0.75
0.5
1990
1995
2000
2005
2010
2015
2020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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