Unstable Prosperity: How Globalization Made the World Economy More Volatile

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The outcomes of globalization: 1990-2020

- **Prosperity**:
  1. PPP-GDP per capita of Advanced Economies (AEs) and Emerging Economies (EEs) grew by factors of 2.6 and 4.5, respectively
  2. Historically low real interest rates
  3. Low inflation, booming asset prices and saving glut

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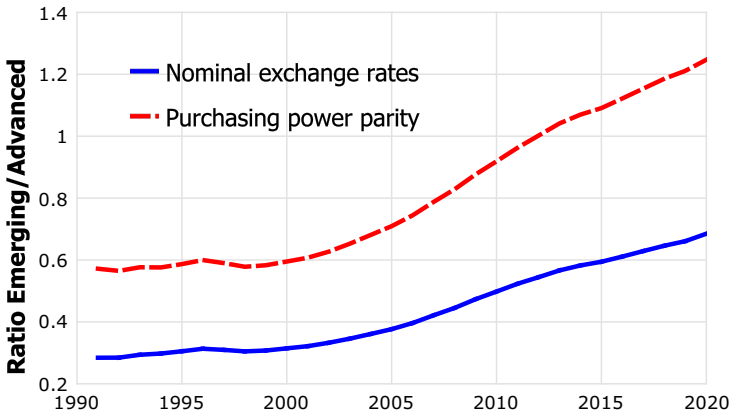
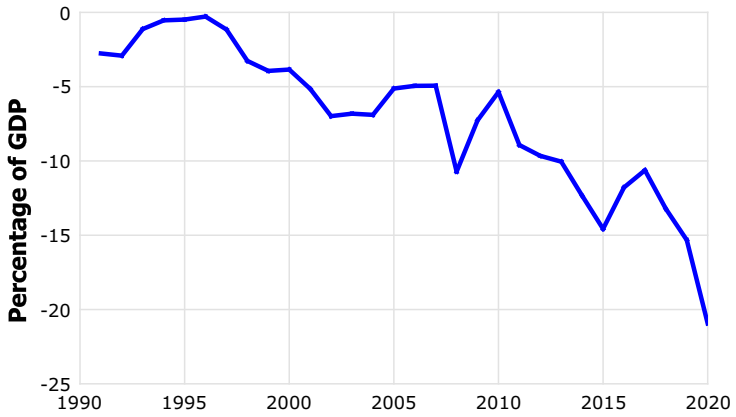
- **Instability**:
  1. Global imbalances (large decline in U.S. NFA position)
  2. Large central bank balance sheets
  3. Historically high public debt in AEs, surge in reserves en EEs
  4. Booming private debt & leverage
  5. Spikes in liquidity premia & market freezes
  6. Higher frequency & severity of financial crises

Key facts of the globalization era

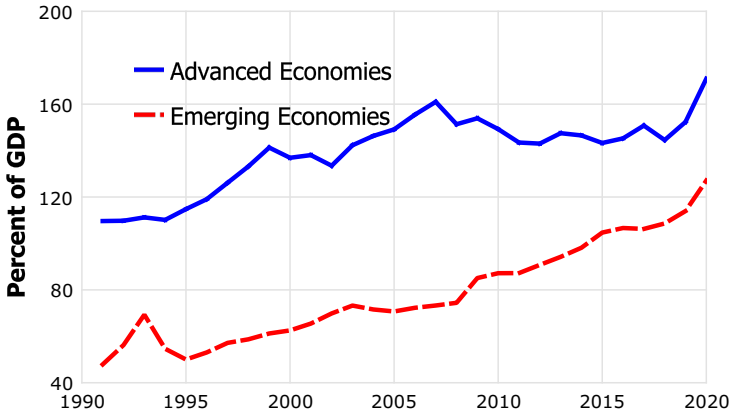
Relative GDP



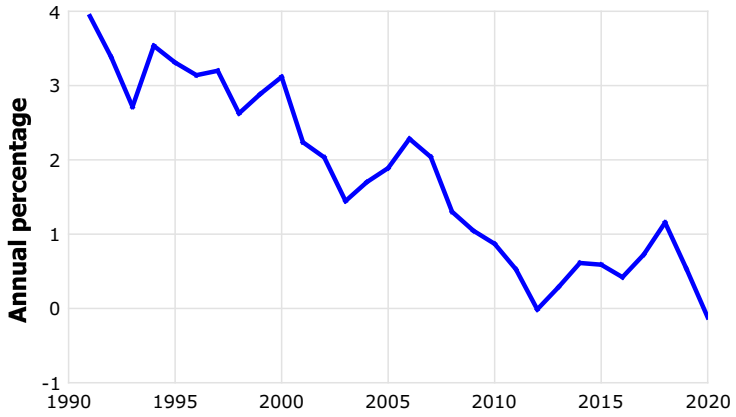
NFA Position Advanced Economies



Private Domest Credit



US Real Interest Rate



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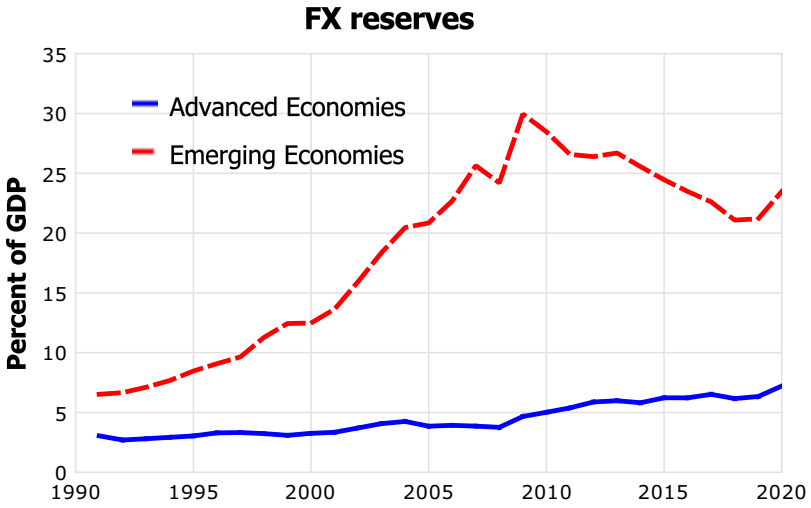

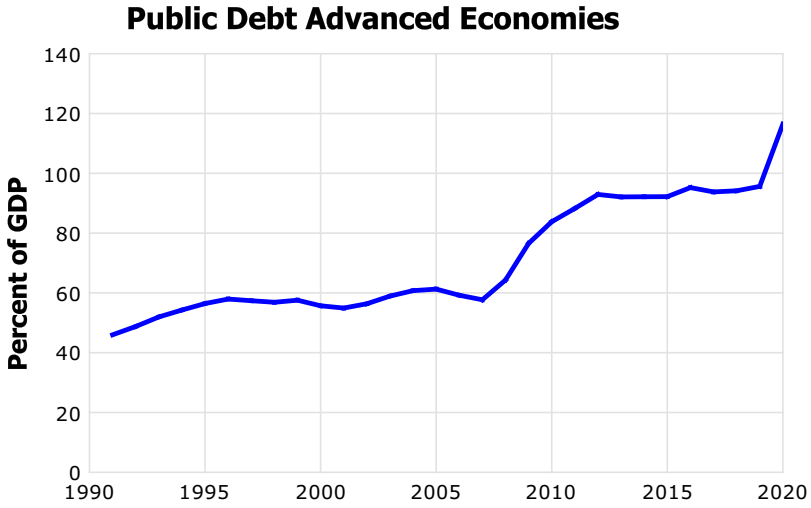

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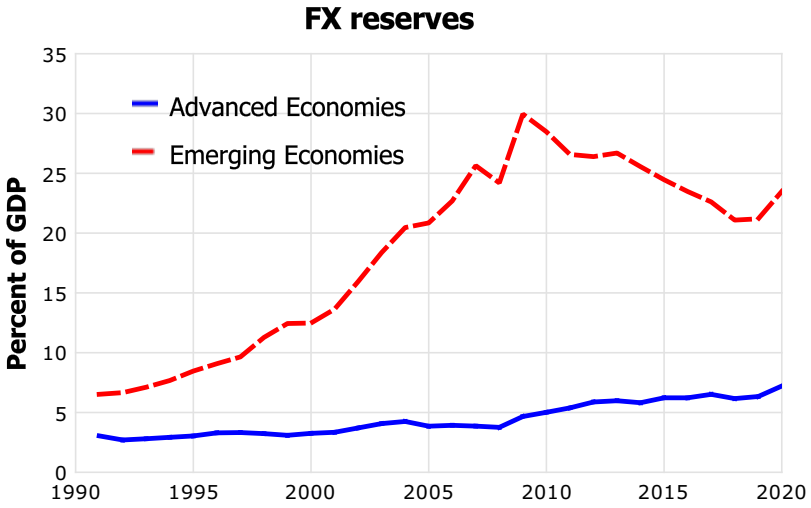

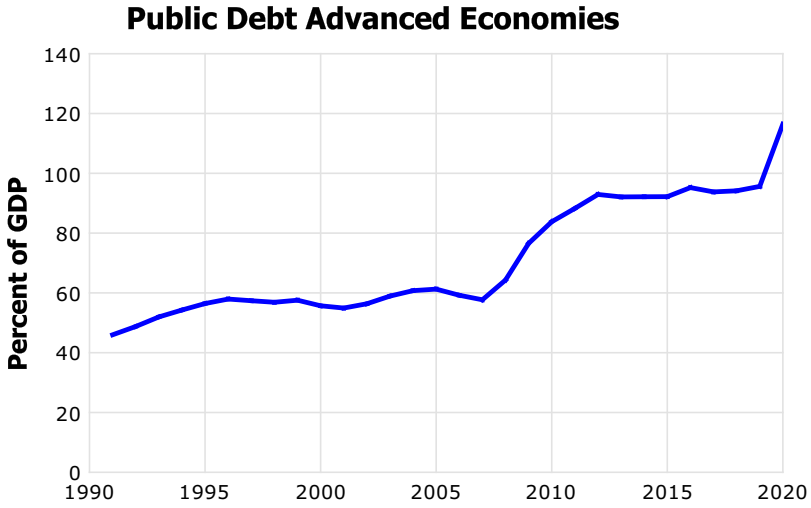

- **Higher frequency of financial crises**
  - AEs: no crises in 1940-1973, a handful 1973-1990, over 20 since then (Reinhart & Rogoff (09))
  - EEs: rare in 1940-1980, some in 1980s, much more frequent since 1990 (Sufi & Taylor (21))

What we do in this paper

1. Propose a two-country, two sector model with private issuance of defaultable "inside money" that links economic growth $\mapsto$ credit/leverage growth $\mapsto$ interest rates $\mapsto$ macro volatility via wealth redistribution

2. Use the model to quantify the contributions of (i) faster $EE's$ growth, (ii) changes in financial structure, and (iii) rise in FX reserves and $AE's$ public debt to credit growth, global imbalances, and lower interest rates.

3. Use it also to quantify effect of lower interest rates and higher leverage on macroeconomic and financial stability

Main results

1. Faster $EE's$ growth & surge in FX explain nearly all of NFA decline and about 1/2 of the fall in interest rate but cannot explain credit growth.

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5. Asset price volatility rose sharply due to financial structure changes

Intuition for the results

- Faster EEs' growth, changes in fin. structure & surge in reserves lowered the interest rate by increasing demand for assets more than supply.

- Higher AE's public debt increased supply of assets, mitigating interest rate drop.

- Lower interest rates caused higher leverage.

- With higher borrowing/leverage, financial crises caused larger financial restructuring, which caused deeper recessions via wealth redistribution.

Model Structure

Two countries:

- **Country 1 (Advanced Economies)**
- **Country 2 (Emerging Economies)**

Two sectors:

- **Lending sector (Entrepreneurs)**
- **Borrowing sector (Households/Firms)**

Lending sector (entrepreneurs)

- Continuum of entrepreneurs (owners of intangible capital, aka venture capitalists, startups, high-tech cos.) with utility $E_0 \sum_{t=0}^{\infty} \beta^t \ln(c_t)$

- Production technology $y_t = z_t{}^{\gamma} l_t^{\gamma} k_t^{1-\gamma}$

  $z_t =$ Time-varying productivity (with $g-1$ long-run growth rate)
  $l_t =$ Labor (wage rate w_t)
  $k_t =$ Capital (rental rate r_t)

- Financial constraint: Production uses fin. assets m_t (working capital)

$$m_t \geq \phi_t (w_t l_t + r_t k_t)$$

$\phi_t =$ Time-varying parameter (private asset demand shifter)

- Financial assets are bonds issued by both countries,

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

$b_{i,t}$	Private defaultable bonds issued by country i at $t-1$,
$\delta_{i,t} \leq 1$	Fraction repaid by country i at t,
$b_{p,t}$	Government bonds issued by AEs at $t-1$.

- Budget constraint

$$\begin{aligned} c_t + q_{1,t} b_{1,t+1} + q_{2,t} b_{2,t+1} + q_{p,t} b_{p,t+1} &= m_t + z_t^{\gamma} l_t^{\gamma} k_t^{1-\gamma} - w_t l_t - r_t k_t \\ &\equiv a_t \end{aligned}$$

Benefits of holding inside money (convenience yields)

1. Positive profits when financial constraint binds ($\xi_{j,t} > 0$)

$$\pi_{j,t} = \left(\frac{\xi_{j,t}}{u'(c_{j,t})} \right) m_{j,t}$$

   which implies wealth is linear in assets $a_{j,t} = [1 + (\xi_{j,t}/u'(c_{j,t}))]m_{j,t}$

2. Expected asset returns rise if the constraint binds in the future

$$q_{i,t}u'(c_{j,t}) = \beta \mathbb{E}_t \left((1 + \hat{\xi}_{j,t+1}) \delta_{i,t+1} u'(c_{j,t+1}) \right)$$

   but this effect vanishes with log utility & linear wealth and decision rules.

Entrepreneur's optimal plans: consumption & factor demands (if financial constraint binds)

$$
\begin{aligned}
l_t &= \left(\frac{\gamma}{\phi_t w_t}\right) m_t, \\
k_t &= \left(\frac{1-\gamma}{\phi_t r_t}\right) m_t, \\
c_t &= (1-\beta) a_t,
\end{aligned}
$$

- Default redistributes wealth away from entrepreneurs, causing a recession: ↑ debt (↑ leverage) ⇒ ↑ redistribution ⇒ deeper recessions (↑ volatility)

Entrepreneur's optimal plans: portfolio choice

$$
\begin{aligned}
q_{1,t}b_{1,t+1} &= \theta_{1,t}\beta a_t, \\
q_{2,t}b_{2,t+1} &= \theta_{2,t}\beta a_t, \\
q_{p,t}b_{p,t+1} &= (1-\theta_{1,t}-\theta_{2,t})\beta a_t
\end{aligned}
$$

$\theta_{1,t}$ and $\theta_{2,t}$ solve these optimal portfolio (first-order) conditions:

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

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

Borrowing sector (households/firms)

- Continuum of households/firms (owners of tangible capital) with utility

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(e_t - z_t \frac{l_t^{1+\frac{1}{\nu}}}{1+\frac{1}{\nu}} \right).$$

- They rent capital k_t to entrepreneurs (depreciates at rate τ, grows exogenously at rate $g-1$).

- Borrow $q_{t-1}d_t$ at $t-1$ and promise to repay d_t at time t, but actual repayment (renegotiated debt) is $\tilde{d}(d_t, \tilde{p}_t k_t) = \min \left\{ d_t \ , \ \tilde{p}_t k_t \right\}$

- Default ($\delta_t < 1$) arises if debt bigger than liquidation value of capital:

$$d_t > \tilde{p}_t k_t.$$

- The liquidation price $\tilde{p}_t$ is a stochastic "sunspot" shock $\varepsilon_t = 0, 1$:

$$\tilde{p}_t = \begin{cases} p_t & \text{with prob. } 1-\lambda \quad (\varepsilon_t = 1) \\ \\ \kappa_t & \text{with prob. } \lambda \quad (\varepsilon_t = 0) \end{cases}$$

$\kappa_t =$ Time-varying parameter (asset supply shifter).

- Convex borrowing cost (pins down portfolio and is akin to debt limit):

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

- Budget constraint:

$$\tilde{d}(d_t, \tilde{p}_t k_t) + e_t + p_t k_{t+1} + \varphi(d_{t+1}, \kappa_{t+1} k_{t+1}) =$$

$$w_t l_t + (r_t - \tau) k_t + p_t k_t g + q_t d_{t+1} + T_t$$

Borrower's first-order conditions

$$w_t = z_t l_t^{\frac{1}{\nu}},$$

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

$$p_t = \beta \mathbb{E}_t \left[r_{t+1} - \tau + g p_{t+1}\right] + \Psi\left(\frac{d_{t+1}}{\kappa_{t+1} k_{t+1}}\right), \quad \Psi'(\cdot) > 0$$

- $\overline{R}_t$ is the interest rate (expected market return of diversified portfolio)
- Debt FOC $\Rightarrow$ effective leverage and $\overline{R}_t$ are negatively related
- Capital FOC $\Rightarrow$ effective leverage and p_t are positively related
- Hence, $\downarrow \overline{R}_t$ increases leverage and price of capital.

Government budget constraints & market clearing

- FX are mainly U.S. short-term T-bills (riskless public debt)
- Gov. budget constraint in Country 1 (AEs):

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

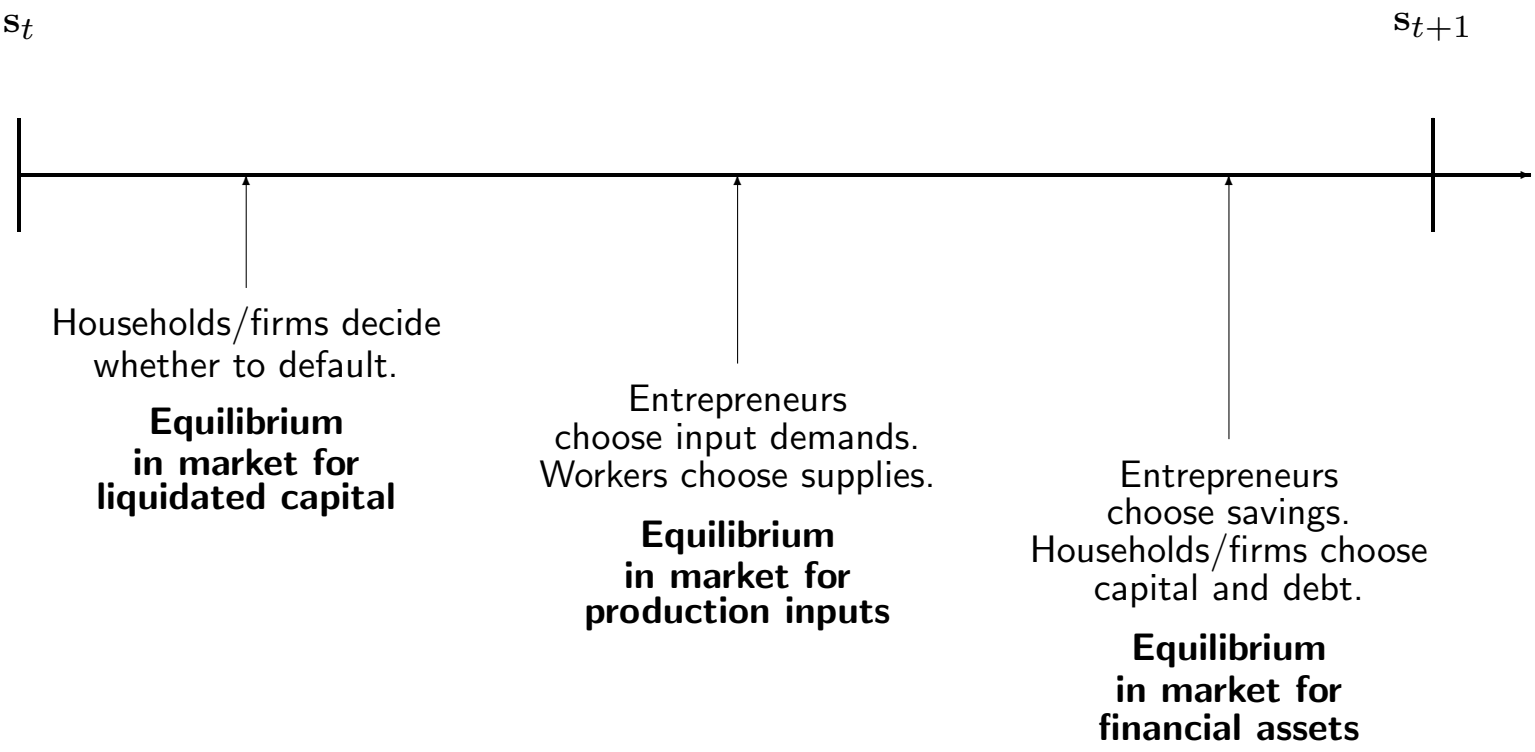
- Gov. budget constraint in Country 2 (EEs):

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

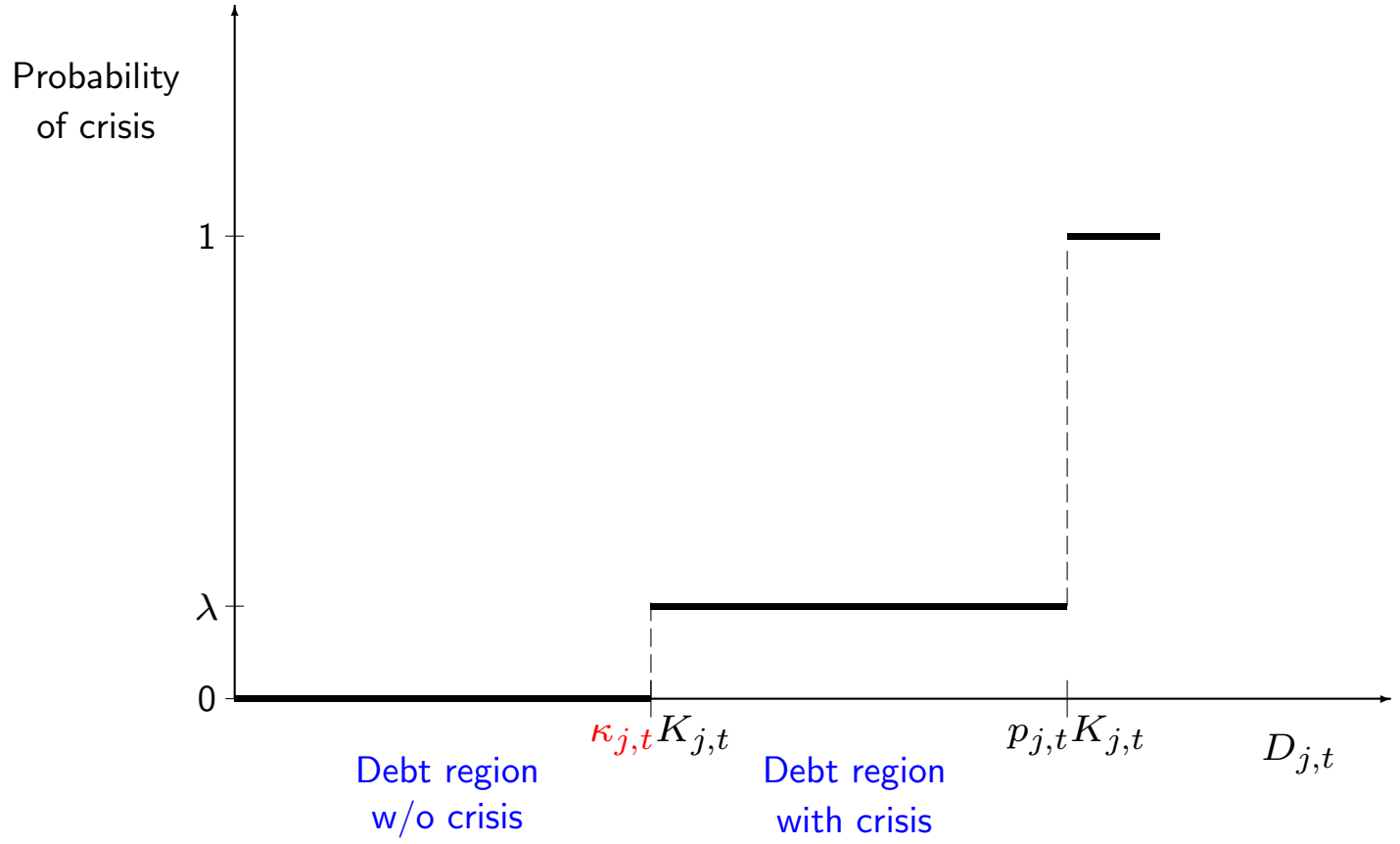
- Market-clearing conditions in asset markets:

$$\begin{aligned} B_{1,1,t+1} + B_{1,2,t+1} &= D_{1,t+1}, \\ B_{2,1,t+1} + B_{2,2,t+1} &= D_{2,t+1}, \\ B_{p,1,t+1} + B_{p,2,t+1} + FX_{1,t+1} + FX_{2,t+1} &= D_{p,t+1}. \end{aligned}$$

Sequential equilibrium within a period



Debt and probability of default/financial crisis



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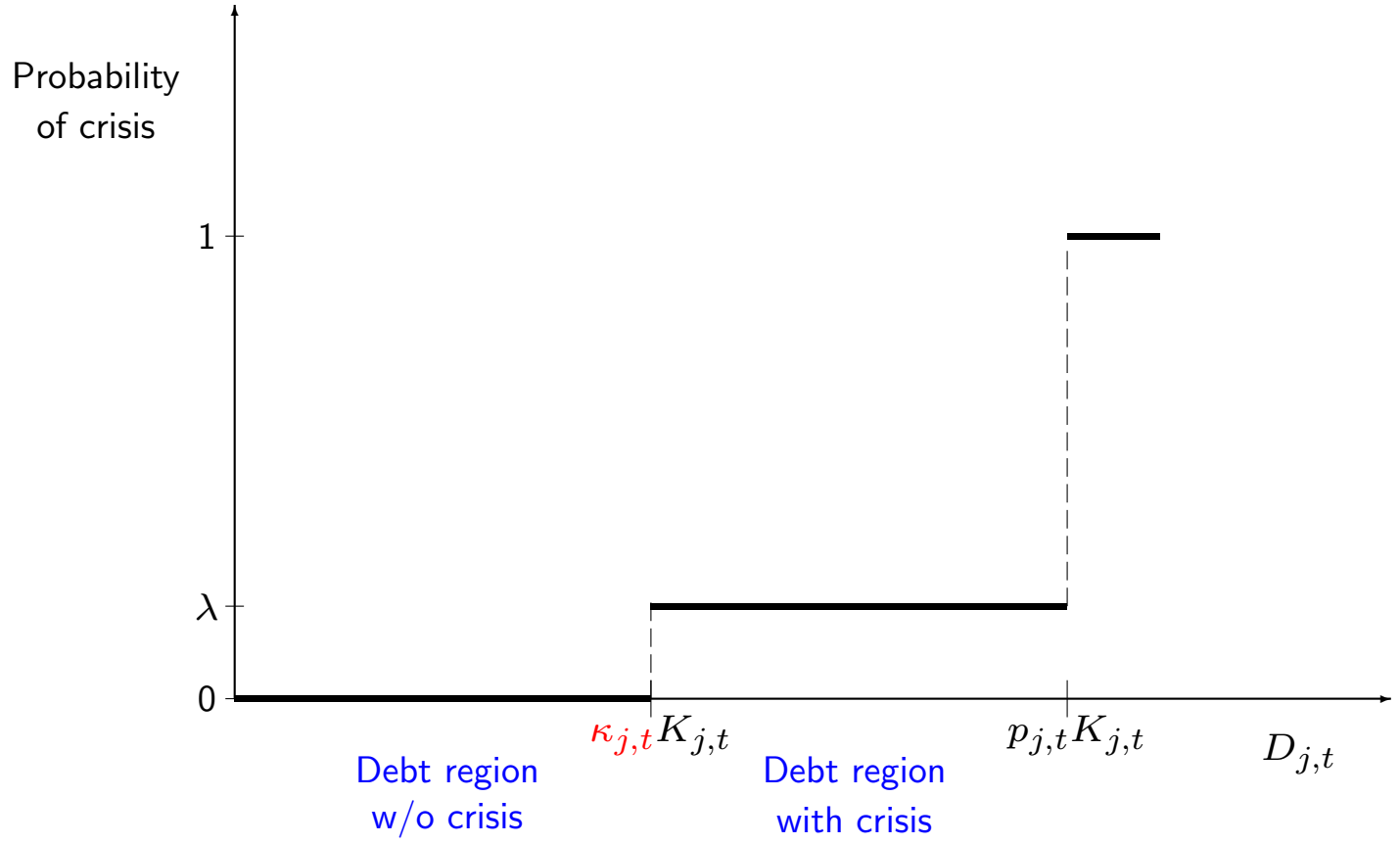

Default requires weak fundamentals ($D_{j,t}/\kappa_{j,t}K_{j,t} \geq 1$) & exogenous sunspot shock ($\varepsilon_t = 0$), micro-founded as self-fulfilling market freeze

QUANTITATIVE ANALYSIS

Numerical solution

- Only stochastic elements are $\varepsilon_{1,t}, \varepsilon_{2,t}$

- In general, date-t state variables include:
  1. Deterministic history of $\{z_{1,t}, z_{2,t}, \phi_{1,t}, \phi_{2,t}, \kappa_{1,t}, \kappa_{2,t}, D_{p,t}, FX_{1,t}, FX_{2,t}\}_t^{\infty}$
  2. Date-t asset positions $B_{1,1,t}, B_{2,1,t}, B_{p,1,t}, B_{1,2,t}, B_{2,2,t}, B_{p,2,t}$
  3. Date-t shocks $\varepsilon_{1,t}, \varepsilon_{2,t}$

- ...but functional forms and model assumptions make equilibrium solution sequential, except for forward-looking asset price

- Date-t equilibrium solutions can be solved as function of date-t states (non-linear system block-recursive from asset price):

$$\begin{aligned}\mathbf{s}_t \equiv\ & (z_{1,t}, z_{2,t}, \phi_{1,t}, \phi_{2,t}, \kappa_{1,t}, \kappa_{2,t}, \kappa_{1,t+1}, \kappa_{2,t+1}, FX_{1,t+1}, FX_{2,t+1}, \\ & D_{p,t+1}, B_{1,1,t}, B_{2,1,t}, B_{p,1,t}, B_{1,2,t}, B_{2,2,t}, B_{p,2,t}, \varepsilon_{1,t}, \varepsilon_{2,t})\end{aligned}$$

Implementation steps

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3. Construct $\{z_{1,t}, z_{2,t}, \phi_{1,t}, \phi_{2,t}, \kappa_{1,t}, \kappa_{2,t}, \varepsilon_{1,t}, \varepsilon_{2,t}\}$ for 1991-2020.

   - $z_{1,t}$, $z_{2,t}$ measured as Solow residuals (include RER & pop. growth)

   - $\phi_{1,t}$, $\phi_{2,t}$, $\kappa_{1,t}$, $\kappa_{2,t}$ constructed so that model matches data for:
   (i) Private domestic credit in advanced economies;
   (ii) Private domestic credit in emerging economies;
   (iii) NFA of advanced economies;
   (iv) World real interest rate.

   - $\varepsilon_{i,t} = 1$ except $\varepsilon_{2,1997} = 0$ and $\varepsilon_{1,2009} = \varepsilon_{2,2009} = 0$

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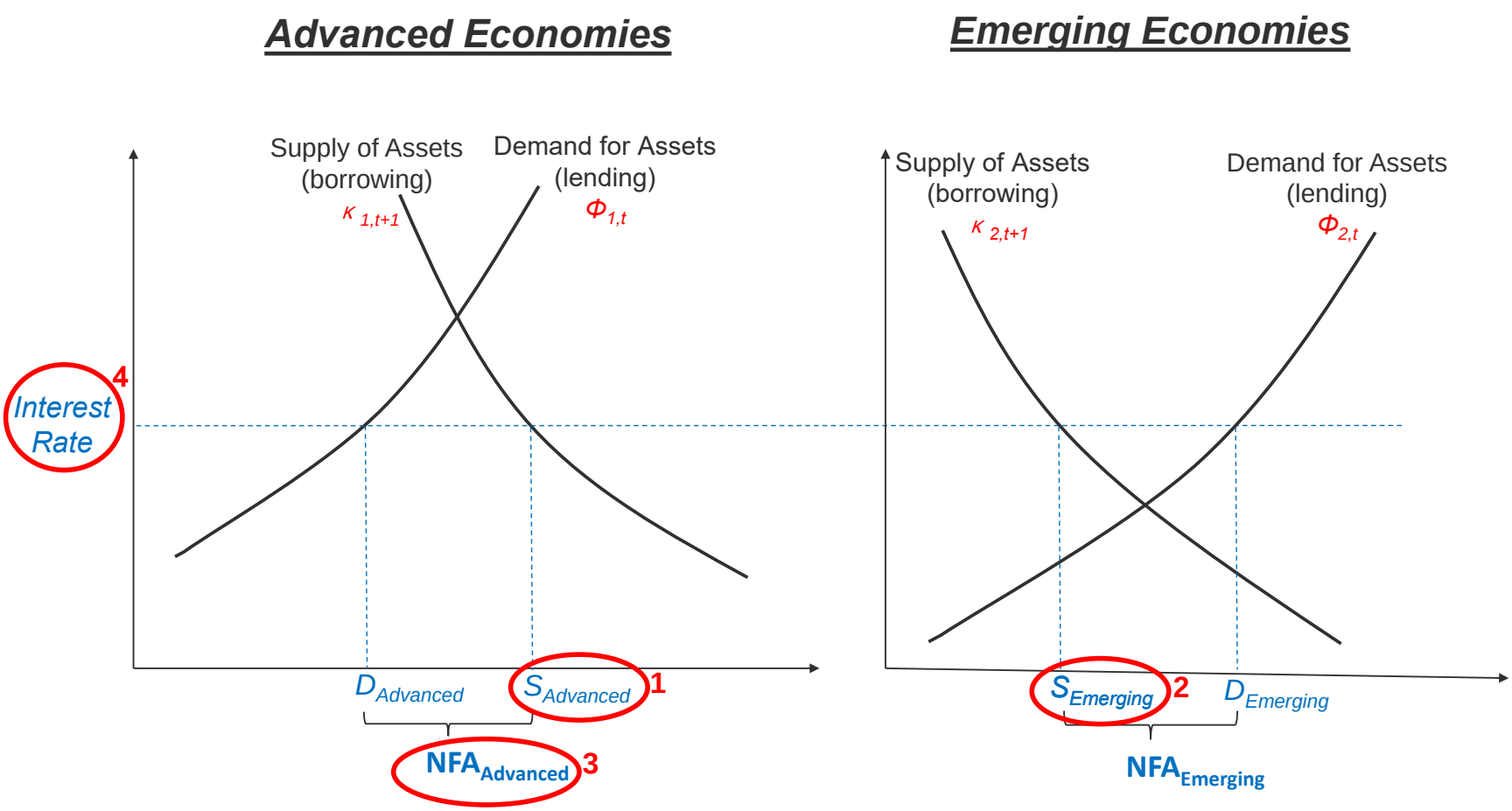
4. Analyze counterfactuals turning off exogenous drivers one at a time & quantify volatility with time-series simulations using random ε draws

Calibration

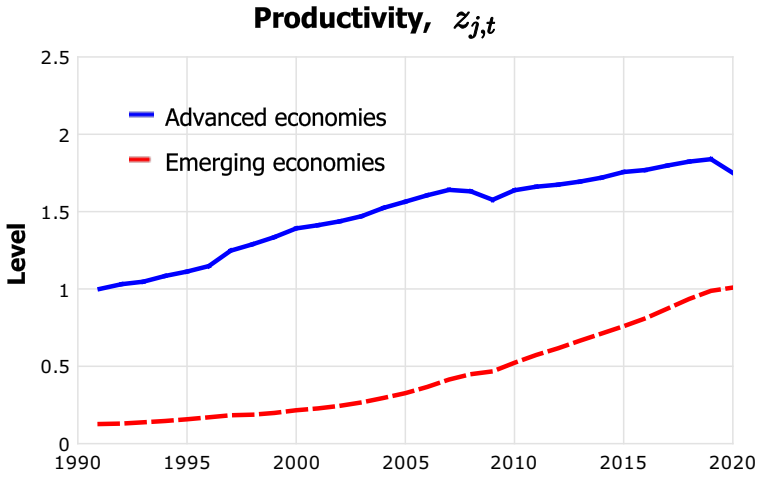
Description	*Parameter*	*Value*
Discount factor	β	0.930
Share of labor in production	γ	0.600
Depreciation rate	τ	0.080
Elasticity of labor supply	ν	1.000
Probability of crises (low sunspot shock)	λ	0.040
Borrowing cost	η	0.100

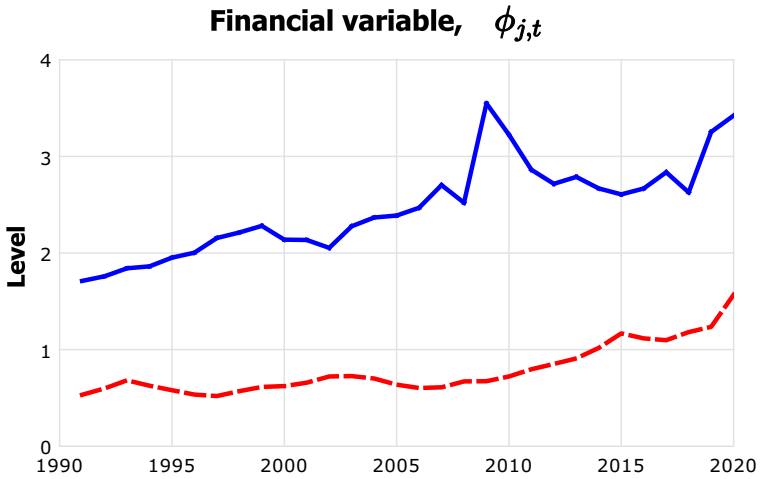
Identification of financial factors

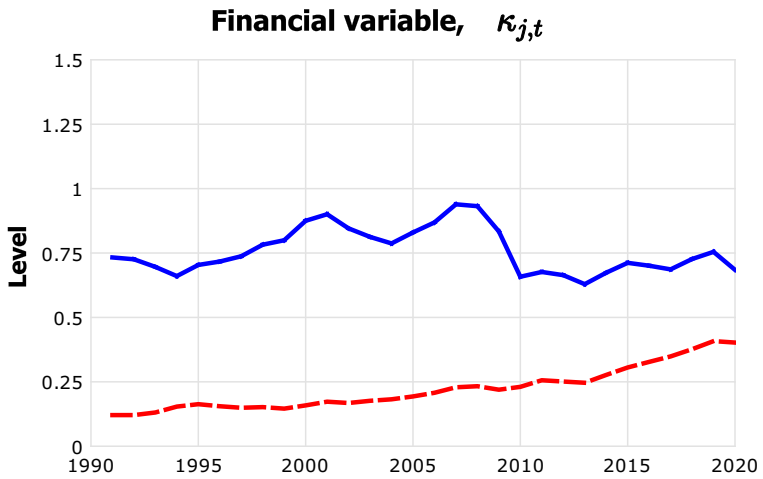
$(\phi_{1,t},\ \phi_{2,t},\ \kappa_{1,t},\ \kappa_{2,t})$



Constructed series of productivity and financial factors

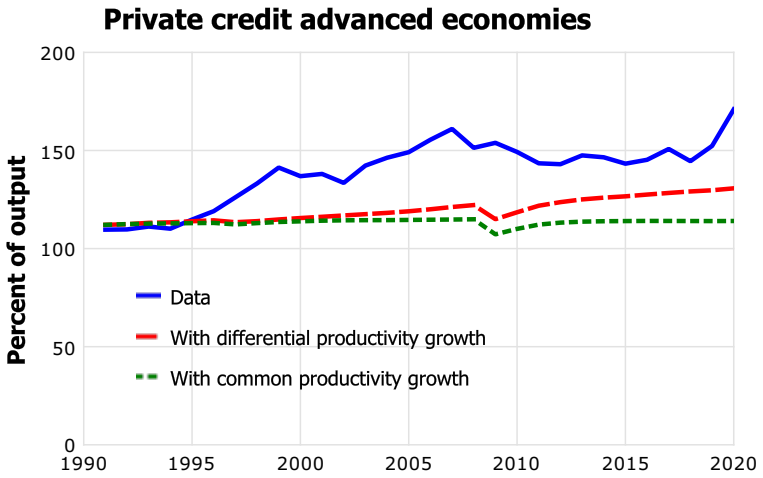


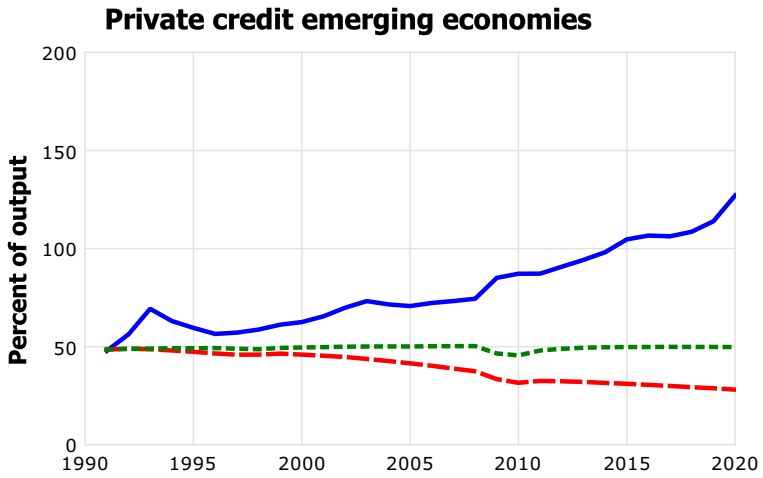


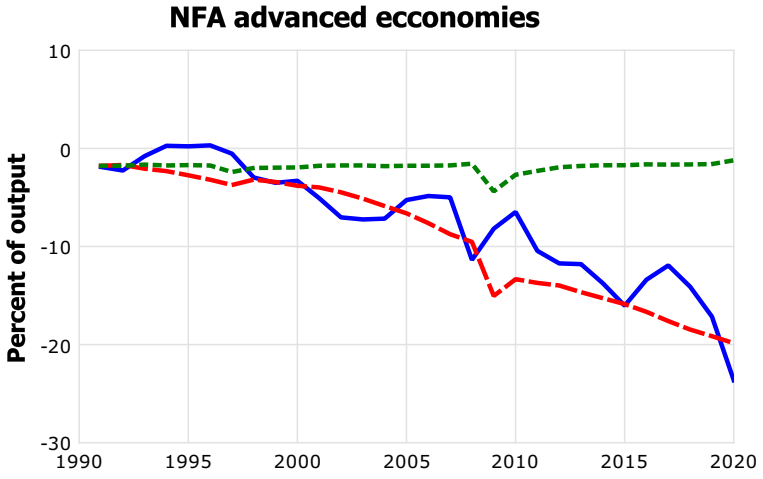


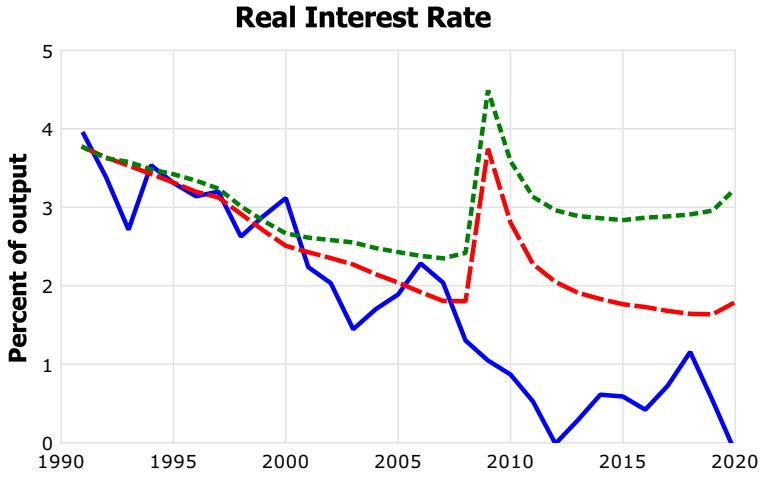
Counterfactual I: Productivity changes only

($z_{1,t}$, $z_{2,t}$ change, $\phi_{1,t}$, $\phi_{2,t}$, $\kappa_{1,t}$, $\kappa_{2,t}$, $FX_{j,t}$, $D_{p,t}$ kept at 1991 values)



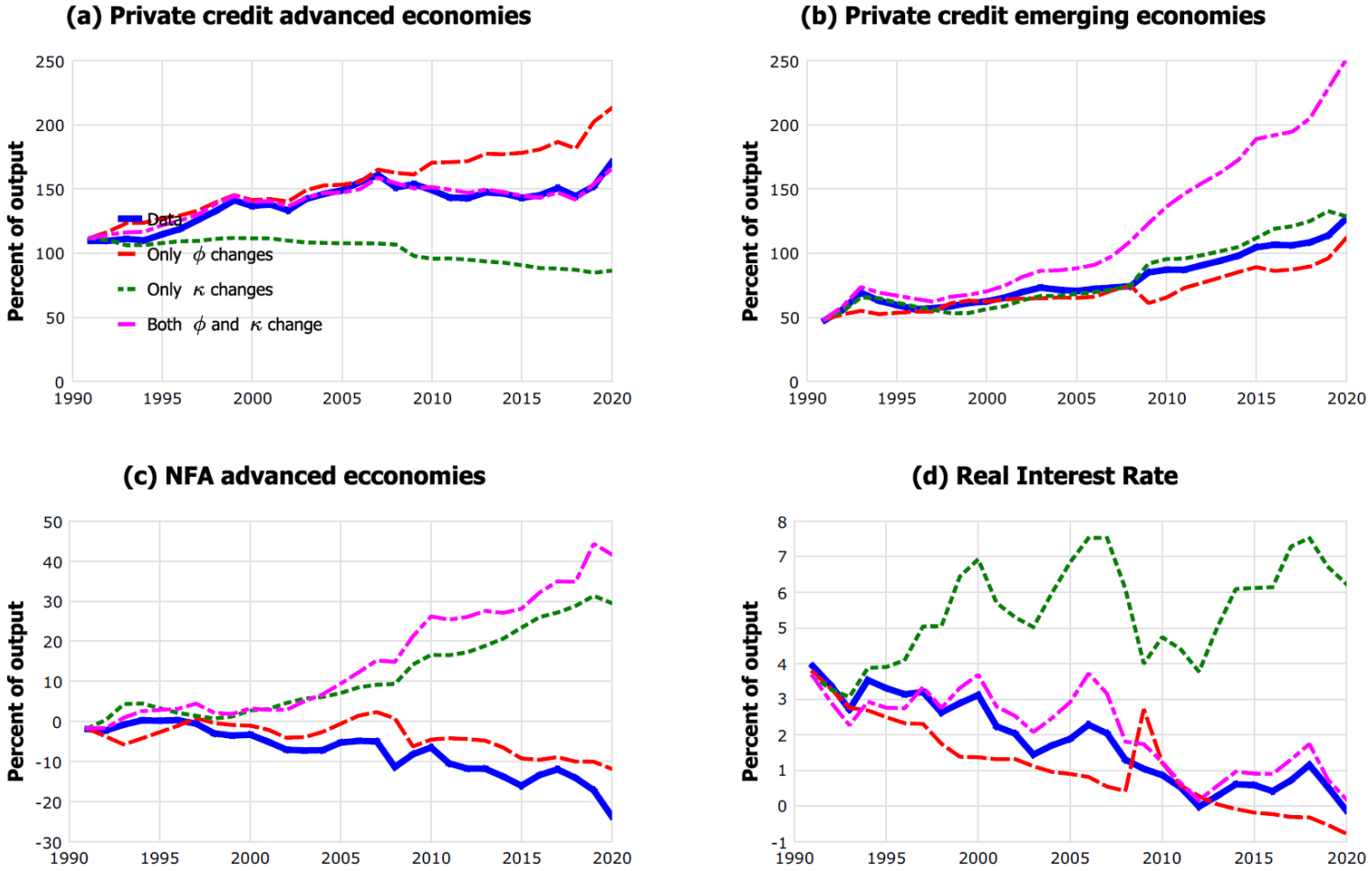






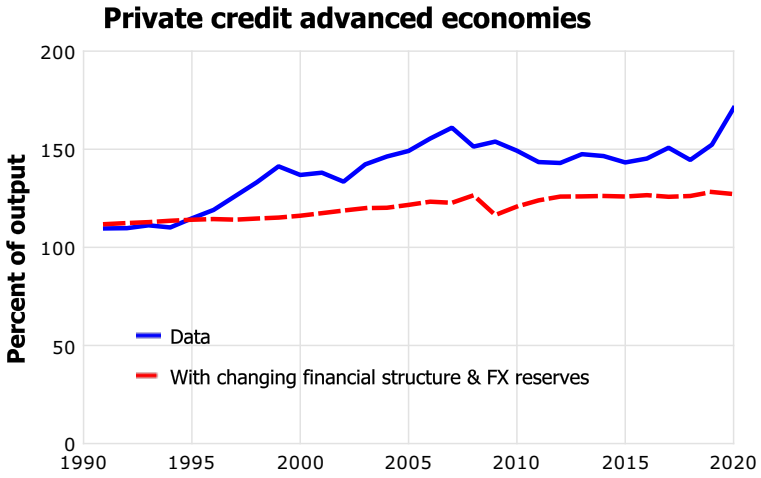
Counterfactual II: Financial changes only

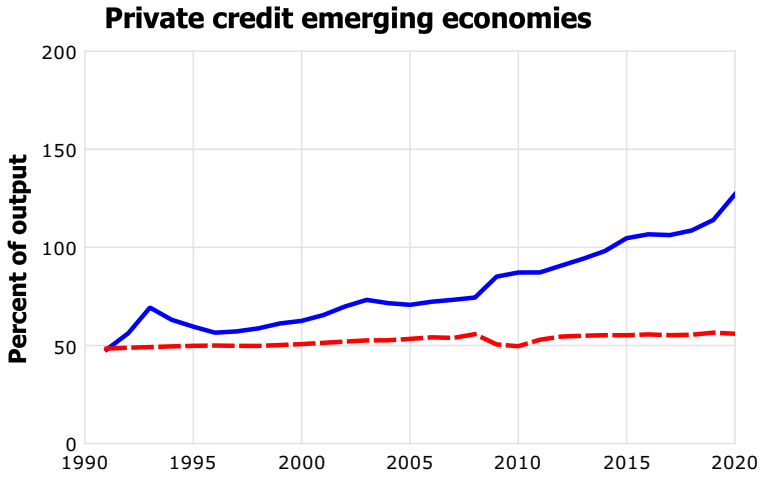
($\phi_{1,t}$, $\phi_{2,t}$ and/or $\kappa_{1,t}$, $\kappa_{2,t}$ change, $z_{1,t}$, $z_{2,t}$, $FX_{j,t}$, $D_{p,t}$ kept at 1991 values)

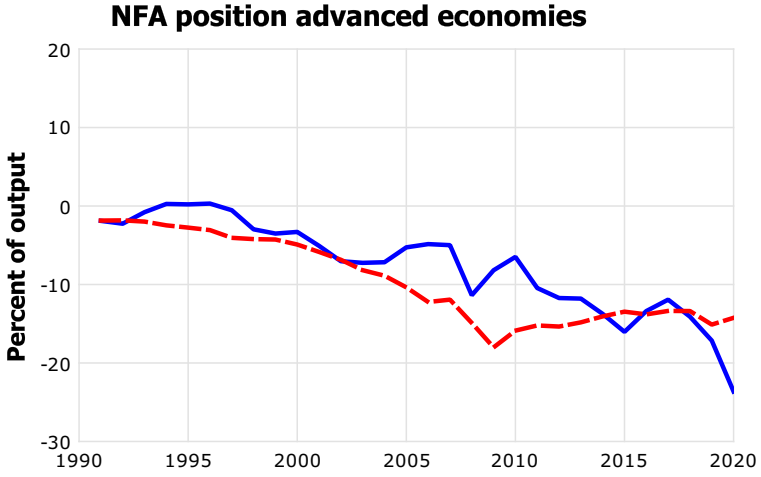


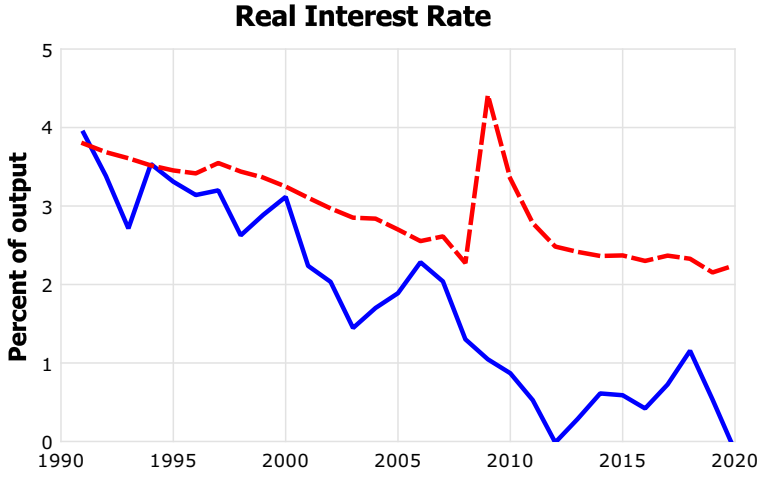
Counterfactual III: Surge in FX reserves only

($FX_{j,t}$ changes, $z_{1,t}$, $z_{2,t}$, $\phi_{1,t}$, $\phi_{2,t}$, $\kappa_{1,t}$, $\kappa_{2,t}$, $D_{p,t}$ constant at 1991 values)



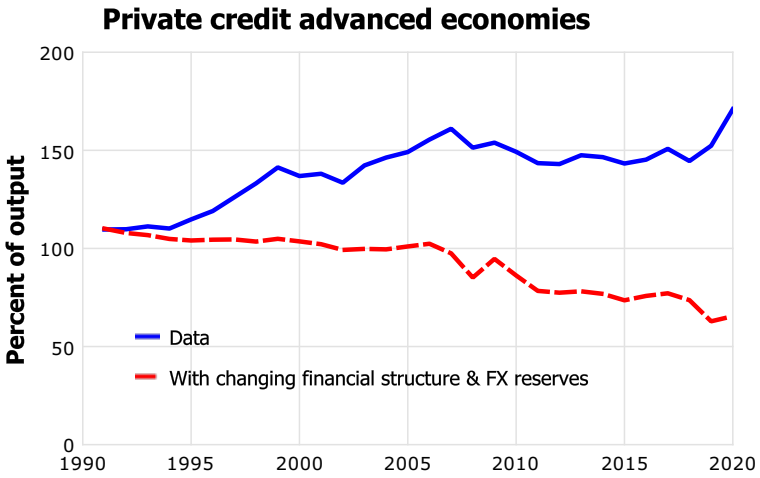


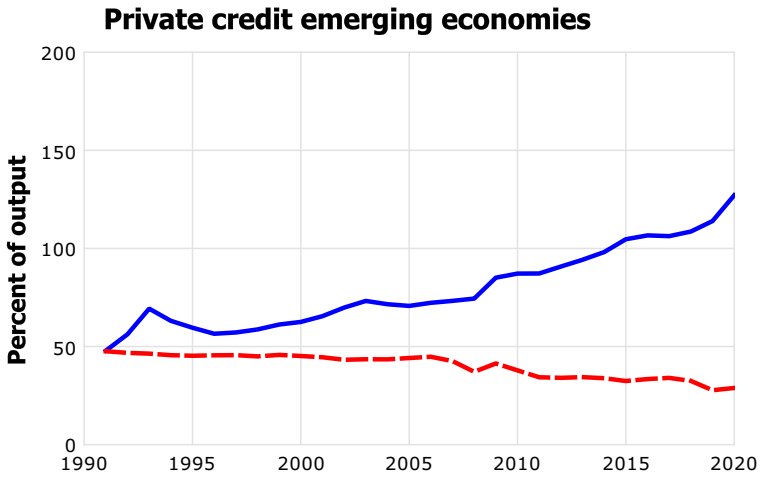


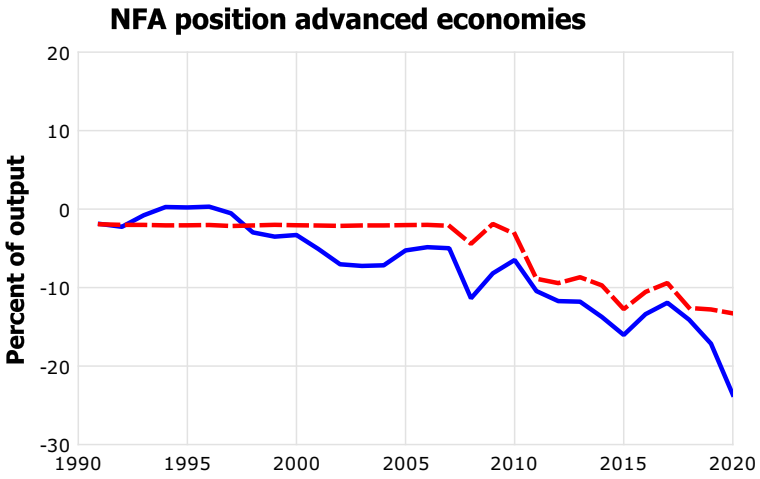


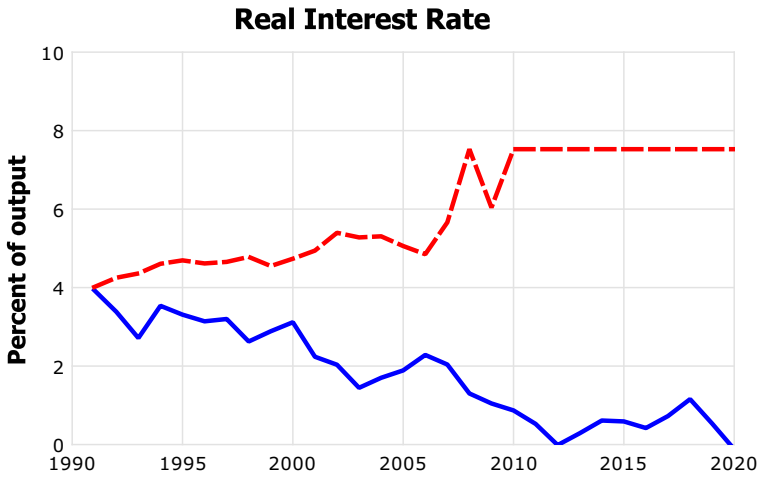
Counterfactual IV: Increase in AE's public debt only

($D_{p,t}$ changes, $z_{1,t}$, $z_{2,t}$, $\phi_{1,t}$, $\phi_{2,t}$, $\kappa_{1,t}$, $\kappa_{2,t}$, $FX_{j,t}$ constant at 1991 values)









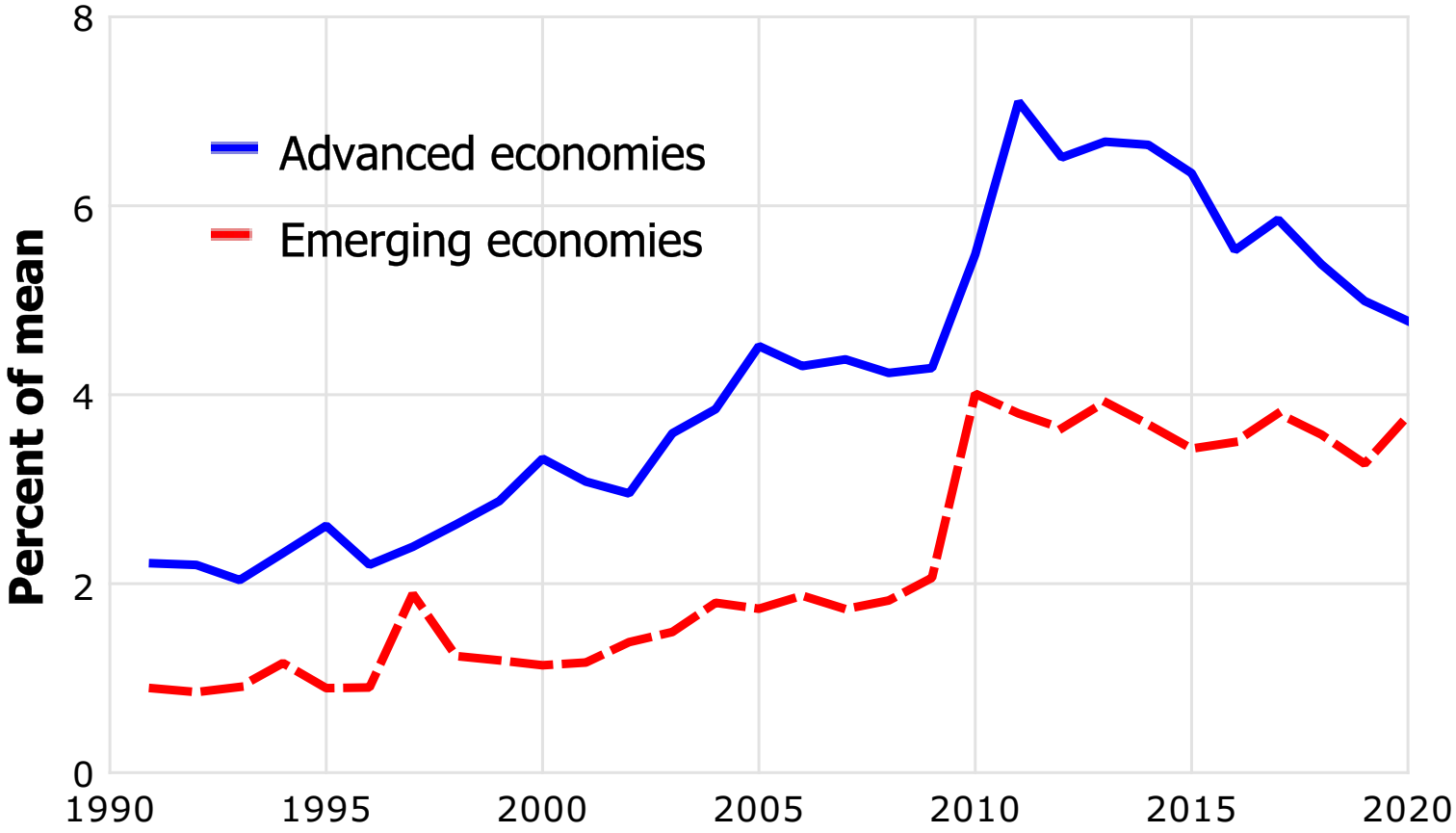
MACROECONOMIC VOLATILITY

Volatility measurement

- Simulate the model over the period 1991-2020.
- Repeat the simulation 10,000 times, each with the same sequences of $z_{i,t}$, $\phi_{i,t}$, $\kappa_{i,t}$, $FX_{i,t}$, $D_{p,t}$ but different draws of the shocks $\varepsilon_{i,t}$.
- In each year, compute the mean and 5/95 percentiles of the 10,000 data points generated by the 10,000 repeated simulations.
- Volatility measure

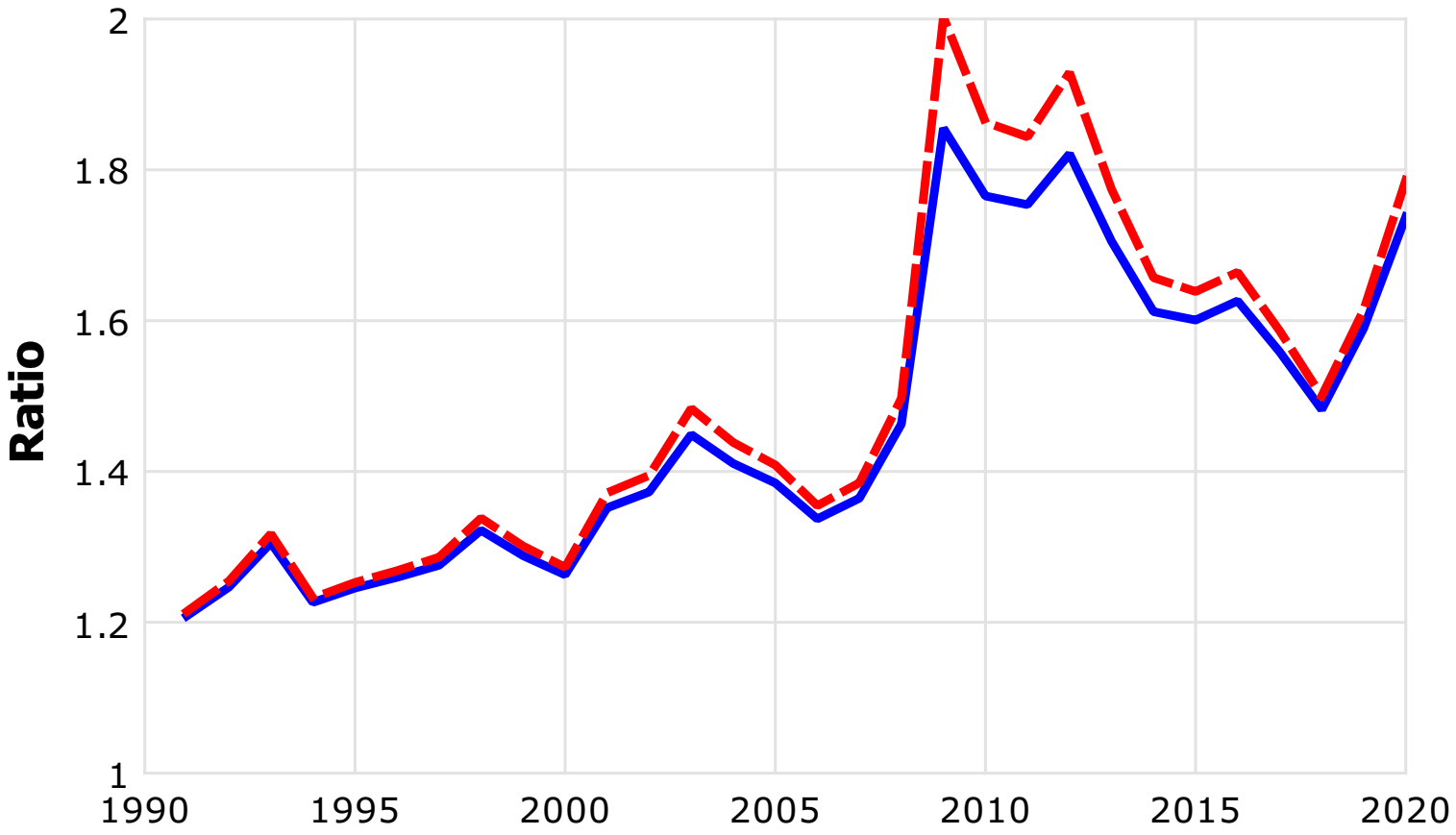
$$VOL_t = \left(\frac{P_t(95) - P_t(5)}{\overline{Y}_t} \right) \times 100.$$

Increased Output volatility



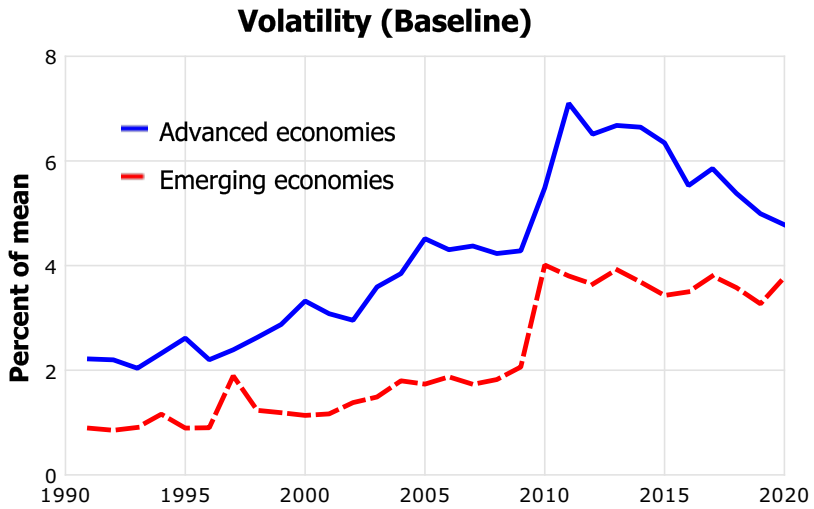
Why did volatility increase?

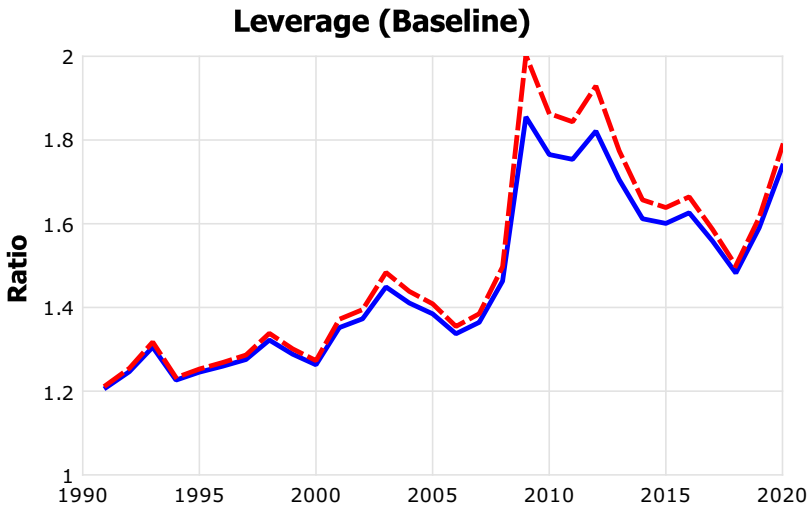
Higher effective leverage ($D_{j,t}/\kappa_{j,t}K_{j,t}$)

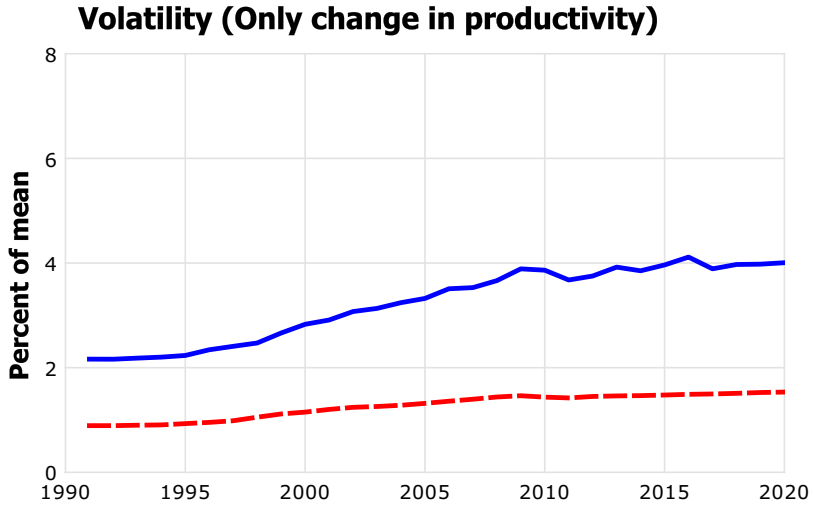


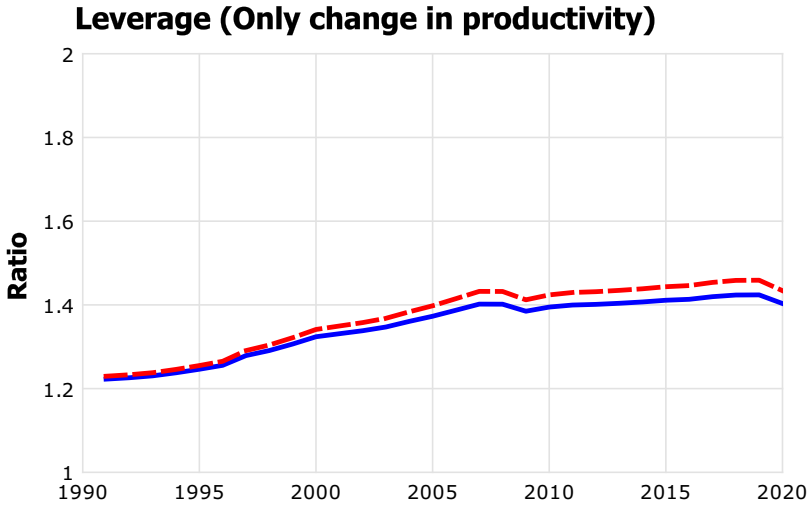
Counterfactuals for increase in volatility

Volatility & leverage: Baseline v. TFP changes only



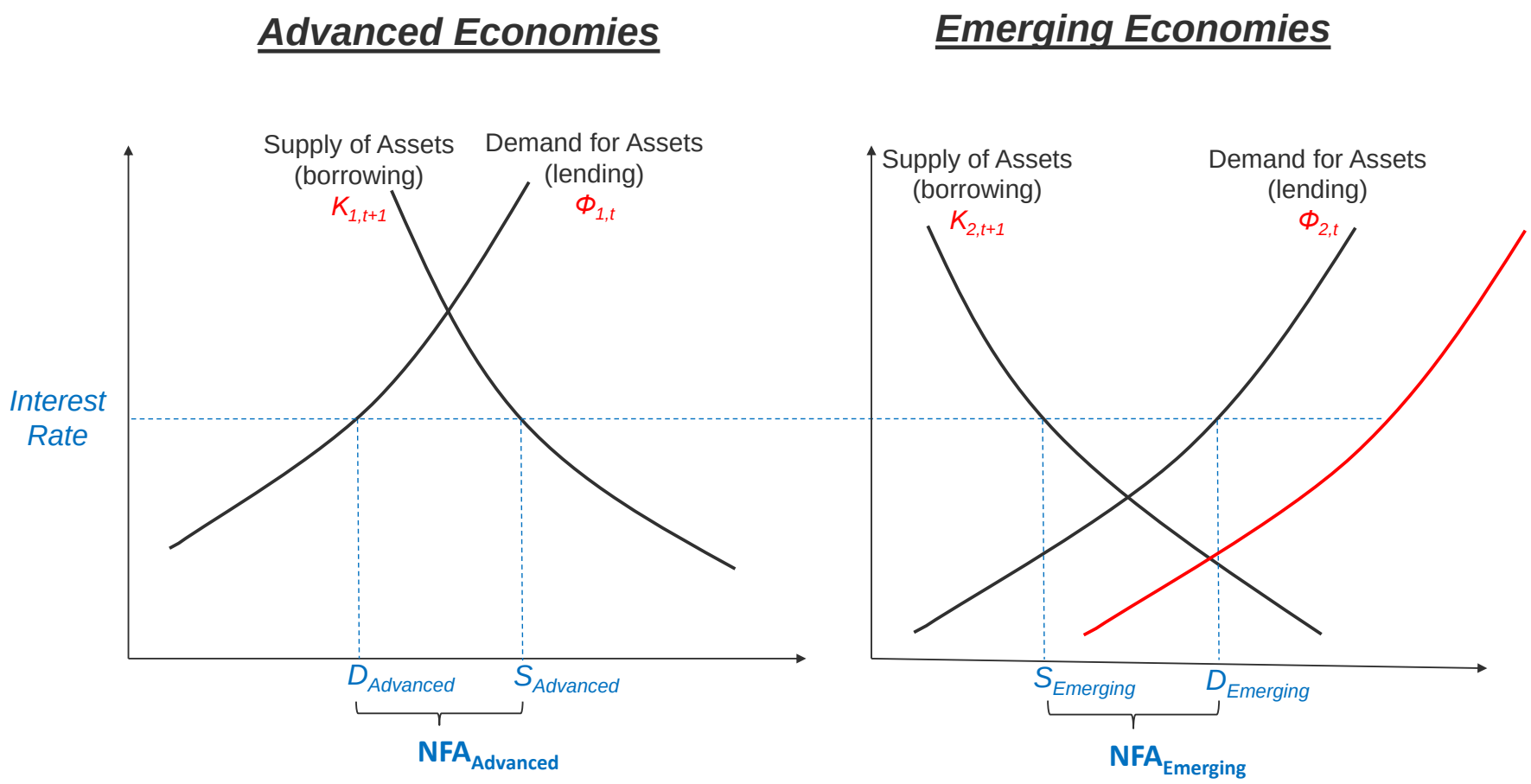




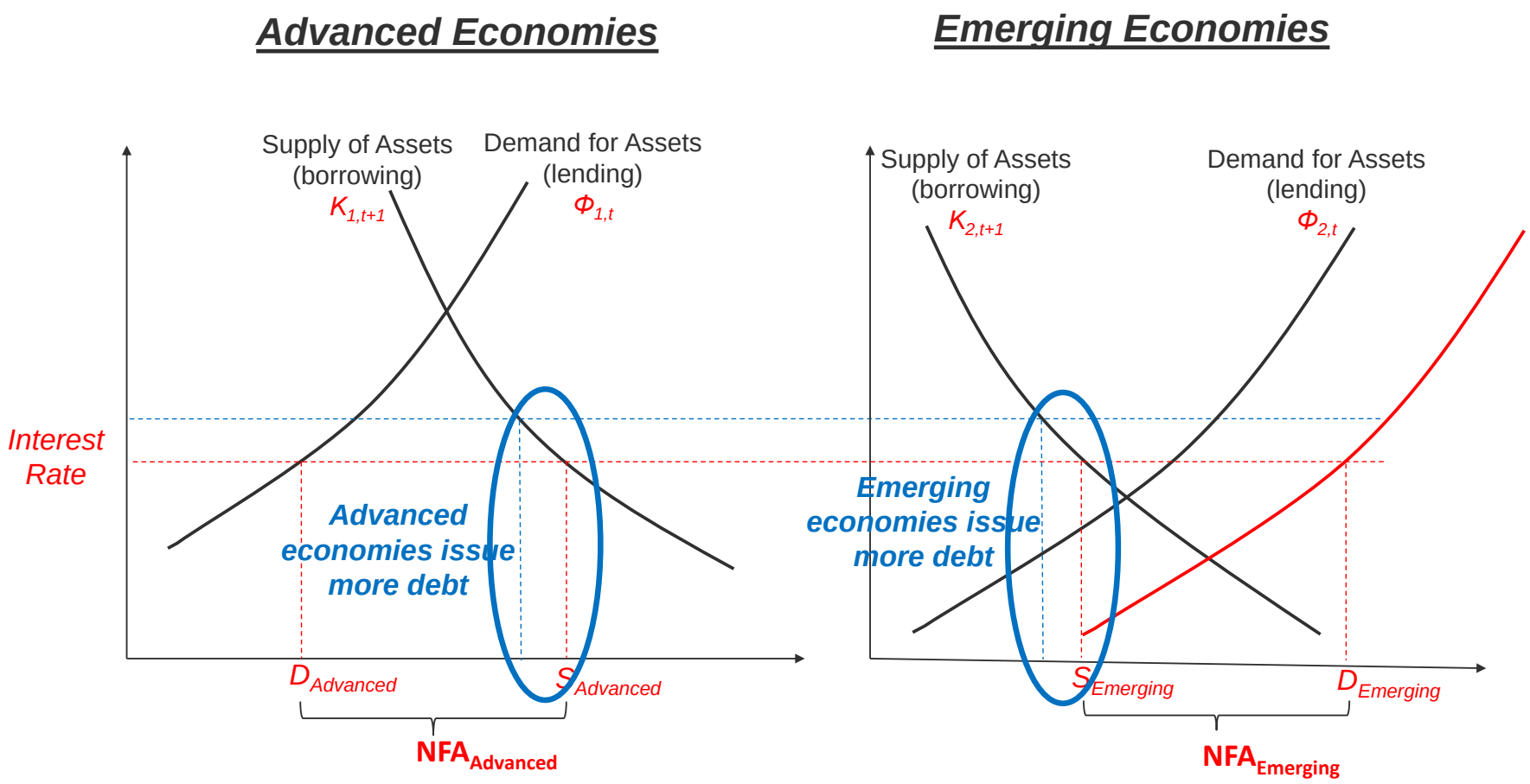


Why did the fast growth of emerging economies increase leverage & volatility?

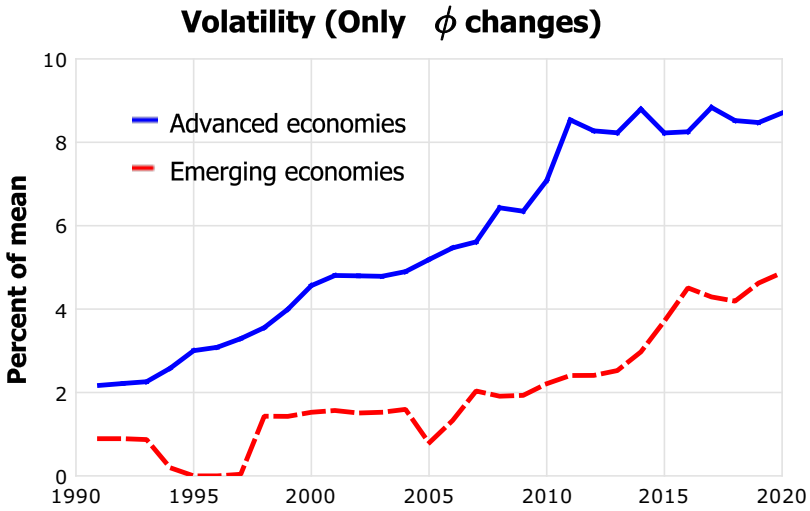
Asset market equilibrium: $EE's$ demand shift

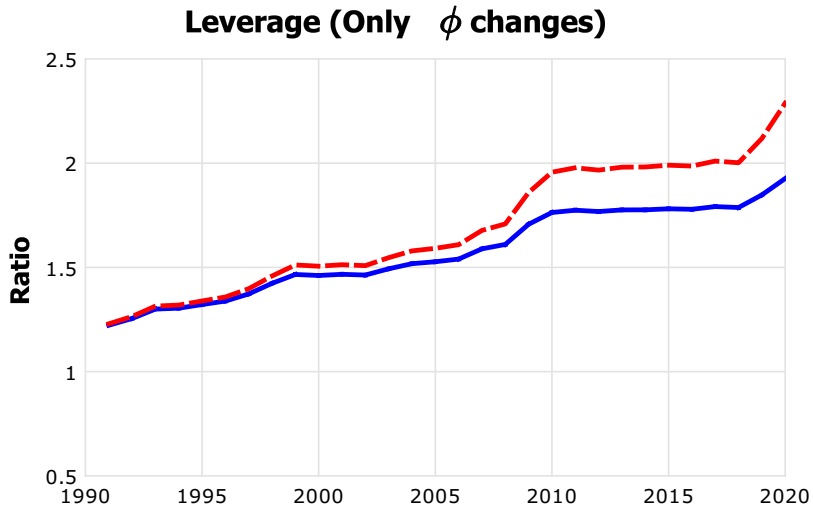


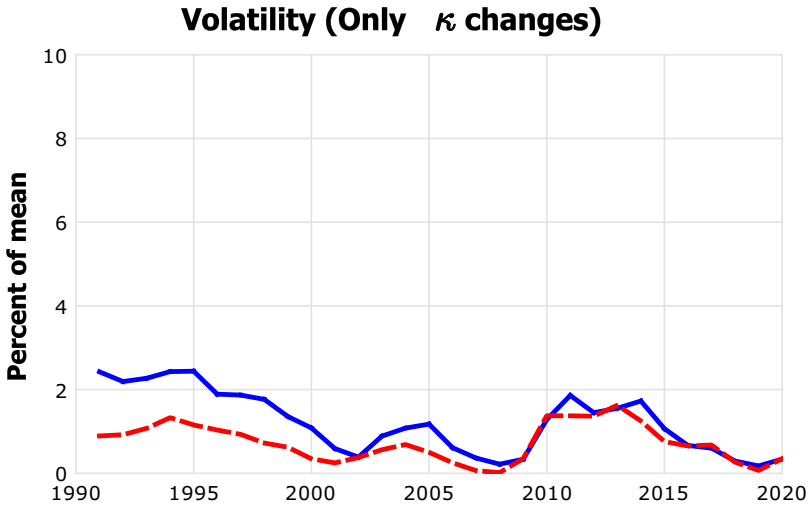
Asset market equilibrium: Fall in interest rate & AE's NFA, higher *global* debt issuance

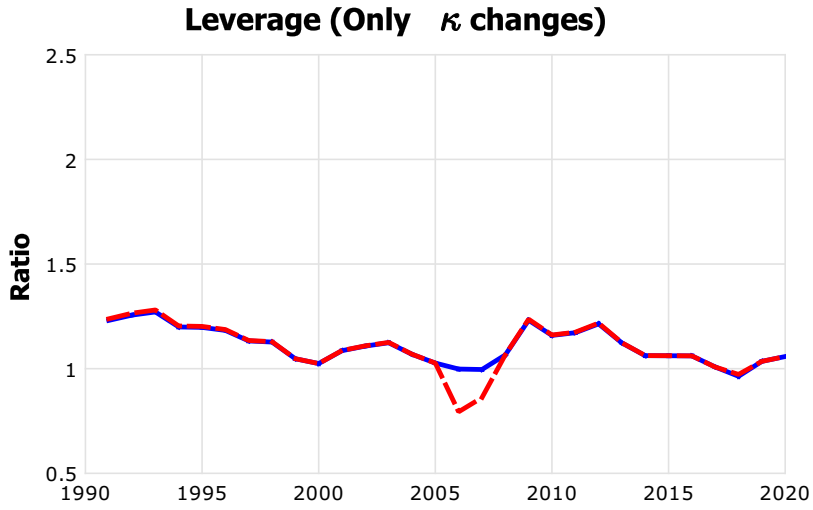


Volatility & leverage: Effects of asset demand v. supply

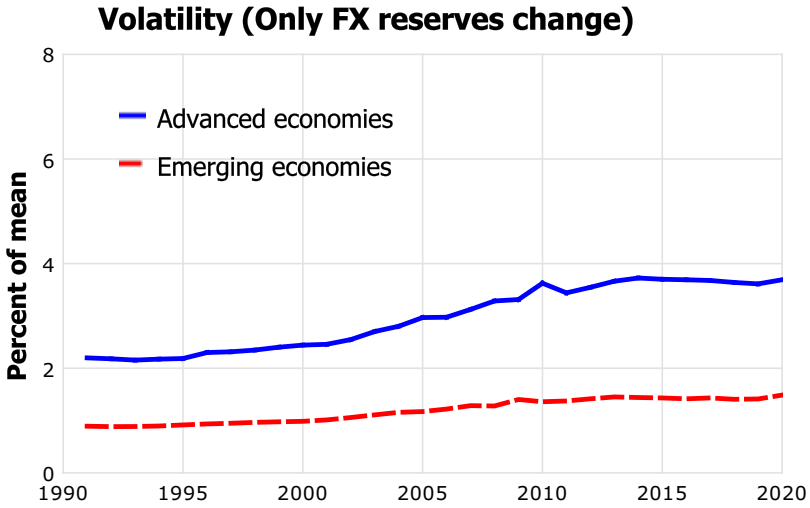


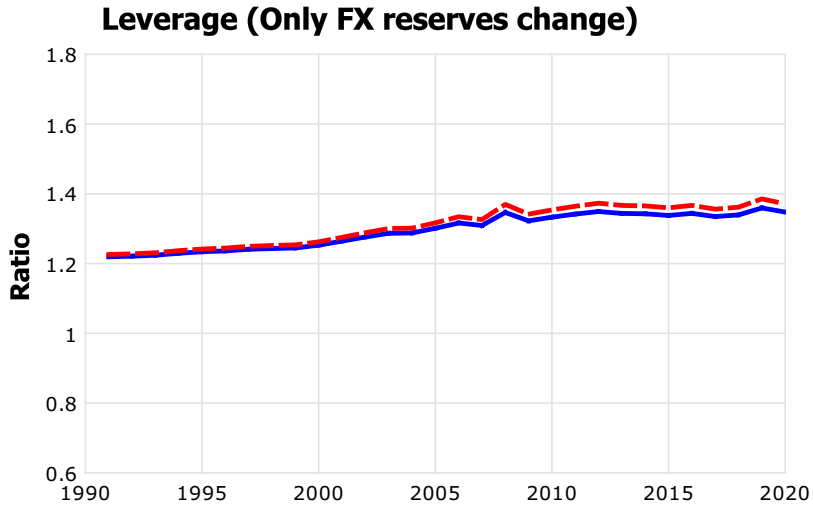


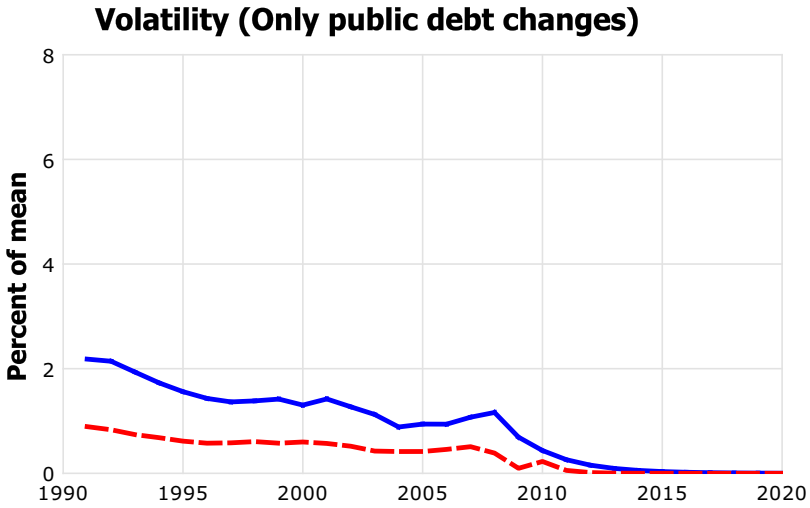


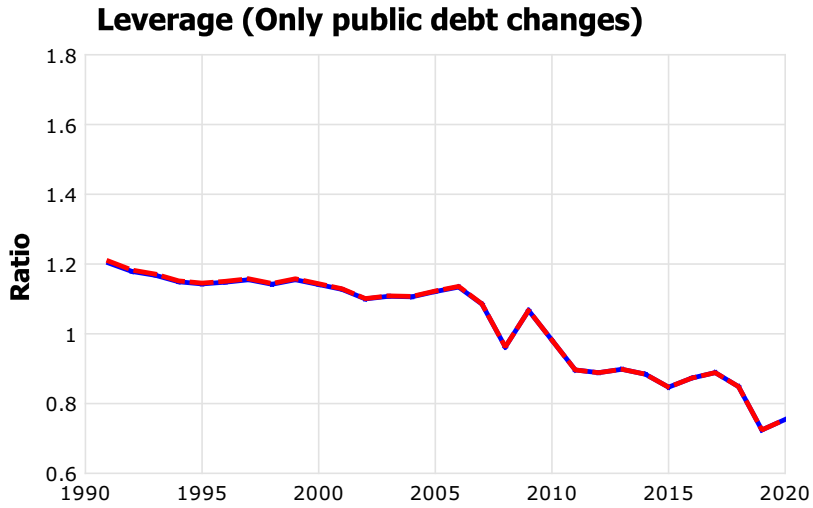


Volatility & leverage: Effects of reserves & AE's debt









Conclusions

- Forces driving world demand for assets (i)EE's relative growth, ii) structural demand changes, iii) surge in FX) grew more than those driving supply (i) higher AE's public debt, ii) structural supply changes)
- As a result the real interest rate and NFA of AE's fell, credit rose globally, and incentives to leverage strengthened.
- Higher leverage increased exposure to crises and macro volatility.
- Output (asset price) volatility rose by a factor of 3-4 (3-10)
- TFP growth and FX alone cannot explain the surge in credit and volatility, particularly post GFC.
- Financial crises become more likely after build-up of leverage at low interest rates (tightening MP at low rates is significantly more risky)