Capital Flows and Sudden Stops

Macroeconomics IV

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References

- Caballero, R.J. and A. Krishnamurthy, "Bubbles and Capital Flow Volatility: Causes and Risk Management," *Journal of Monetary Economics*, 53(1), 35-53, January 2006.
- Caballero, R.J., Emmanuel Farhi, and Pierre-Olivier Gourinchas, "An Equilibrium Model of "Global Imbalances" and Low Interest Rates," *American Economic Review* 2008, 98:1, pgs 358-393.
- Caballero, R.J. and A. Krishnamurthy, "Global Imbalances and Financial Fragility." *American Economic Review Papers and Proceedings*, Vol 99, No. 2, May 2009, pp. 584-588

Introduction

- Massive capital flows and extensive and heated policy debate. The IMF, QE2, Currency wars, ...
- Concern with sudden stops
- Global "imbalances"
- Goal: Introduce you to some of these topics (among other reasons: the global context is key for understanding significant macroeconomic events in the modern world)

Caballero-Krishnamurthy I: Overview

- Emerging market economies have significant growth potential but limited financial development.
- Limited domestic financial instruments means that agents seek to store value (hoard liquidity) abroad.
- These outflows are costly – would rather grow the economy. But physical assets generate few financial assets.
- In this environment rational (real estate) bubbles are likely to arise (akin to dynamic inefficiency).
- But bubbles depend on coordination and hence are fragile. Crashes are likely to take place.
- There is a sort of "aggregate liquidity illusion." Too much investment in real estate and too little in true international collateral. Agents undervalue the aggregate fragility that such decision brings.

The Model

- OLG
- Two goods: Storable international good; perishable domestic good.
- Born with $\{W_t, RK_t\}$.
- When old:
  - All plants produce RK_t
  - Half of the plants have an investment opportunity (entrepreneurs and bankers). Can produce RI_{t+1} units of domestic goods for an investment of I_{t+1} units of international resources.
  - $W_t' = (1 + r^*)W_t$

The Model

- Local loan market:

$$\frac{1}{2} I_{t+1} \leq \frac{1}{2} \psi \frac{RK_t}{p_{t+1}}; \qquad \frac{1}{2} W_t'$$

$$1 \leq p_{t+1} \leq R.$$

Let's assume

$$\psi R < 1; \qquad W = K$$

$$p_{t+1} = 1$$

- "Dynamic inefficiency:" $g > r*$ (note that we could have $R >> g$)

$$NetOutflow_t = W_t - (1 + r^*) W_{t-1} = (g - r^*) W_{t-1} > 0.$$

Real Estate Bubbles

- Stochastic bubble: crashes with probability λ.

$$\widetilde{r^b} = \{g, -1\}$$

$$W' = W_t \left(1 + r^* + \alpha_t(\tilde{r}^b - r^*)\right)$$

$$RK_t + RW_t^{'} + (R - \tilde{p}_{t+1})\frac{\psi R}{\tilde{p}_{t+1}} K_t.$$

$$RK_t + W_t^{'}\tilde{p}_{t+1}.$$

Real Estate Bubbles

$$\max_{0\leq\alpha\leq 1} \mathrm{E_t}\left\{RK_t + W_t^{'}\frac{R+\tilde{p}_{t+1}}{2} + \frac{R-\tilde{p}_{t+1}}{2}\frac{\psi R}{\tilde{p}_{t+1}}K_t\right\}.$$

$$(1-\lambda)\frac{R+p^B_{t+1}}{2}\Delta r^b - \lambda(1+r^*)\frac{R+p^C_{t+1}}{2} \qquad (1)$$

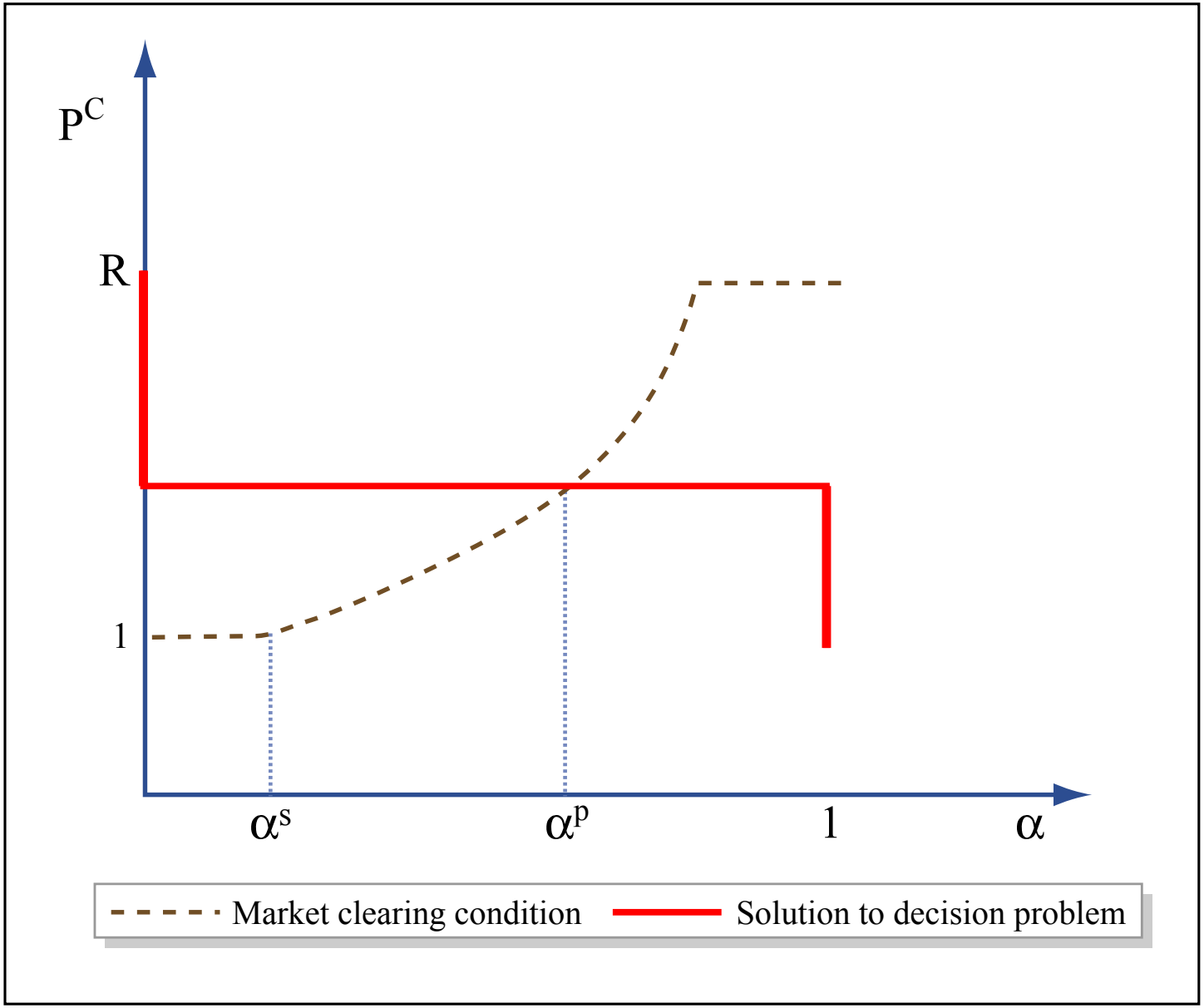
$$\Delta r^b \equiv g - r^*$$

$$p^B = 1$$

and (credit crunch)

$$p^C = \frac{\psi RK}{(1-\alpha)W(1+r^*)} = \frac{\psi R}{(1-\alpha)}$$

Real Estate Bubbles



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Excess Volatility

- Social foc (derivative w.r.t. α):

$$(1-\lambda)\frac{R+1}{2}\frac{\Delta r^b}{1+r^*}-\lambda R$$

- Private:

$$(1-\lambda)\frac{R+1}{2}\frac{\Delta r^b}{1+r^*}-\lambda\frac{R+p^C_{t+1}}{2}$$

- $p^C_{t+1} < R$: Banker does not share equally in the marginal product R. Thus, it overinvests in bubble-asset
- Welfare maximizing choice: set α^S to the maximum value that does not lead to a credit crunch if the bubble crashes.

Aggregate Risk Management Policies

- Prudential Banking Regulations (liquidity requirements)
  - Each generation is forced to maintain $(1-\alpha^S)$ in international reserves (e.g. Argentina during the convertibility plan). Thus, even if the bubble bursts there is no credit crunch.
  - Problem: at $p^C_{t+1}=1$ there is a strong incentive to cheat (as in Jacklin 1987). Agent wants to set $\alpha=1$ (expected gain relative to investing α^S).

$$W(1-\alpha^S)(\widehat{r^b}-r^*)>0$$

  - If portfolio decisions are costly to observe, a liquidity requirement will be costly to impose. If the costs are high enough, the economy will revert to the equilibrium $\alpha=\alpha^p$.
- Capital Inflow Sterilization
  - Less monitoring of positions but government needs to have credible taxation power.
  - Sterilization: Sell bonds in exchange for capital flows [it is called sterilization for monetary reasons, which I'll omit here – no monetary friction]

Aggregate Risk Management Policies

- Capital Inflow Sterilization
  - Issue one period debt with face value G_t at interest rate r_t^G. Raise taxes τ_s on the international endowment of generation t. Revenue invested at r^*, and returned to generation t. If large enough, can solve the excess volatility problem. If taxation ability is not large enough, then the govt can't credibly raise interest rate and sterilization fails.

$$\left(\tau_s W_t + \frac{G_t}{1+r_t^G}\right)(1+r^*) - G_t = 0$$

$$G_t > G_t^* \equiv (1-\alpha^p) W_t (1+r^*)$$

  - If it works,

$$W' = W_t(1-\tau_s)\left(1 + r^G + \alpha_t(\tilde{r}^b - r^G)\right)$$

  - The private's foc is:

$$(1-\lambda)\frac{R + p_{t+1}^B}{2}(g - r^G) - \lambda(1+r^G)\frac{R + p_{t+1}^C}{2}$$

Aggregate Risk Management Policies

- Capital Inflow Sterilization
  - Evaluated at $p^B_{t+1} = p^C_{t+1} = 1$, yields

$$r^G_t = (1-\lambda)g - \lambda = \widehat{r^b}.$$

  - If the government sells debt that raises $(1-\alpha^S)W_t$ resources at t, agents purchase the debt and bubbles. Since at the margin debt crowds out the bubble, they must have the same expected return. Doing so requires to raise taxes of:

$$\tau_s = (1-\alpha^S)\frac{\widehat{r^b} - r^*}{1+r^*}$$

  - If the govt is limited in its ability to raise taxes, then it can only implement small sterilizations, which is ineffective since it just crowds out external (safe) bonds ($r^G_t = r^*$).
  - Important: Even if it works, it will leave some bubbles since there is still a "dynamic inefficiency."

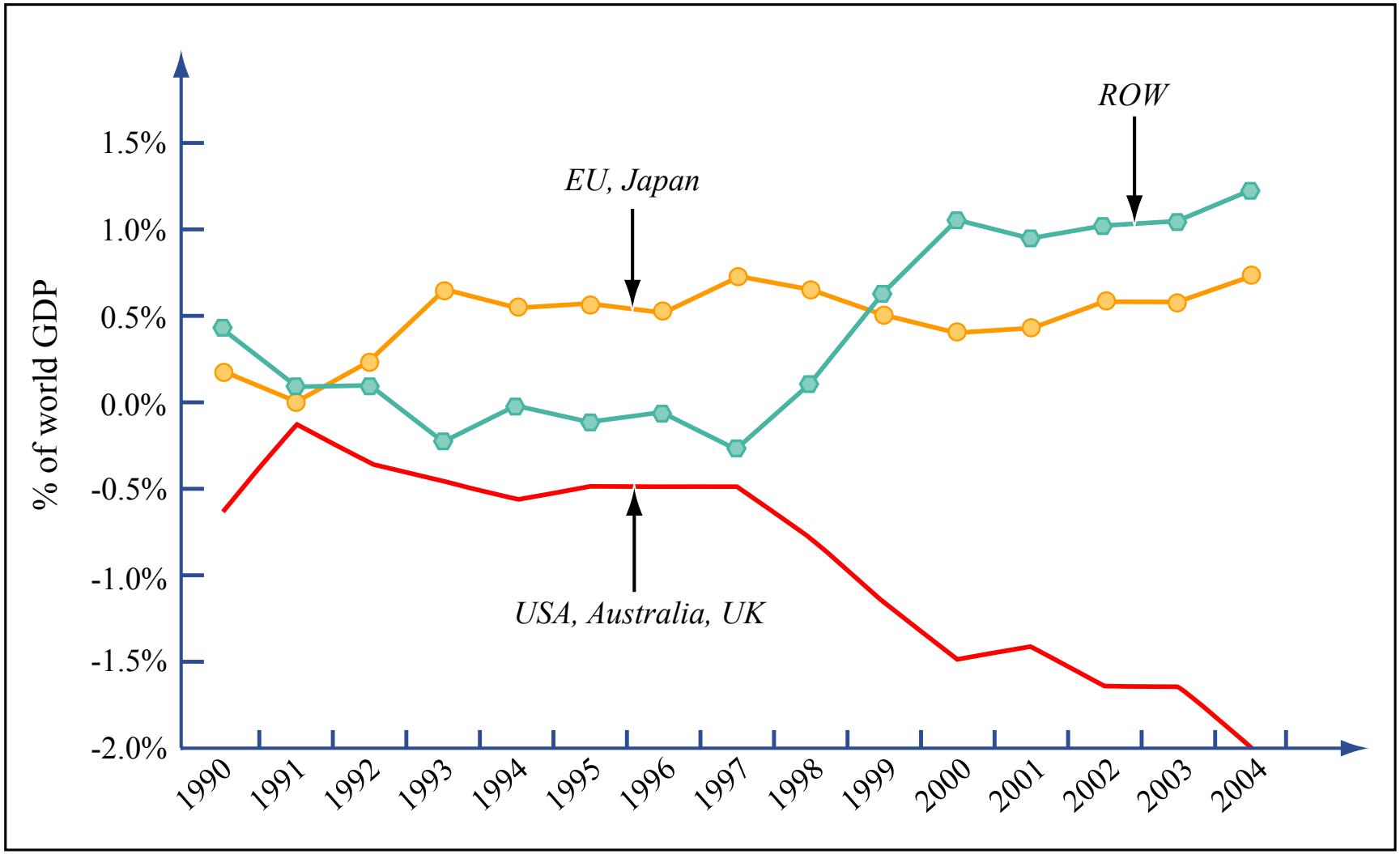
Taking Stock

- (Even RE) Bubbles are likely to arise when there is a large demand for store of value, relative to the supply of store of value
- There are many reasons behind demand for store of value, from consumers and corporations
- If the latter are financially constrained, then bubbles and investment may be complements
- But agents may overexpose themselves to the fragility of these bubbles
- Asian/Russian crisis:
  - Fundamentally changed prudence in EMEs
  - Led to massive capital flows to US (Global Imbalances literature). Eventually people got it that it wasn't expansionary policy in US, but a global equilibrium phenomenon
  - As such, the likelihood of a sudden stop to the US seemed remote.. still, substantial fragility built within the US financial system

Caballero-Farhi-Gourinchas: Introduction

- In this section of the course we focus on the global economy and, in particular, on the forces behind the so called "global imbalances"
- An equilibrium model of global imbalances [mainly Caballero-Farhi-Gourinchas (an older version, which is a bit more pedagogical than the AER version)]

Current Account by Region



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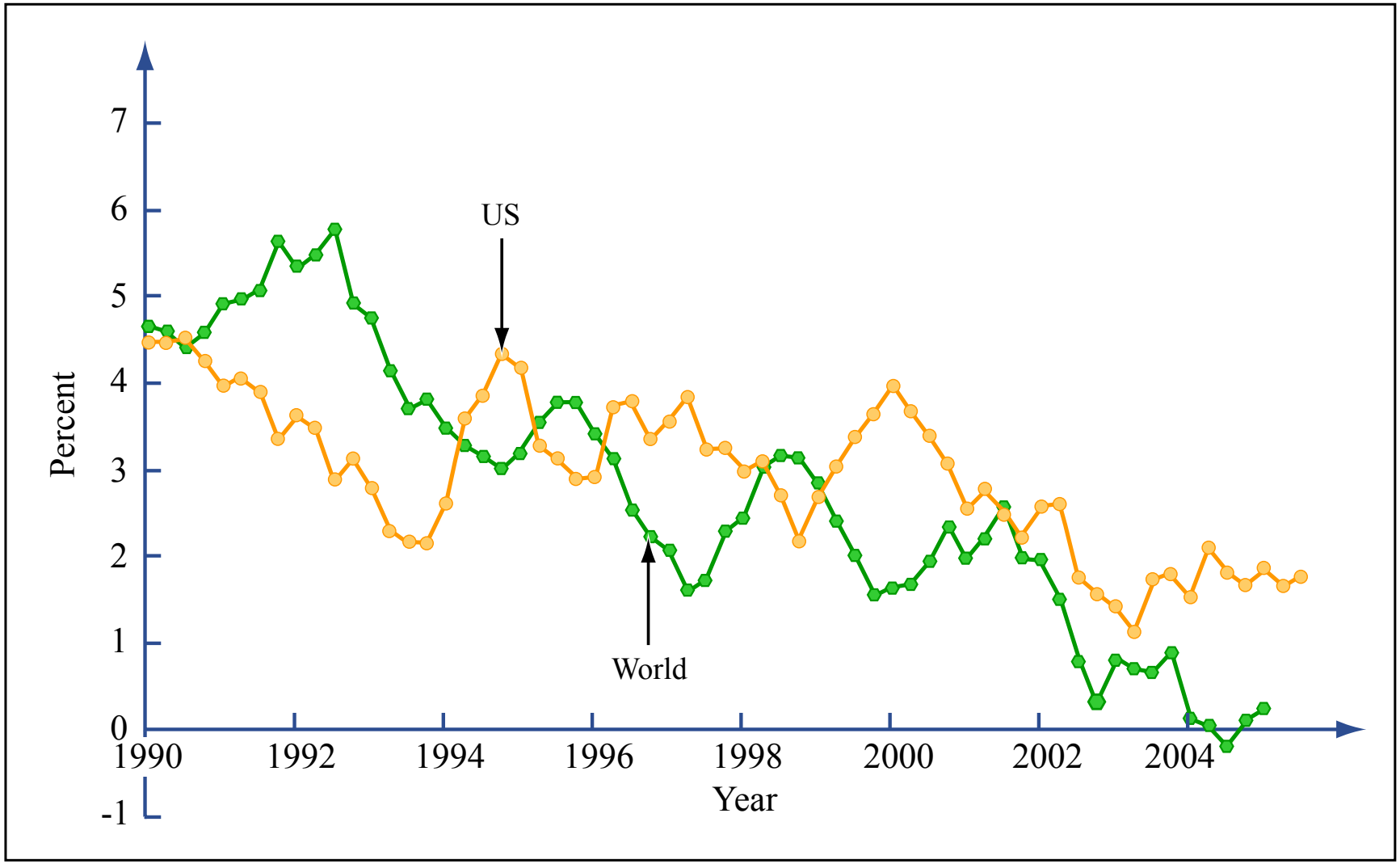
World and US Interest Rates



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The Conventional View

- Sudden stops analogy (the US as a banana republic...)
  - Emerging Markets
  - The 1980s
- Implications for the Euro/Dollar exchange rate (big fuss in the last quarter of 2004). Premise: Adjustment has to happen soon
  - Obstfeld-Rogoff: analysis *conditional* on adjustment
  - Blanchard-Giavazzi-Sa: More gradual adjustment (no further shifts in the US direction).

Global (Equilibrium) Views

- Basic idea: there are global forces behind recent events
  - Demographics and other structural factors in Japan and Europe
  - Global savings glut
  - Growth differentials and heterogeneous financial development
  - China – Bretton Woods II
  - Oil

Caballero, Farhi, Gourinchas

- Provides a framework to analyze equilibrium in global financial markets and the impact of regional macroeconomic shocks
- It is a "shell" type model...

Basic Structure

- Split the world: $U - E - R$
- Key: Regions are heterogeneous in growth potential and financial development
  - $U : \delta,\ g$
  - $E : \delta,\ g^E < g$
    (note: E competes with U in producing global assests)
  - $R : \delta^R < \delta,\ g^R \geq g$
    (note: it matters a great deal *who* is growing faster than U)
- I will focus on the $U - R$ world

Basic Model (closed ec.)

- Continuous time OLG; birth rate=death rate= θ
- Agents only consume just before dying: $C = \theta W$
- One tree / no physical investment (for now)
- Capitalizable and non-capitalizable output

$$X_t = \delta X_t + (1 - \delta) X_t$$

Basic Model (closed ec.)

$$r_t V_t = \delta X_t + \dot{V}_t$$

$$\dot{W}_t = -\theta W_t + (1-\delta) X_t + r_t W_t$$

$$W_t = V_t = \frac{X_t}{\theta}$$

$$r_t = \frac{\dot{X}_t}{X_t} + \delta\theta = g + \delta\theta \equiv r_{aut}$$

Discussion of the setup

Two key ingredients

- The role of asset supply

$$\begin{aligned} PV_t &= \int_t^\infty X_s e^{-\int_t^s r_u du} ds \\ V_t &= \delta PV_t \\ N_t &= (1-\delta) PV_t \end{aligned}$$

- A 'non-Ricardian' consumption function (a la Blanchard (1985) or Weil (1987))

$$C_t = \theta(W_t + \beta N_t) \quad ; \quad \beta < 1$$

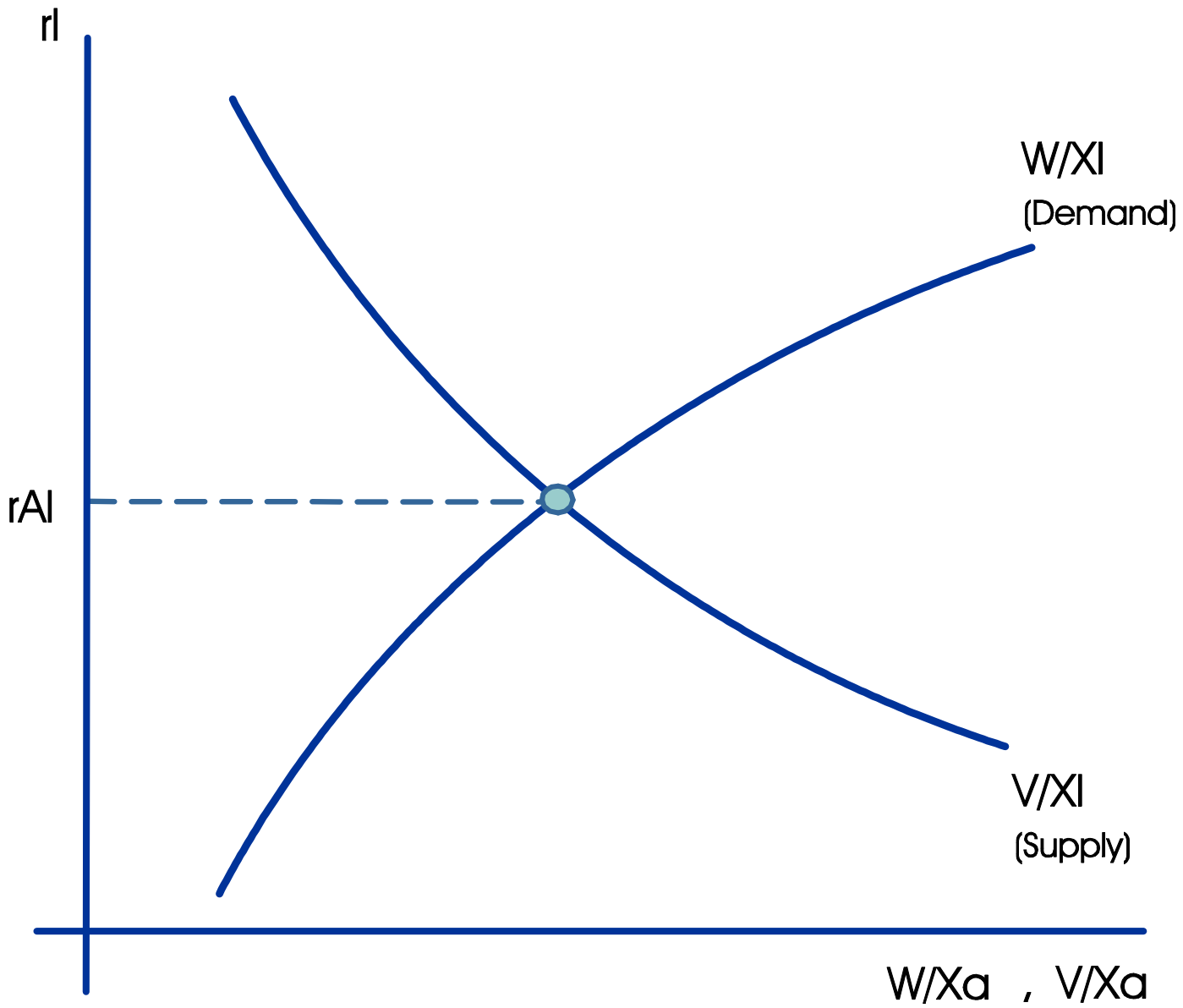
Small Open Economy

- Take r as given

$$V_t = \int_t^\infty \delta X_s e^{-r(s-t)} ds$$
$$= \frac{\delta}{r-g} \cdot X_t$$

$$W_t = W_0 e^{(r-\theta)t} + \int_0^t (1-\delta) X_s e^{(r-\theta)(t-s)} ds$$
$$\underset{t \to \infty}{\to} \frac{(1-\delta)}{g+\theta-r} \cdot X_t$$

The Metzler Diagram



Small Open Economy

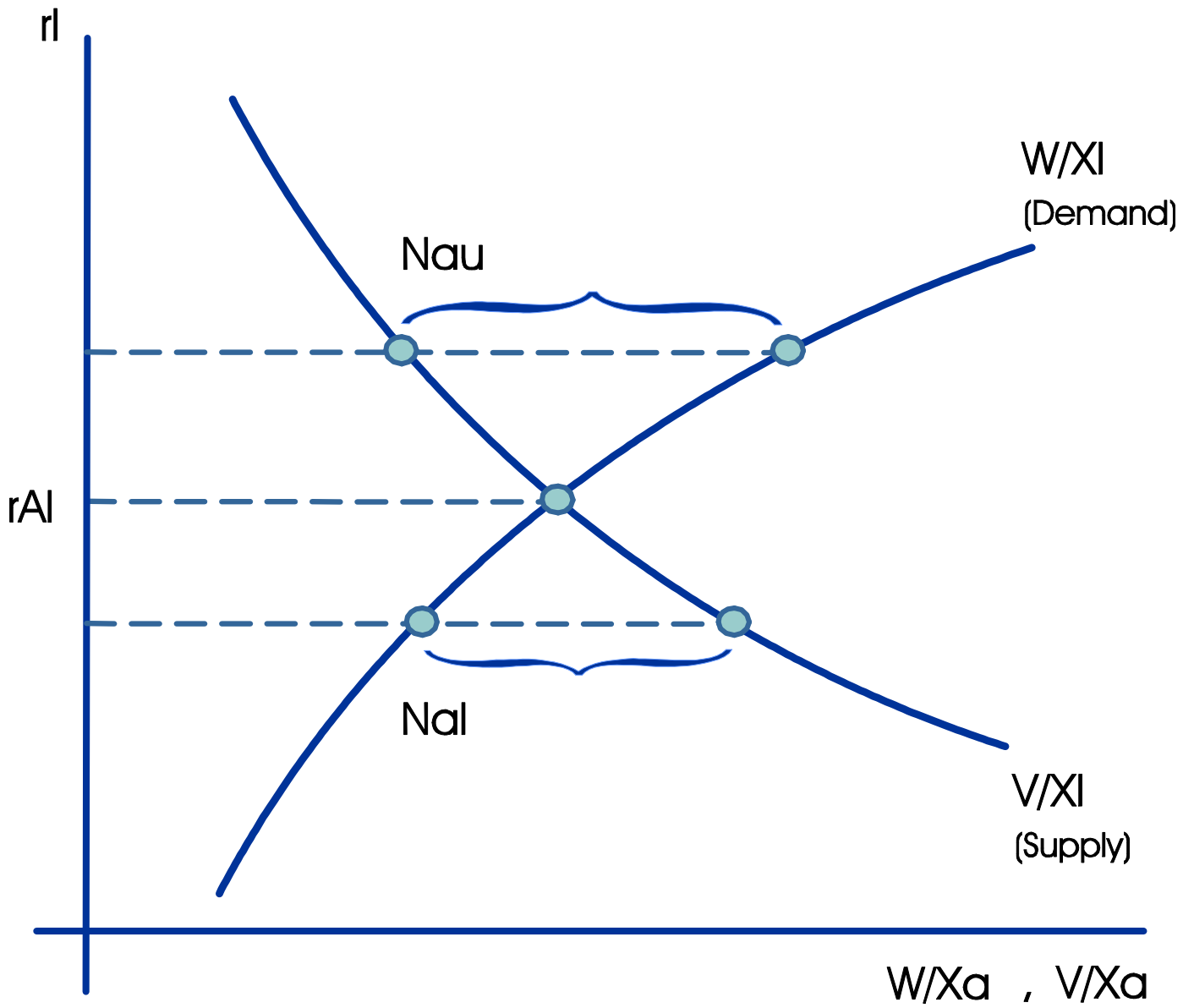
$$CA_t \equiv \dot{W}_t - \dot{V}_t$$

$$\begin{aligned}\frac{CA_t}{X_t} &\underset{t\to\infty}{\to} g \cdot \frac{W_t - V_t}{X_t} \\ &= g \cdot \left(\frac{1-\delta}{g+\theta-r} - \frac{\delta}{r-g} \right) \\ &= -g \cdot \frac{r_{aut} - r}{(g+\theta-r)(r-g)}\end{aligned}$$

Lemma

Metzler diagram applies for any path $\{r_t\}$ *s.t.* $\lim r_t = r$.

The Metzler Diagram



A $U - R$ World

- Shock: $\delta^R = \delta - \Delta_\delta$
- *Interpretation?* The perception that, in the aggregate, financial instruments are less sound; following, e.g., the collapse of a bubble, corporate governance problems, loss of intermediation capital, decline in property rights protection, increased perception of 'crony capitalism'.... (factors present in Asian/Russian crises)
- Two environments: $g^R = g$ and $g^R > g$.

$$r_t = x_t^U (g + \delta\theta) + (1 - x_t^U)(g^R + \delta^R\theta)$$

$$r_{aut}^R \leq r_t < r_{aut}^U$$

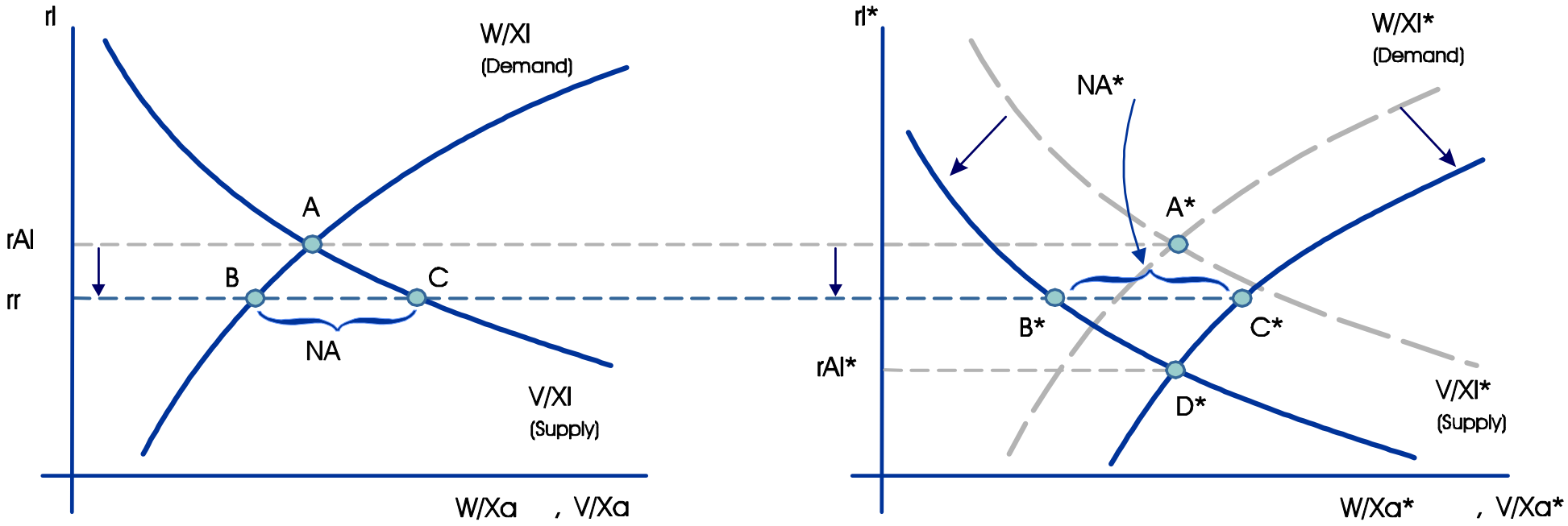


Figure: The Metzler diagram for a permanent drop in δ^R

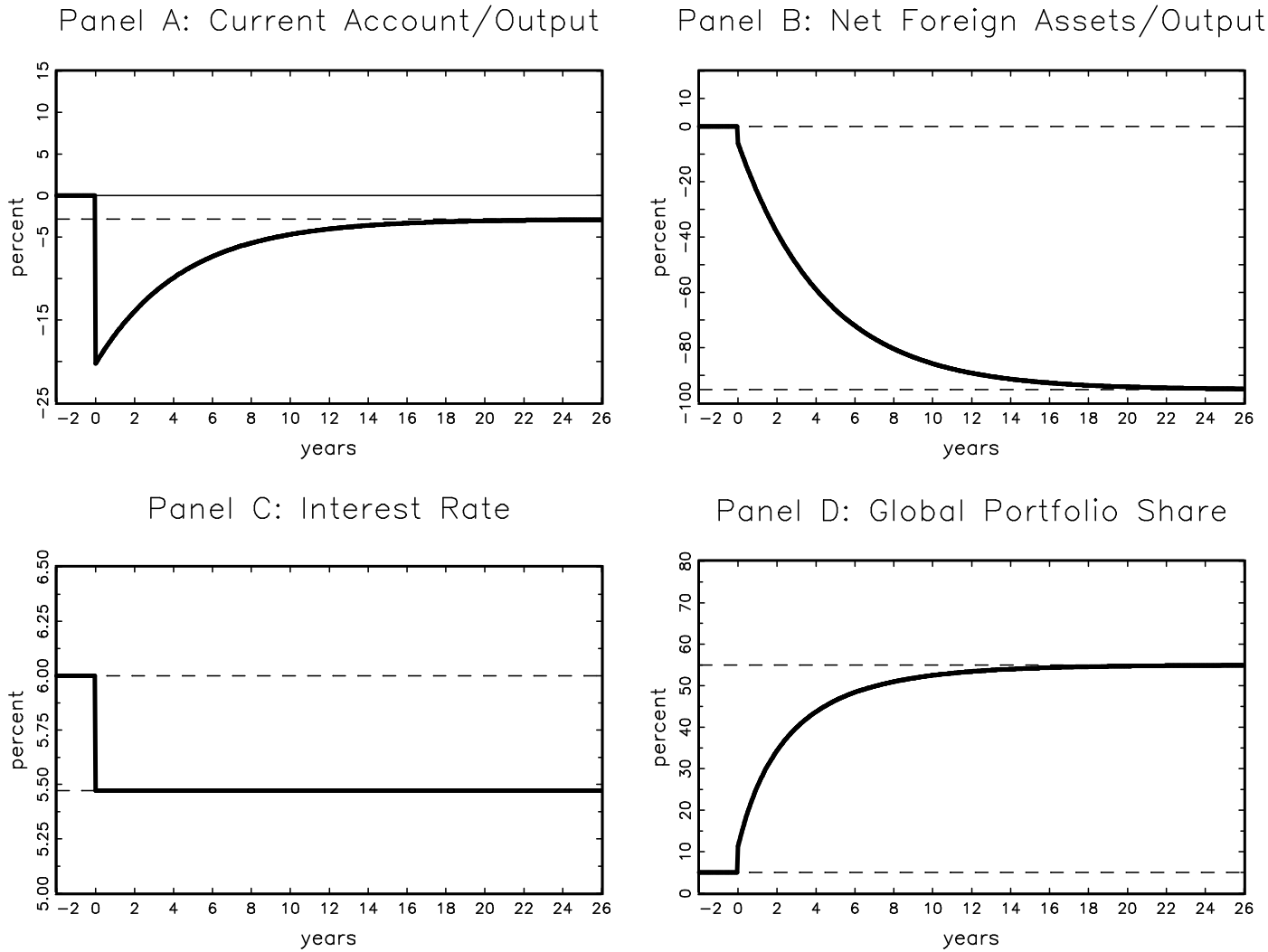


Figure: A Collapse in δ^R when $g^R = g$

A $U - R$ World when $g^R > g$

- If $g^R > g$, demand for assets rises faster that supply. This implies that r_t continues to fall, further expanding the asymptotic current account deficit in U.

$$\lim_{\substack{t\to\infty \\ g^R>g}} \frac{CA_t^U}{X_t^U} < \lim_{\substack{t\to\infty \\ g^R=g}} \frac{CA_t^U}{X_t^U} < 0$$

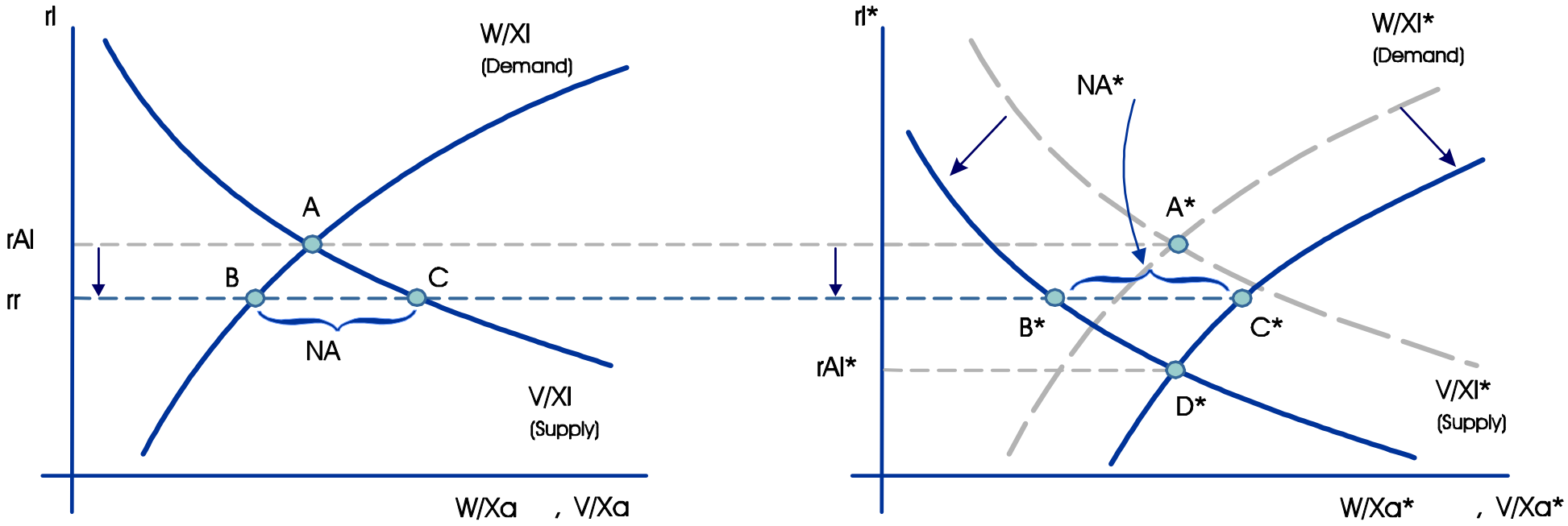


Figure: The Metzler diagram for a permanent drop in δ^R

Caballero-Krishnamurthy II: Introduction

- The conventional wisdom blames the crisis on a combination of insufficient regulation, loose monetary policy, greed...
- Of course we need to work on them, we always do... and policy will continue to play catching up...
- However, much of that discussion underestimates the importance of the global context in which these phenomena have taken place
- In particular, there is an enormous demand for AAA instruments from the rest of the world:
  - Over the last decade the US has experienced large and sustained capital inflows from foreigners seeking US assets to store value (CFG)
  - Especially after the NASDAQ/Tech bubble and bust, and the rise in commodity prices, excess world savings have looked predominantly for safe debt investments
- We present a simple model that allows us to capture some of the key effects of the increase in demand for US AAA assets

Main Substantive Results

- During good times, external demand for AAA assets leads to:
  - An increase in the value of US **risky** assets
  - A drop in the real interest rate (CFG) **and** in the risk premium
  - A sharp rise in the leverage of US financial institutions
- Fragility with respect to negative shocks
  - Sharp rise in risk premium and drop in riskless rate
  - Sharp drop in US wealth
  - (even if AAAs are AAA)

Model

- There is a continuum of US financial institutions, with mass one, that own assets which generate cash flows of X_t^d per unit time (payments from mortgage loans, credit card loans, auto loans, etc.), where,

$$\frac{dX_t^d}{X_t^d} = gdt + \sigma dZ_t$$

- The external demand for US assets, from foreign central banks for example, is in particular a demand for high-grade debt. They allocate an exogenous stream of funds to investments in assets produced by the US financial system

$$\frac{dX_t^f}{X_t^f} = gdt + \psi\sigma dZ_t; \qquad \psi < 1.$$

Model

- Foreigners withdraw and accumulate riskless (AAA) debt according to:

$$c_t^f = \rho B_t^f$$

$$dB_t^f = (X_t^f - \rho B_t^f)dt + r_t B_t^f dt.$$

Model

- The financial institutions' owners/equity-holders are local investors who maximize preferences:

$$E_t \int_t^{\infty} e^{-\rho(s-t)} ln\ c_{t+s}^d\ ds.$$

$$W_t = V_t - B_t^f.$$

- To imply:

$$c_t^d = \rho W_t$$

Model

- In equilibrium:

$$X_t^d + X_t^f = \rho W_t + \rho B_t^f = \rho V_t$$

- Which implies that the value of **risky** US asset rises with capital inflows:

$$V_t = \frac{X_t^d + X_t^f}{\rho}$$

- And so does domestic wealth early on:

$$W_t = \frac{X_t^d}{\rho} + \frac{X_t^f - \rho B_t^f}{\rho}.$$

Real interest rate

- Define the foreign debt-to-asset ratio (leverage) and the foreign-to-total flows as:

$$b_t^f \equiv \frac{B_t^f}{V_t}, \qquad x_t^f \equiv \frac{X_t^f}{X_t^d + X_t^f}$$

- Then:

$$\begin{aligned} r_t &= \rho + E_t[dc_t/c_t] - Var_t[dc_t/c_t] \\ &= \left(\rho + g - \sigma^2\right) - \rho x_t^f + \sigma^2 \left(1 - \frac{\left(1 - (1-\psi)x_t^f\right)^2}{1 - b_t^f}\right) \end{aligned}$$

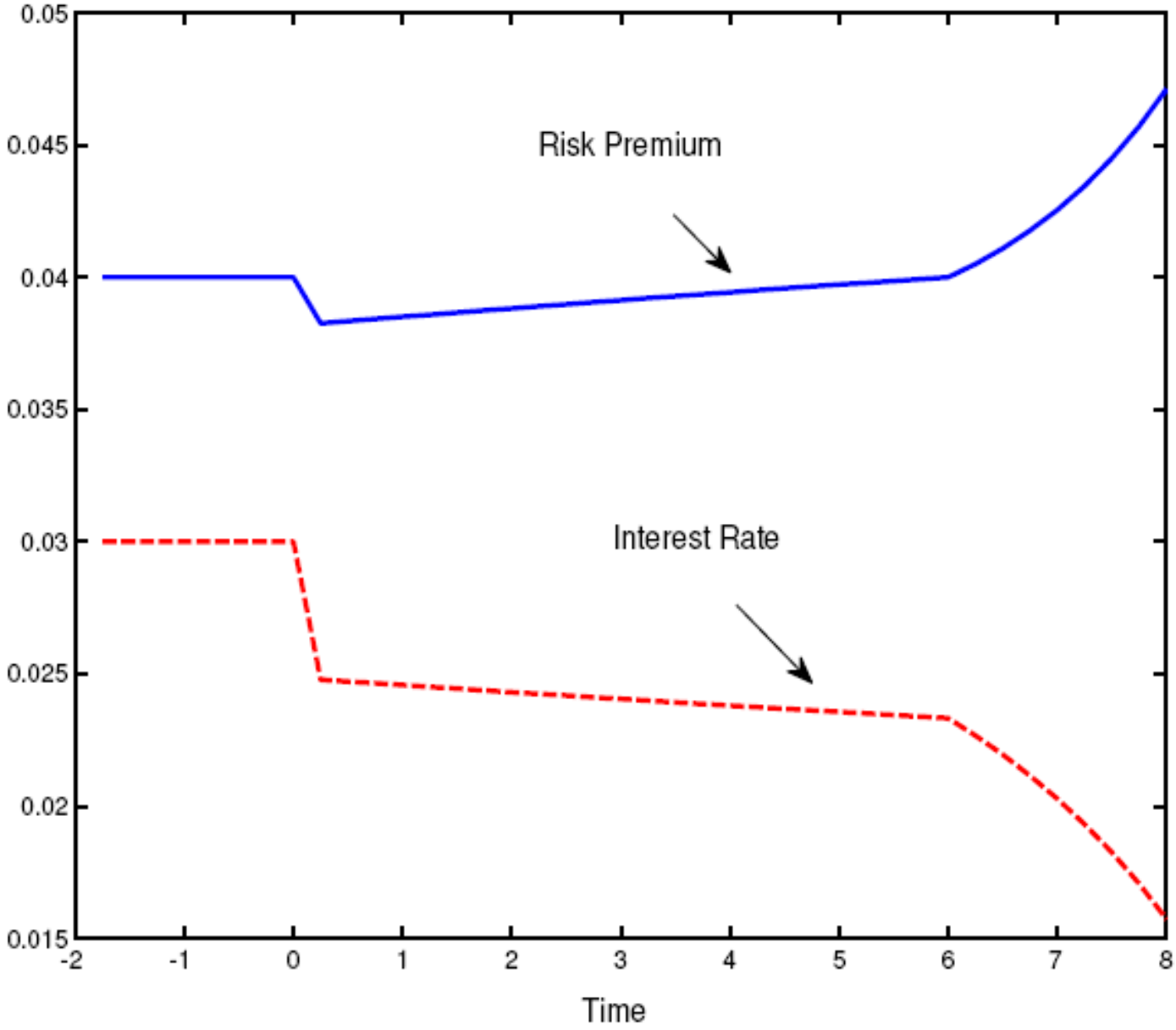
Risk premium

- Let us consider a hypothetical asset-i, whose return depends on innovations in the risk factor dZ_t:

$$dR_t^i = E_t[dR_t^i]dt + \sigma^i dZ_t.$$

$$\begin{aligned} E_t[dR_t^i] - r_t &= Cov_t[dR_t^i, dW_t / W_t] \\ &= \sigma^i \sigma \frac{1 - (1-\psi)x^f}{1 - b_t} \end{aligned}$$

Fragility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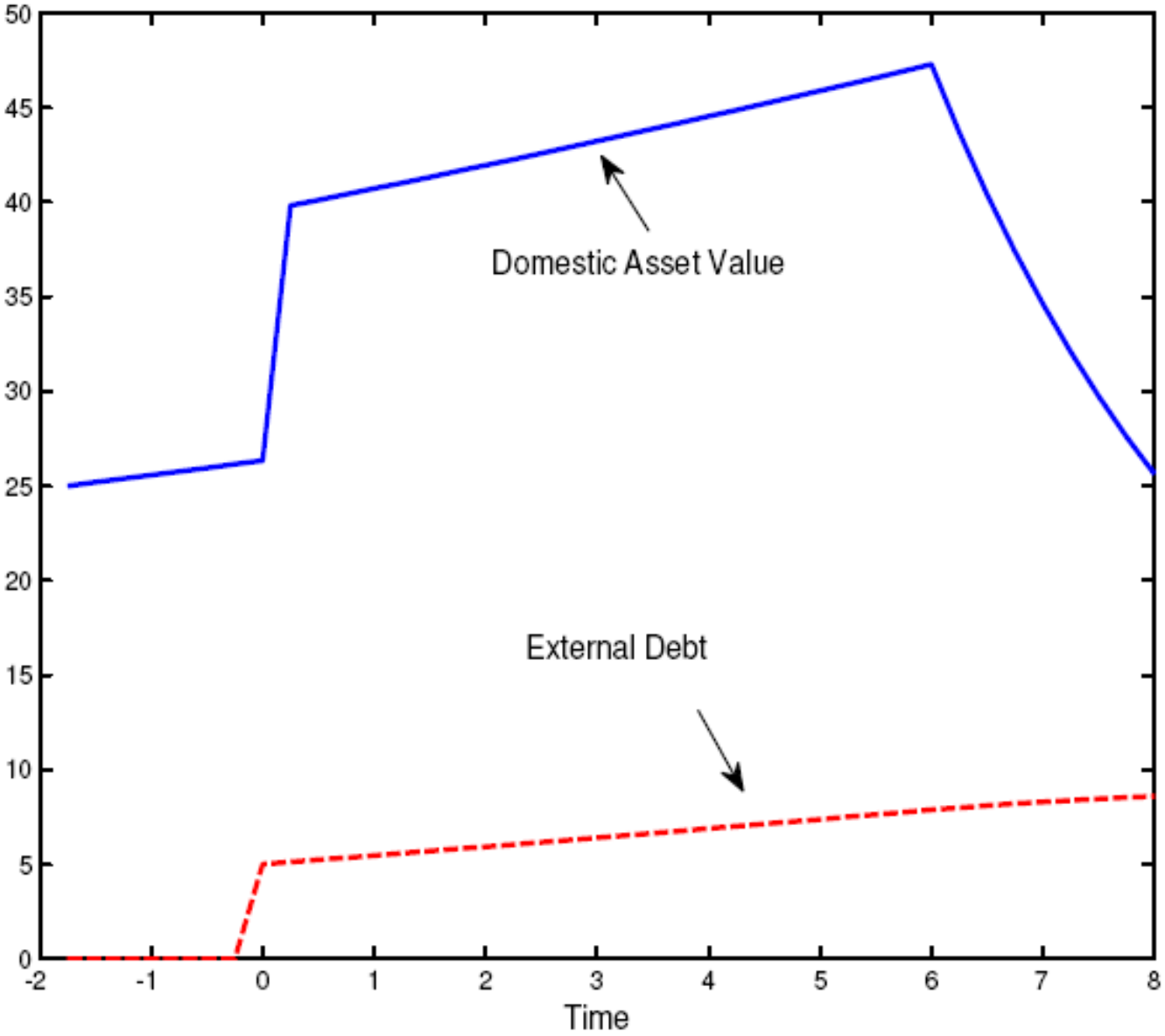
Risk Premium
Interest Rate
Time

Fragility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Time
Domestic Asset Value
External Debt

Final remarks

- We do **not** argue that there were no incentive problems before the crisis, or that the severity of the crisis itself was not exacerbated by policy mistakes and agency problems...
- Instead, we argue that the same forces that have shaped global imbalances, are behind many of the developments and patterns we have seen in terms of securitization, leverage, and risk premia
- This observation is important since it points to a structural reason for the kind of volatility we have seen recently, which will not go away (just) with more regulation...

14.454 Economic Crises

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