Chapter 23: International Macroeconomics
Graduate Macroeconomics Slides

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Outline

Why Open-Economy Macro?

- Business cycles co-move across countries via trade and finance; many shocks are global.

- Two robust facts:
  - Net exports / current account are *countercyclical*.
  - Real exchange rate (RER) and terms of trade (ToT) often *appreciate in booms*.

- We study transmission using a two-country model under alternative financial structures.

Core Identities

- GDP: $Y = C + I + G + NX$ with NX net exports.

- Balance of Payments: $\mathrm{CA} + \mathrm{FA} + \mathrm{KA} = 0$ (often $\mathrm{KA} \approx 0$).

- Savings–Investment: $S = Y - C - G = I + NX$. With $\mathrm{CA} \approx NX$, a CA deficit implies $S < I$ financed by capital inflows.

U.S. BOP Evidence

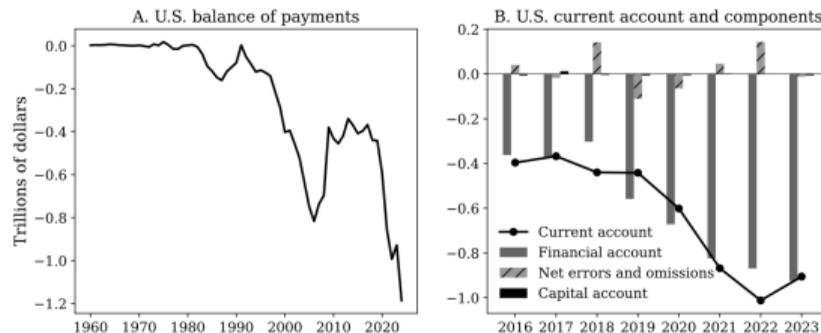

Figure 23.1: Balance of payments (left) and current, capital, and financial accounts (right) in the U.S.

Source: BEA International Transactions and IMF Data, Balance of Payments.

Declining external balance since mid-1990s; linked to global imbalances and the U.S. "exorbitant privilege" (Caballero et al., 2008; Farhi and Maggiori, 2017).

GDP per Capita and Size

- Persistent income gaps and heterogeneity in country size shape trade patterns and external balances.

- Surplus vs. deficit countries follow different saving, investment, and borrowing trajectories.
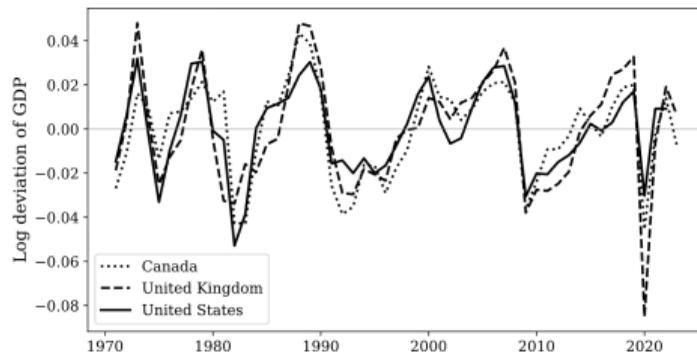

Figure 23.2: Log-deviations in GDP per capita (HP-filtered)

Notes: Hodrick-Prescott filtered log GDP, using $\lambda = 100$ for this annual data.

Macro Co-Movement and Correlations

- Output, consumption, hours: cross-country correlations; external balances are countercyclical (Backus et al., 1994).

- Investment more volatile and procyclical; consumption less volatile than output.

Selected Moments

Table 23.1: HP-filtered Business Cycles Around the World

Statistic	US	All Economies	Advanced	Emerging Markets	Low-Income Countries
Standard Deviations					
σ_y	1.96	2.89	2.13	3.10	2.41
σ_c/σ_y	0.94	1.24	1.03	1.16	2.35
σ_g/σ_y	1.18	2.02	1.17	1.91	4.50
σ_i/σ_y	4.55	3.04	3.46	2.76	4.77
σ_x/σ_y	4.11	3.91	3.43	3.55	7.87
σ_m/σ_y	3.47	4.08	3.40	3.87	7.19
$\sigma_{tb/y}$	0.61	1.75	1.07	1.82	2.41
$\sigma_{ca/y}$	0.72	1.79	1.20	1.82	2.51
Correlations with y					
c	0.93	0.67	0.84	0.66	0.41
g	0.02	0.33	0.04	0.38	0.35
i	0.65	0.70	0.76	0.71	0.47
x	0.17	0.17	0.32	0.13	0.30
m	0.67	0.40	0.62	0.37	0.35
tb/y	-0.59	-0.27	-0.41	-0.27	-0.09
tb	-0.62	-0.28	-0.41	-0.27	-0.15
ca/y	-0.53	-0.31	-0.36	-0.32	-0.09
ca	-0.59	-0.28	-0.38	-0.28	-0.10
Auto correlations					
y	0.51	0.54	0.47	0.55	0.49
c	0.53	0.47	0.45	0.49	0.37
g/y	-0.63	-0.21	-0.61	-0.17	0.09
i	0.21	0.51	0.47	0.53	0.43
x	0.55	0.44	0.43	0.46	0.36
m	0.23	0.40	0.29	0.43	0.39
tb/y	0.62	0.41	0.50	0.41	0.20
CA/y	0.67	0.40	0.51	0.40	0.15
Means					
tb/y	-2.3	-1.0	-0.7	-0.1	-9.2

Exchange Rates and Relative Prices

- Real exchange rate $Q_t = \dfrac{e_t\, P_t^*}{P_t}$ is volatile and often appreciates in booms.

- Terms of trade $T_t = \dfrac{P_{H,t}}{P_{F,t}}$ co-moves with output; PPP deviations are sizable and persistent.

- RER and ToT reallocate demand across countries in response to shocks.

More Evidence

- Procyclical appreciation + countercyclical NX are hard to reconcile without home bias and incomplete risk sharing.

- Productivity shocks transmit via relative prices and wealth effects.
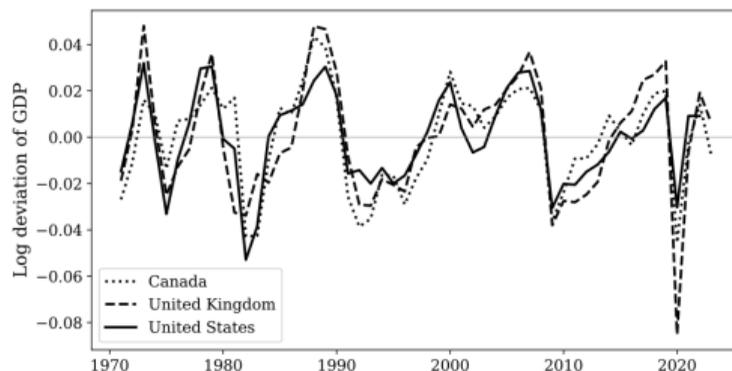

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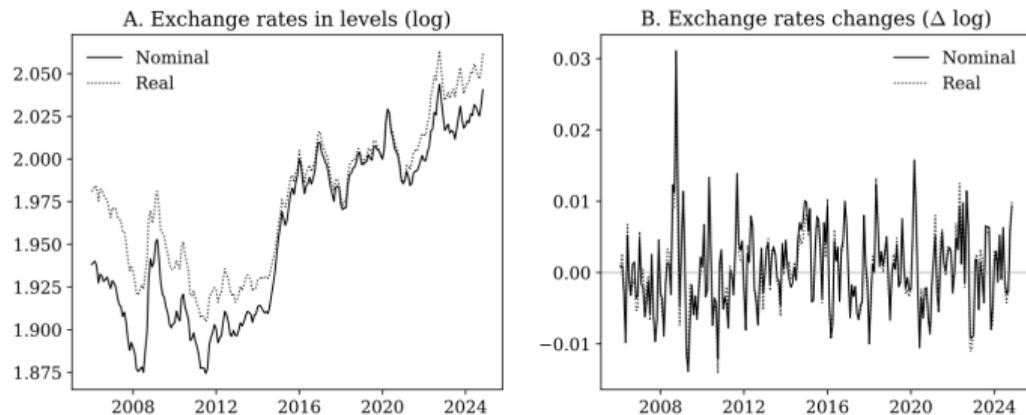
More Figures

Figure 23.3: Nominal and Real U.S. Exchange Rates, in levels (left) and changes (right)

Source: FRED. The NER corresponds to the series DTWEXBGS in FRED, "Nominal Broad U.S. Dollar Index, Index Jan 2020=100, Monthly, Not Seasonally Adjusted." The RER corresponds to the series RBUSBIS, "Real Broad Effective Exchange Rate for United States, Index Jan 2020=100, Monthly, Not Seasonally Adjusted."
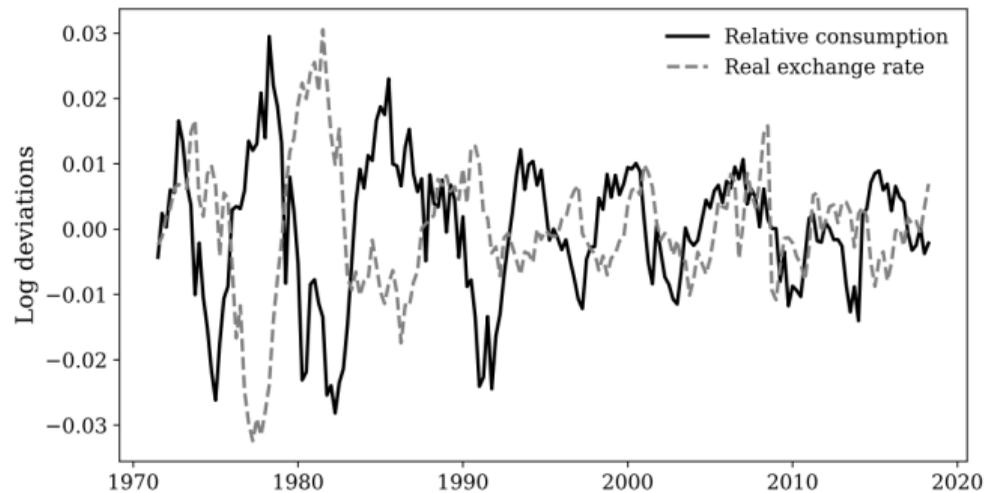
Figure 23.4: The U.S. real exchange rate and relative consumption (HP-filtered)
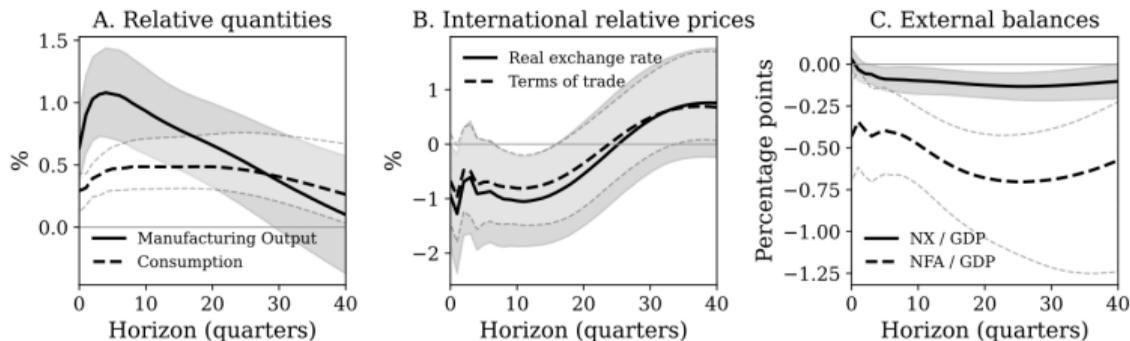
Source: (Corsetti et al., 2008)

Figure 23.5: Empirical estimates of the cross-country transmission of productivity shocks: U.S. to rest of world

Source: Corsetti, Dedola, and Leduc (2014) (Figures 1 and 2). *Notes*: estimated impulse response to a positive U.S. labor productivity shock. Charts report median response of U.S. variables relative to G10 rest of the world, as well as the 16th and 84th percentiles of the posterior distribution, satisfying the sign restrictions detailed in Section 2.1 of Corsetti et al. (2014). Rest of the world is PPP-weighted and comprises the following advanced economies: Japan, Germany, UK, Italy, France, Canada, Australia, Sweden, and Ireland. RER = real exchange rate; TOT = terms of trade; NX/GDP = net exports to GDP; NFA/GDP = net foreign assets to GDP. Estimation sample: 1973Q1-2004Q4.

Source: (Corsetti et al., 2014)

Preferences, Goods, and Prices

Representative household with CRRA over a CES Armington composite (Corsetti et al., 2008):

$$U = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{C_t^{1-\sigma} - 1}{1-\sigma}, \qquad C_t = \left[\alpha C_{H,t}^{\frac{\varphi-1}{\varphi}} + (1-\alpha) C_{F,t}^{\frac{\varphi-1}{\varphi}}\right]^{\frac{\varphi}{\varphi-1}}.$$

Price index (dual):

$$P_t = \left[\alpha^\varphi P_{H,t}^{1-\varphi} + (1-\alpha)^\varphi P_{F,t}^{1-\varphi}\right]^{\frac{1}{1-\varphi}},$$

Terms of trade and real exchange rate:

$$T_t \equiv \frac{P_{H,t}}{P_{F,t}}, \qquad Q_t \equiv \frac{e_t P_t^*}{P_t}.$$

RER–ToT Link

Log-linearize around a symmetric steady state with $Q_t = T_t = 1$. Then

$$\mathcal{Q}_t = (2a_H - 1)\,\mathcal{T}_t. \text{(Eq. 23.21)}.$$

Interpretation: With home bias $\alpha > \frac{1}{2}$, a ToT depreciation (home goods cheaper) is a real depreciation.

Demand System and Budget Constraint

CES demand:

$$\frac{C_{H,t}}{C_{F,t}^*} = \left(\frac{\alpha}{1-\alpha}\right)^{\varphi} \left(\frac{P_{F,t}}{P_{H,t}}\right)^{\varphi} = \left(\frac{\alpha}{1-\alpha}\right)^{\varphi} T_t^{-\varphi}.$$

World demand for home/foreign: $D_{H,t}$, $D_{F,t}^*$. Market clearing:

$$D_{H,t} = Y_{H,t}, \qquad D_{F,t}^* = Y_{F,t}^*.$$

Home budget (real, CPI deflated):

$$P_t C_t = P_{H,t} X_{H\to H,t} + P_{F,t} X_{F\to H,t} + \text{net factor income} + \Delta \mathrm{NFA}_t,$$

with an analogous constraint abroad.

Three Benchmark Market Structures

- **Complete markets:** state prices equalize; risk sharing holds state by state.

- **Financial autarky:** no international asset trade; period-by-period trade balance.

- **Bond economy:** single real non-contingent bond; real UIP relates real rates and inflation differentials.

Complete Markets: Risk Sharing

Real pricing kernels equalize:

$$\frac{u'(C_{H,t})}{P_t} = \kappa \, \frac{u'(C_{F,t}^*)}{P_t^*}, \quad \kappa > 0.$$

With CRRA, the consumption gap and RER satisfy

$$\sigma\left(\widehat{C_{H,t}} - \widehat{C_{F,t}^*}\right) = \widehat{Q}_t \quad \Rightarrow \quad \widehat{C_{H,t}} - \widehat{C_{F,t}^*} = \frac{1}{\sigma}\,\widehat{Q}_t.$$

A real appreciation (home goods expensive) lowers home consumption relative to foreign under full risk sharing.

Bond Economy: Real UIP and MU Wedge

With a single real bond (normalize $e_t \equiv 1$), no-arbitrage implies

$$\mathbb{E}_t \left[\frac{u'(C_{t+1})}{u'(C_t)} \frac{P_t}{P_{t+1}} \right] = \mathbb{E}_t \left[\frac{u'(C_{t+1}^*)}{u'(C_t^*)} \frac{P_t^*}{P_{t+1}^*} \right] \text{(Eq. 23.18)},$$

equivalently relating real rates and expected inflation differentials (Eq. 23.19). Define the ex-post MU wedge

$$\epsilon_{t+1} \equiv \frac{u'(C_{t+1})}{u'(C_t)} \frac{P_t}{P_{t+1}} - \frac{u'(C_{t+1}^*)}{u'(C_t^*)} \frac{P_t^*}{P_{t+1}^*} = \frac{\chi_{t+1}}{\chi_t} - \frac{\chi_{t+1}^*}{\chi_t^*}.$$

which has $\mathbb{E}_t[\varepsilon_{t+1}] = 0$ under real UIP.

Linearization: Two Key Relations

Around the symmetric steady state ($\mathcal{Q}_t = \mathcal{T}_T = 1, \alpha > \frac{1}{2}$):

$$\hat{\mathcal{Q}}_t = (2a_H - 1)\hat{\mathcal{T}}_t.(23.21), \hat{\mathcal{W}}_t = \sigma\left(\hat{C}_t - \hat{C}_t^*\right) - \hat{\mathcal{Q}}_t,$$

Under complete markets: $\widehat{W}_t = 0$. In the bond economy: $\mathbb{E}_t[\widehat{W}_{t+1} - \widehat{W}_t] = 0$ (relative wealth is a random walk in the linearized solution).

Relative Demand and Relative Supply

- Relative supply is pinned by endowments/technology: $\widehat{Y_{H,t}} - \widehat{Y_{F,t}^*}$.

- Relative demand depends on T_t (CES) and on wealth distribution (financial regime).

- Equilibrium: RD(T_t) intersects RS; Q_t linked to T_t via home bias.

Financial Autarky: Wealth Channel and RD Slope

Autarky wealth gap:

$$\hat{\mathcal{W}}_t^{FA} = \sigma \left[\hat{Y}_{H,t}^S - \hat{Y}_{F,t}^{*S} - 2(1 - a_H)\hat{\mathcal{T}}_t \right] - (2a_H - 1)\hat{\mathcal{T}}_t. \text{(Eq. 23.25)}.$$
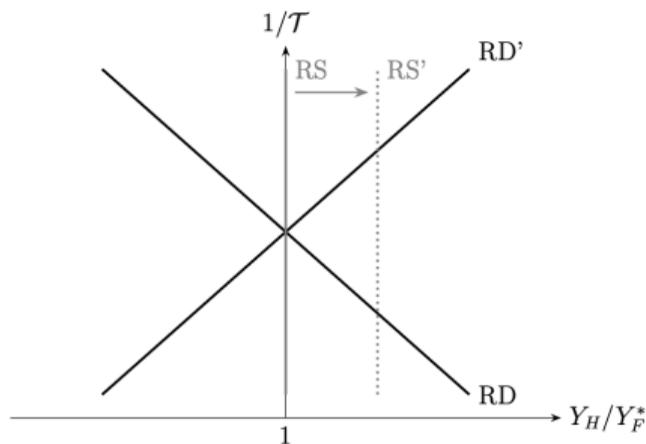
Relative demand schedule:

$$\hat{D}_{H,t} - \hat{D}_{F,t}^* = \left[1 - 2a_H(1 - \phi) \right] \hat{\mathcal{T}}_t. \text{(Eq. 23.26)}.$$

Implication: RD can slope up or down depending on φ and α; with $\alpha = \frac{1}{2}$ (PPP), RD slopes down as in complete markets.

Graphical Equilibrium

Figure 23.6: Relative demand and relative supply

A home-biased world with strong complementarity (low φ) can yield upward-sloping RD; productivity shocks shift RS and move the equilibrium along RD (Ch. 23).

Impact of a Home Productivity Increase

- Output rises; ToT depreciates (home goods cheaper).

- Expenditure switching raises exports; wealth effects via relative prices can offset or overturn switching.

- **Complete markets:** risk sharing dampens consumption differentials; NX typically countercyclical.

- **Autarky/bond economy:** wealth effects amplify imbalances; RER/ToT may appreciate in booms with strong home bias.

Adding Capital and Labor

- Production $Y_{i,t} = A_{i,t} K_{i,t}^{\alpha} (Z_{i,t} L_{i,t})^{1-\alpha}$ and $K_{i,t+1} = (1-\delta) K_{i,t} + I_{i,t}$.

- Choices $\{C_{i,t}, I_{i,t}, K_{i,t+1}, L_{i,t}\}$; Euler + labor FOC as in RBC.

- Trade/finance regimes carry over; relative prices now also reflect factor accumulation.

Equilibrium with Production

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_{i,t}^{1-\sigma} - 1}{1 - \sigma} - \Psi \frac{L_{i,t}^{1+\eta}}{1 + \eta} \right),$$

subject to budget + capital accumulation. Optimality:

$$\frac{u_C(C_{i,t})}{P_{i,t}} = \beta \, \mathbb{E}_t \left[\frac{u_C(C_{i,t+1})}{P_{i,t+1}} \, R_{i,t+1}^{\text{real}} \right], \qquad \frac{u_L(L_{i,t})}{u_C(C_{i,t})} = \text{real wage}_{i,t},$$

plus goods/asset market clearing per financial regime. Linearization adds capital dynamics.

Implications with Capital

- More persistence via capital; investment booms widen external deficits on impact.

- RER/ToT move with both expenditure switching and wealth effects; incomplete sharing helps match procyclical appreciations.

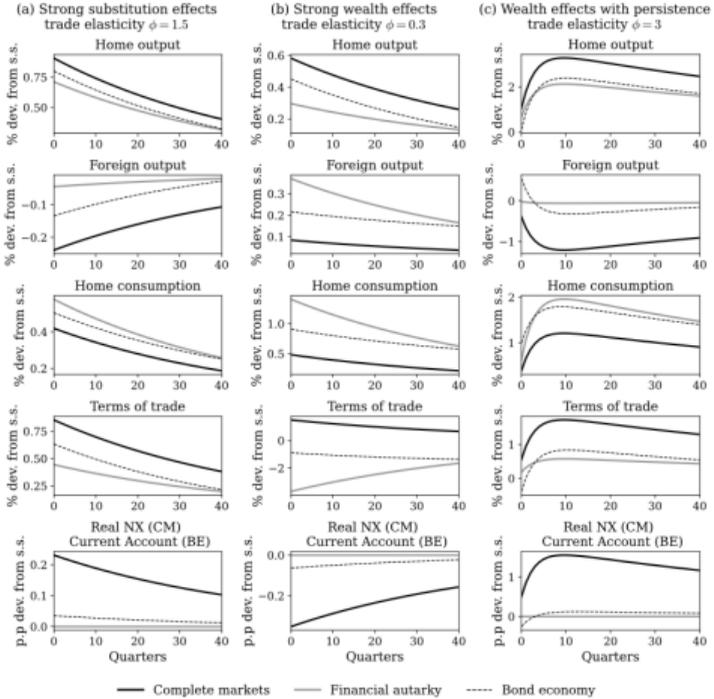# Substitution and wealth effects in the international transmission mechanism

Figure 23.7: International transmission of positive home productivity shock

Calibration Targets and Parameters

- Preferences (β, σ, η); technology (α, δ); trade (φ, α); finance: complete/autarky/bond.

- Targets: volatility/cyclicality of Y, C, I, NX; RER/ToT dynamics; cross-country correlations.

- Bond economy + home bias $(\alpha > \frac{1}{2})$ + low $\varphi \Rightarrow$ countercyclical NX and procyclical appreciations.

Model vs. Data

Table 23.2: Synchronized business cycles

Statistic	1971:Q3-2018:Q2	1971:Q3-2007:Q4
Correlations (US vs ROW)		
GDP	0.58	0.56
C	0.46	0.44
I	0.56	0.48
CPI	0.62	0.57
Backus-Smith Correlation (US vs ROW)		
Rel C vs RER	-0.49	-0.53

Notes: ROW includes Aus, Can, Fra, Ger, Ire, Ita, Jap, Swe, UK. All data detrended over 1971:Q3-2018:Q2 period using Hodrick-Prescott filter with $\lambda = 1600$. Source: update of Corsetti, Dedola, and Leduc (2008b).

Source: (Corsetti et al., 2008)

Compare variances, correlations, and IRFs across regimes; bond economy often matches external balances and relative prices best.

What We Learned

- RER/ToT and external balances reflect demand switching and wealth effects.

- Financial incompleteness + home bias reconcile countercyclical NX and procyclical appreciations.

- Adding production raises persistence; nominal rigidities can be layered for open-economy NK.

Extensions

- Two-country NK with price stickiness and incomplete pass-through.

- Portfolio choice and valuation effects; ToT externalities and policy trade-offs.

- Heterogeneous agents and global imbalances; EM frictions.

From CES to CPI and RER–ToT Link

$$P_t = \left[\alpha^{\varphi} P_{H,t}^{1-\varphi} + (1-\alpha)^{\varphi} P_{F,t}^{1-\varphi} \right]^{\frac{1}{1-\varphi}},$$

and with $Q_t = \frac{e_t P_t^*}{P_t}$, symmetry, and $Q_t = T_t = 1$ at SS:

$$\widehat{Q}_t = (2\alpha - 1)\, \widehat{T}_t \quad \text{(Eq. 23.21)}.$$

Risk Sharing vs. Wealth Gap

Complete markets $\Rightarrow \sigma(\widehat{C_{H,t}} - \widehat{C^*_{F,t}}) = \widehat{Q}_t$. Define $\widehat{W}_t$ (PV of net claims, real) and linearize:

$$\widehat{W}_t = \sigma(\widehat{C_{H,t}} - \widehat{C^*_{F,t}}) - \widehat{Q}_t,$$

so $\widehat{W}_t = 0$ under complete markets; with a single bond, $\mathbb{E}_t[\widehat{W}_{t+1} - \widehat{W}_t] = 0$.

Autarky: Wealth Channel and RD

$$\widehat{W}_t^{\text{FA}} = \sigma\left(\widehat{Y_{H,t}} - \widehat{Y_{F,t}^*} - 2(1-\alpha)\,\widehat{T}_t\right) - (2\alpha - 1)\,\widehat{T}_t,$$

$$\widehat{D}_{H,t} - \widehat{D}_{F,t}^* = \left[1 - 2\alpha(1-\varphi)\right]\widehat{T}_t.$$

Real UIP (Bond Economy)

With real rates R_t, R_t^*:

$$R_t^{-1}\mathbb{E}_t\left[\frac{P_t}{P_{t+1}}\right] = (R_t^*)^{-1}\mathbb{E}_t\left[\frac{P_t^*}{P_{t+1}^*}\right],$$

and the ex-post marginal-utility wedge has zero conditional mean.

References I

Backus, D. K., Kehoe, P. J., and Kydland, F. E. (1994). Relative price movements in dynamic general equilibrium models of international trade. In Van der Ploeg, F., editor, *Handbook of International Macroeconomics*, chapter 3, pages 62–69. Basil Blackwell.

Caballero, R. J., Farhi, E., and Gourinchas, P.-O. (2008). An equilibrium model of 'global imbalances' and low interest rates. *American Economic Review*, 98(1):358–393.

Corsetti, G., Dedola, L., and Leduc, S. (2008). International risk sharing and the transmission of productivity shocks. *The Review of Economic Studies*, 75(2):443–473.

Corsetti, G., Dedola, L., and Leduc, S. (2014). The international dimension of productivity and demand shocks in the u.s. economy. *Journal of the European Economic Association*, 12(1):153–176.

Farhi, E. and Maggiori, M. (2017). A model of the international monetary system. *The Quarterly Journal of Economics*, 133(1):295–355.

Thank you!

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