Macroeconomics B, EI060

Class 11

Financial accelerator, trilemma

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What you will get from today class

- How does financial integration propagate shocks and policy (Devereux and Yetman 2010)?
  - The role of the specific type of financial integration.
- Does a flexible exchange rate provides autonomy?
  - The international trilemma and its evolution (Aizenman 2019).
  - Getting autonomy from exchange rate flexibility and capital control (Klein and Shambaugh 2015).

A question to start

Integrating financial markets across countries exposes them to each other's shocks, and lead to stronger co-movements.

Do you agree? Why or why not?

FINANCIAL INTEGRATION AND TRANSMISSION

International financial integration and constraints

- How do shocks and policy transmit internationally?
- Trade linkages are not large enough to give strong co-movements.
- Model with cross-border lending, possibly subject to borrowing constraints (Devereux and Yetman, 2010).
  - Constraints are always binding, or never (different variants of the model).
- The specific assets traded, and the presence of constraints matter. Transmission of a bad productivity shock in Home country:
  - With international trade in bonds, lower Home output but higher Foreign output (negative co-movement).
  - With international trade in equity, *without* leverage constraint, lower consumption in both countries, investment falls only in Home (no investment correlation).
  - With international trade in equity, and *with* leverage constraint, lower consumption and investment in both countries (positive co-movement).

Savers and investors

- Each country has two types of agents: n investors and $1-n$ savers.
- Both maximize a standard intertemporal utility of consumption, with discount factor:

$$\theta_{t+1}^k = \beta^k \theta_t^k = \zeta^k \left(1 + \bar{C}_t^k\right)^{-\eta} \theta_t^k \qquad k = I, S$$

- The presence of the average consumption of savers $\bar{C}_t^S$ (or investors $\bar{C}_t^I$) ensures that the discount factor falls, and thus borrowing increases, as consumption increases.
  - Ensures stationnarity of wealth.
- Savers are more patient than investors: $\zeta^K > \zeta^I$.

Use of capital

- Investors can purchase equity (capital) in the domestic and foreign economy, and issue bonds (borrow).
- Capital from investors is used by firms producing output $y = AF(L, K)$.
- Savers can purchase bonds issued by domestic investors, or capital that they used themselves producing output $y^S = G(k)$, with $G' > 0$ and $G'' < 0$.
  - Both the savers' own technology and firms produce the same world good.
  - Efficiency of capital use is not necessarily the same depending of whether it is held by investors or savers.
  - Real cost of a missallocation of capital.

Budget constraints

- Home savers are paid a wage from the firms, get their own output, and invest in bonds (B^S denotes debt) and their own capital (k_1^S):

$$C_t^S + q_{1,t}\left(k_{1,t}^S - k_{1,t-1}^S\right) = W_t^S + G\left(k_{1,t-1}^S\right) + B_t^S - R_{t-1}B_{t-1}^S$$

- Capital is not produced, and the price of Home capital is $q_{1,t}$.
- Home investors purchase capital in both countries (k_1^I and k_2^I) and get dividend yields R_{iK}:

$$\begin{aligned} & C_t^I + q_{1,t}\left(k_{1,t}^I - k_{1,t-1}^I\right) + q_{2,t}\left(k_{2,t}^I - k_{2,t-1}^I\right) \\ = \; & W_t^I + R_{1K,t}k_{1,t-1}^I + R_{2K,t}k_{2,t-1}^I + B_t^I - R_{t-1}B_{t-1}^I \end{aligned}$$

- Investors can face a leverage constraint that limits their debt as a share of the value of assets. Home and Foreign equity prices matter:

$$B_t^I \leq \kappa\left(q_{1,t}k_{1,t}^I + q_{2,t}k_{2,t}^I\right)$$

Savers' Euler conditions

- Savers have two Euler conditions: with respect to the bond, and the capital for their own use.
- The expected discounted returns are equalized:

$$E_t \zeta^S \left(1 + \bar{C}_t^S\right)^{-\eta} U'\left(C_{t+1}^S\right) \left(\frac{q_{1,t+1} + G'\left(k_{1,t}^S\right)}{q_{1,t}} - R_t \right) = 0$$

Investors' Euler conditions

- Investors have three Euler conditions: with respect to the bond, the Home equity and the Foreign equity.
  - μ is the multiplier on the borrowing constraint, if binding.
- When binding constraint ($\mu > 0$): expected return on equities exceeds the cost of debt (ω_t is the share invested in Home equity and $r_{i,t+1} = (q_{i,t+1} + R_{iK,t+1}) / q_{i,t}$):

$$E_t \zeta^I \left(1 + \bar{C}_t^I\right)^{-\eta} U'\left(C_{t+1}^I\right) \frac{\omega_t r_{1,t+1} + (1 - \omega_t) r_{2,t+1} - R_t}{1 - \kappa} = \mu_t > 0$$

- Borrowing constraint does not affect the portfolio allocation between Home and Foreign equity (both are equally good collateral):

$$E_t \zeta^I \left(1 + \bar{C}_t^I\right)^{-\eta} U'\left(C_{t+1}^I\right) (r_{1,t+1} - r_{2,t+1}) = 0$$

Market equilibria

- Clearing of the world good market: consumption by savers and investors in both countries = output of firms in both countries + output of savers' own production.
- Bonds are in zero net supply. Clearing of the bond market:
  - If it is internationally segmented:

$$nB_t^I + (1-n)\,B_t^S = 0 \qquad ; \qquad nB_t^{*I} + (1-n)\,B_t^{*S} = 0$$

  - If it is integrated:

$$nB_t^I + (1-n)\,B_t^S + nB_t^{*I} + (1-n)\,B_t^{*S} = 0$$

Capital market equilibrium

- Available quantity of capital in each country is set to 1.
- Clearing of the capital market .
  - If it is internationally segmented:

$$\begin{aligned} nk^{I}_{1,t} + (1-n)\, k^{S}_{1,t} &= 1 \\ nk^{*I}_{2,t} + (1-n)\, k^{S}_{2,t} &= 1 \end{aligned}$$

  - If it is integrated:

$$\begin{aligned} n\left(k^{I}_{1,t} + k^{*I}_{1,t}\right) + (1-n)\, k^{S}_{1,t} &= 1 \\ n\left(k^{I}_{2,t} + k^{*I}_{2,t}\right) + (1-n)\, k^{S}_{2,t} &= 1 \end{aligned}$$

Constraint and capital allocation in the steady state

- When the leverage constraint is not binding, the marginal product of capital is equalized between firms and savers' technology:

$$G'\left(k_1^S\right) = AF_2\left(1, n\left(k_1^I + k_1^{*I}\right)\right) = AF_2\left(1, 1-(1-n)\,k_1^S\right)$$

- This fully pins down the allocation of Home capital between Home savers and World investors.
- If the constraint is binding, the marginal product of capital is lower in the savers' technology:

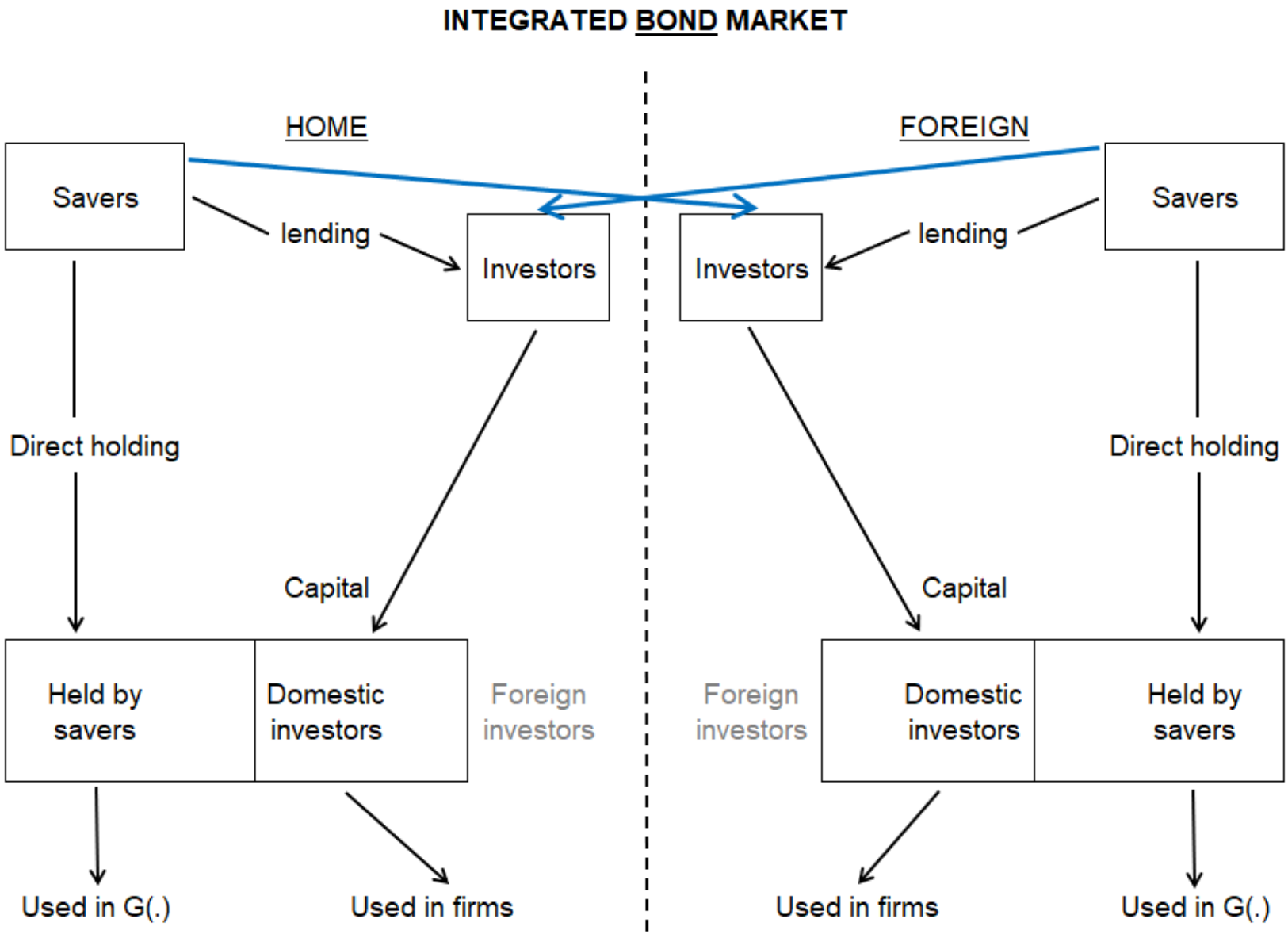
$$G'\left(k_1^S\right) < AF_2\left(1, n\left(k_1^I + k_1^{*I}\right)\right)$$

  - Inefficient capital allocation.

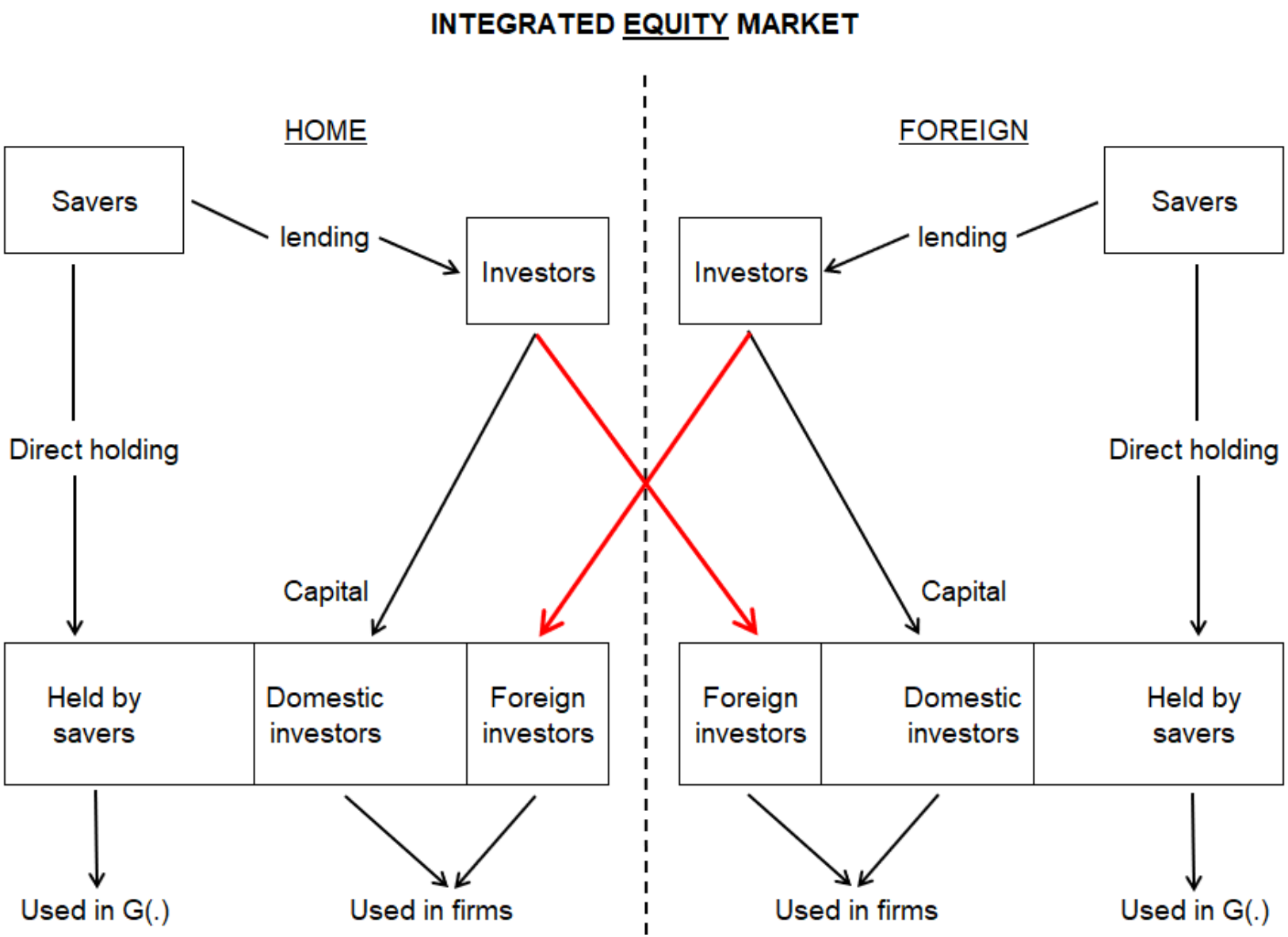
Solving the model

- Log-linear approximation around the steady state.
  - Variants with binding constraints, variants without (not a model with "occasionally binding constraints").
- The equity portfolio choice in the steady state matters for the international allocation of asset returns.
  - Computed using a quadratic approximation of the investors' Euler conditions.
  - Iceberg transaction cost on investing abroad (second-order) allows to fine-tune the portfolio home bias.
- Impact of a negative shock in Home productivity under various scenarios of financial markets integration:
  - Segmented equity, integrated bond, with binding constraint.
  - Integrated equity, segmented bond, no binding constraint.
  - Integrated equity, segmented bond, with binding constraint.
  - Integrated equity and bond, with binding constraint.

Financial integration with bonds



Financial integration with bonds and equity



Integrated bond market

- Savers can lend to investors in both countries.
  - Equity markets are segmented: investor can only hold domestic capital.
- Lower Home productivity reduces consumption and capital use by firms in the Home country.
  - Capital is redirected to the now relatively more efficient savers' technology
- Lower equity prices tighten the constraint of Home investors.
  - Lower demand for loans reduces the interest rate.
- Lower interest rate stimulates lending in the Foreign country, where investors are not exposed to Home equity.
  - Capital use by Foreign firms and consumption increase.

- Dynamics under bond integration.

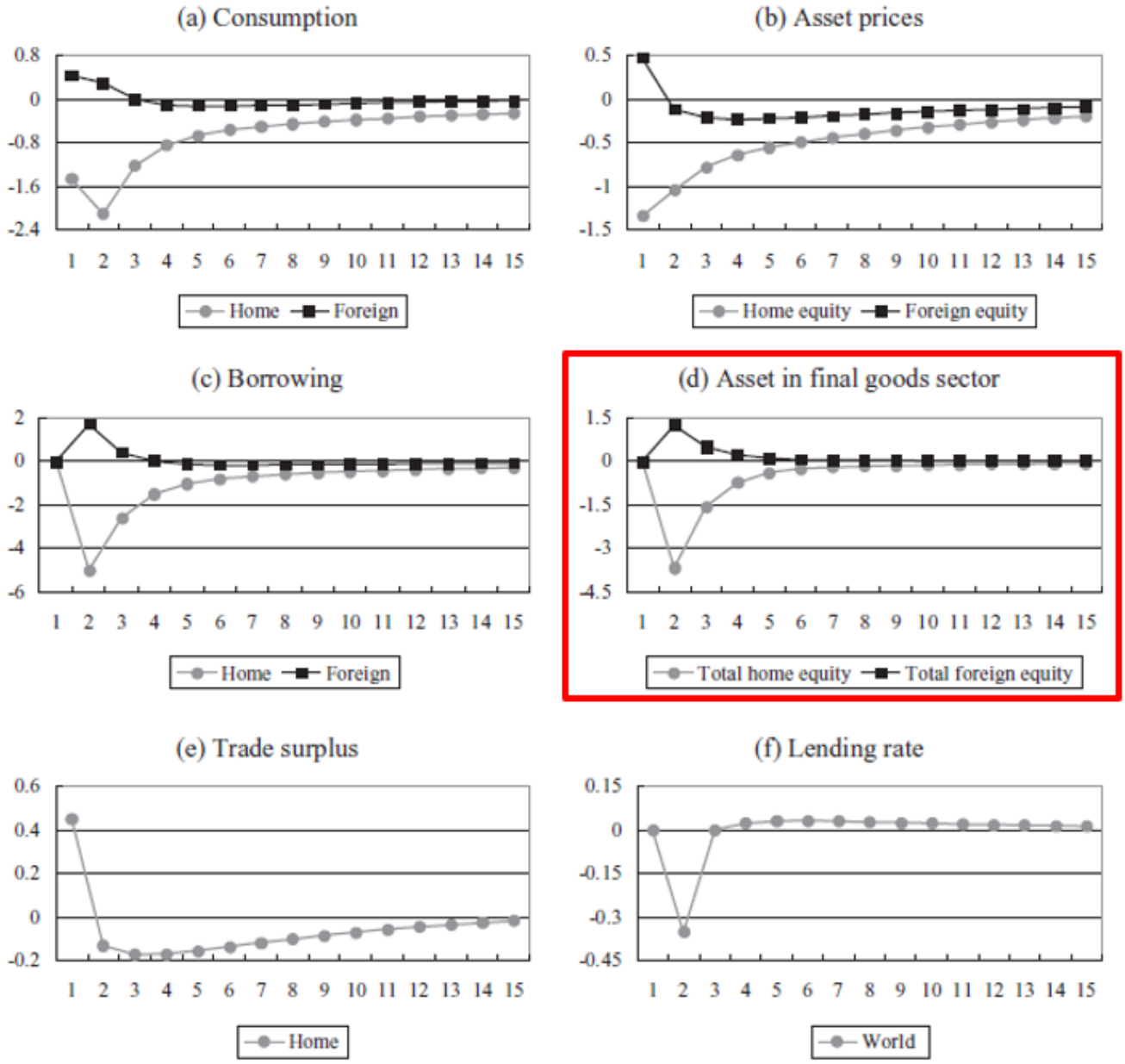


FIG. 8. Integrated Bond Markets, Segregated Equity Markets.

Devereux, Michael, and James Yetman (2010) "Leverage Constraints and the International Transmission of Shocks", *Journal of Money, Credit and Banking* 42, pp. 71-105.

Integrated equity markets, no constraint

- Lower Home productivity reduces the world supply of the good.
- Consumption falls in both countries, before a gradual recovery.
- The dynamics of consumption translate into a higher real interest rate.
- The value of capital (equity prices q_1 and q_2) falls in both countries.
- Capital use in firms falls in Home: redirected to the now relatively more efficient savers' technology. No change in Foreign.
  - No co-movement in capital use across countries.

- Dynamics under equity integration, without financial constraints.

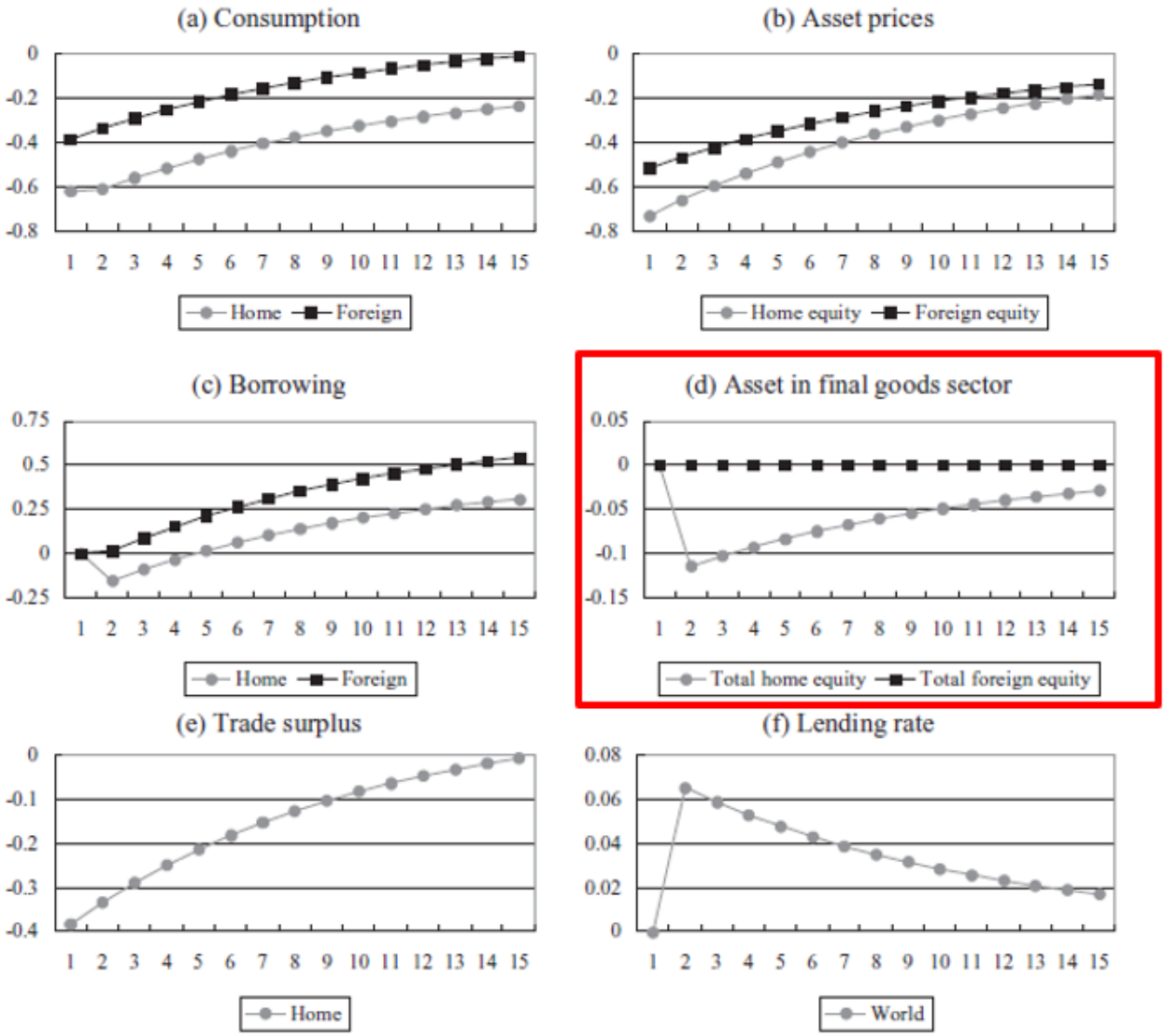


FIG. 3. No Leverage Constraints, Partial Diversifications.

Devereux, Michael, and James Yetman (2010) "Leverage Constraints and the International Transmission of Shocks", *Journal of Money, Credit and Banking* 42, pp. 71-105.

Integrated equity markets, with constraint

- Lower Home productivity again reduces consumption in both countries, before a gradual recovery.
- The value of capital (q_1 and q_2) falls in both countries.
- This now tightens the borrowing constraints in the Home *and* Foreign economies.
  - Capital use is diverted towards the savers, also in the Foreign economy.
  - Strong co-movement in capital use across countries.
- Demand for bonds falls, leading to a lower real interest rate.
- Whether or not the bond market is also integrated makes little difference.

- Dynamics under equity integration, with financial constraints.

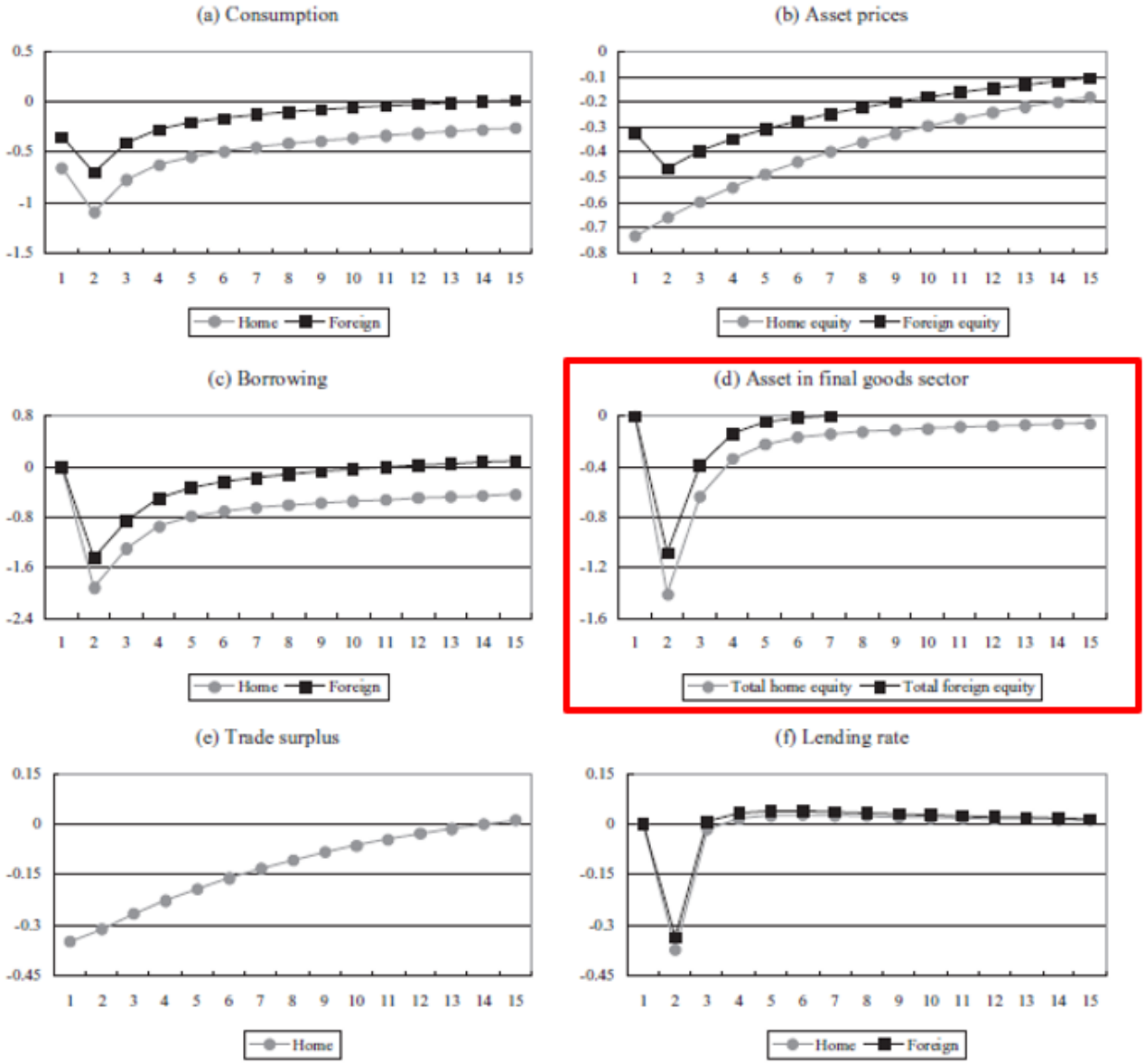


FIG. 5. High Leverage Constraints, Partial Diversifications.

Devereux, Michael, and James Yetman (2010) "Leverage Constraints and the International Transmission of Shocks", *Journal of Money, Credit and Banking* 42, pp. 71-105.

Bottom line

- International financial linkages in equity, along with borrowing constraints, lead to a strong international transmission.
- Capital usage by firms is much more volatile, and highly positively correlated across country.
  - The correlation is zero in the absence of constraints, and negative if only bond markets are integrated.
- Limit of the model: we contrast a world were the constraint is always binding to one where it never is.
  - Allows us to use approximation techniques around the steady state.
  - Since then, solving models with occasionally binding constraint is possible.

THE USEFULNESS (OR NOT) OF

FLEXIBLE EXCHANGE RATES

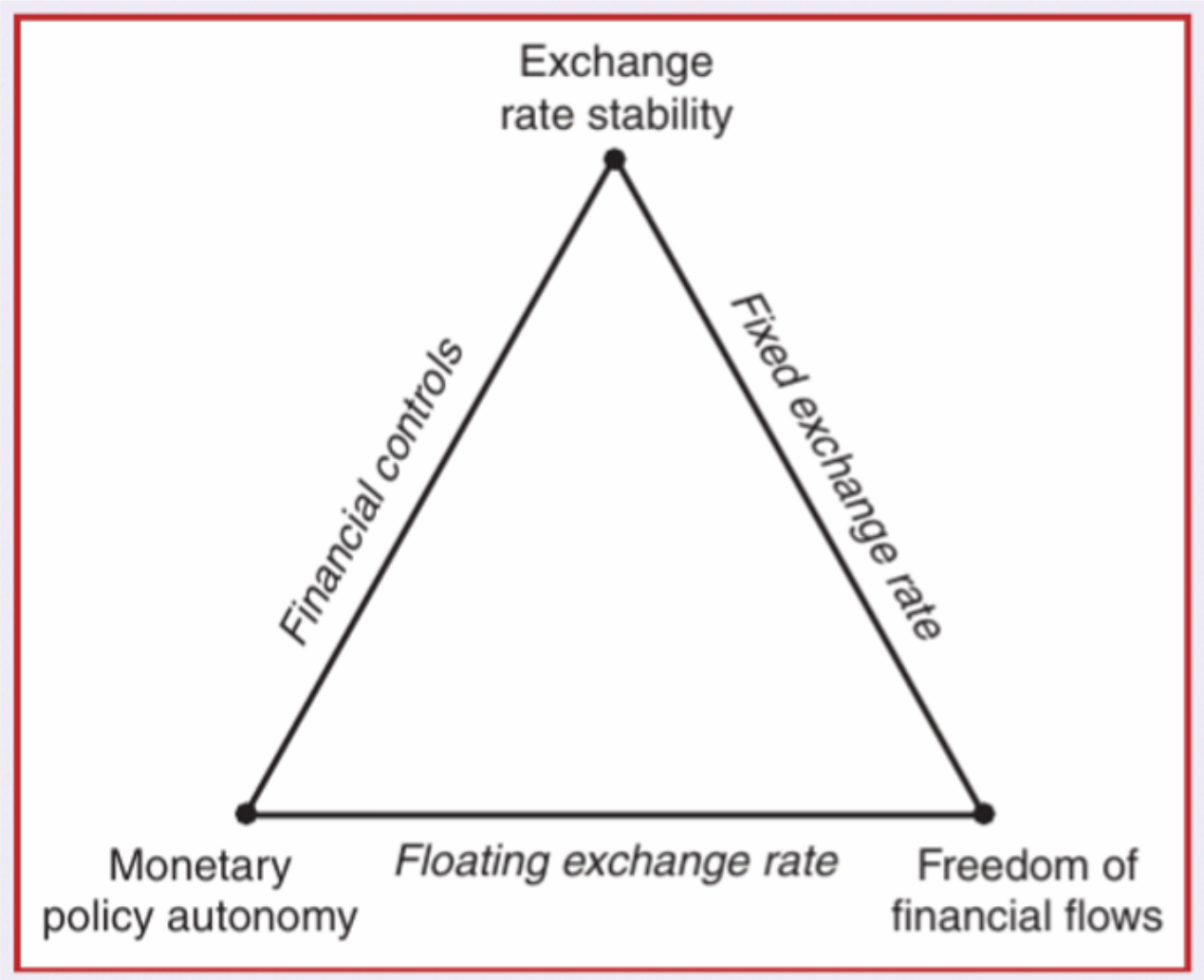
External and internal balances

- Policy makers want to reach three objectives:
  - Monetary policy autonomy.
  - Stable exchange rate.
  - Capital mobility.
- Recall the interest parity condition:

$$i_t = i_t^* + (E_{t+1} - E_t)/E_t$$

The trilemma

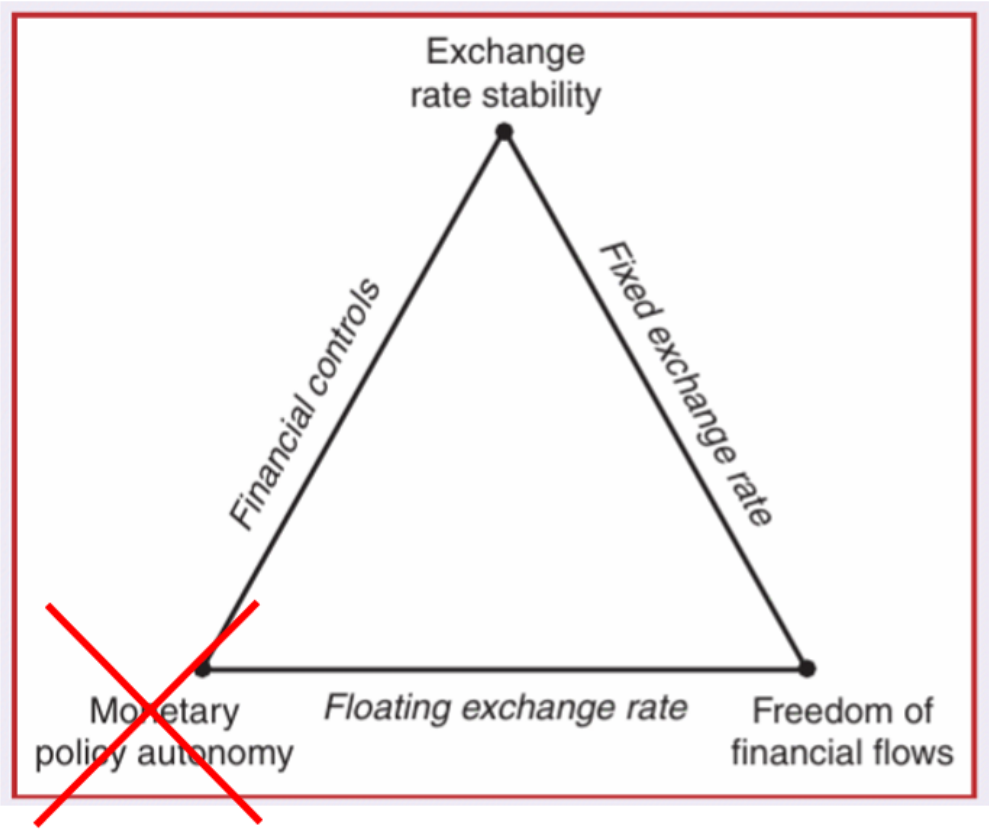
- Represent the three objectives: monetary policy autonomy, exchange rate stability, free capital flows:



How to adjust to a foreign shock?

- Consider that i_t^* increase. One can simply raise i_t, but policy is not autonomous.

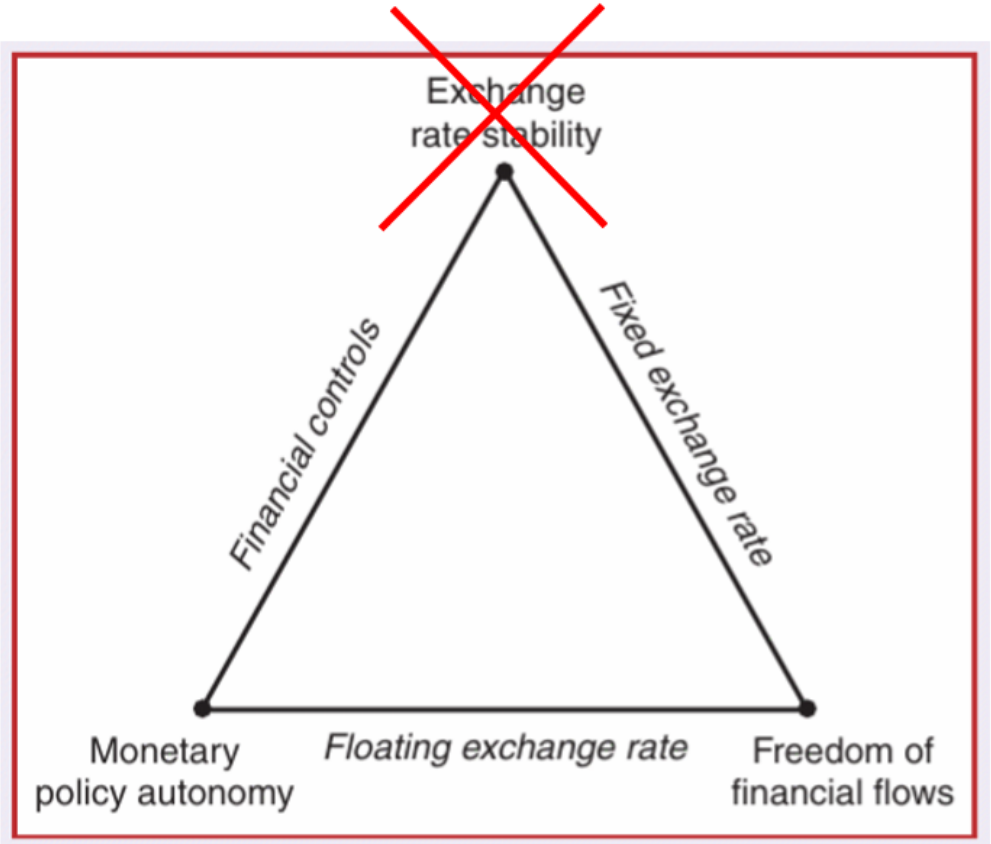
$$i_t \uparrow \quad = \quad i_t^* \uparrow + (E_{t+1} - E_t) / E_t$$



Preserving autonomy

- We could leave i_t unchanged, but the exchange rate will appreciate between today and tomorrow.

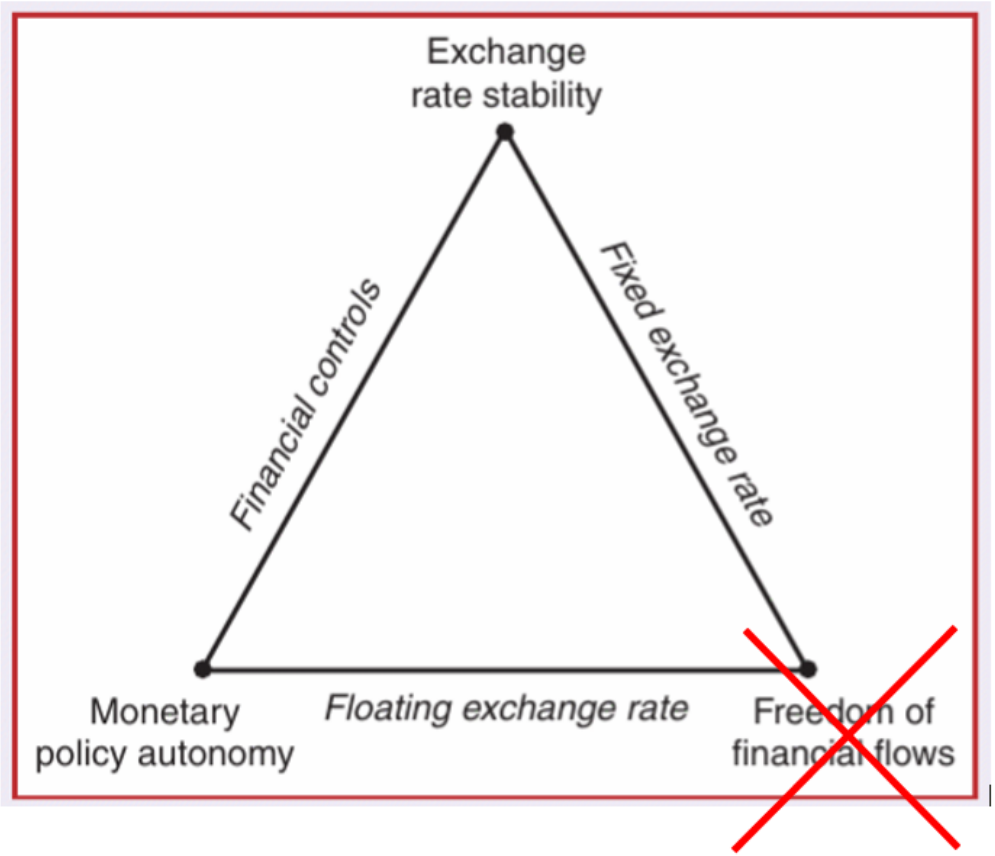
$$i_t = i_t^* \uparrow + (E_{t+1} - E_t)/E_t \downarrow$$



Preserving autonomy and FX stability

- We can prevent investors from arbitraging domestic and foreign bonds (capital controls), abandoning capital mobility:

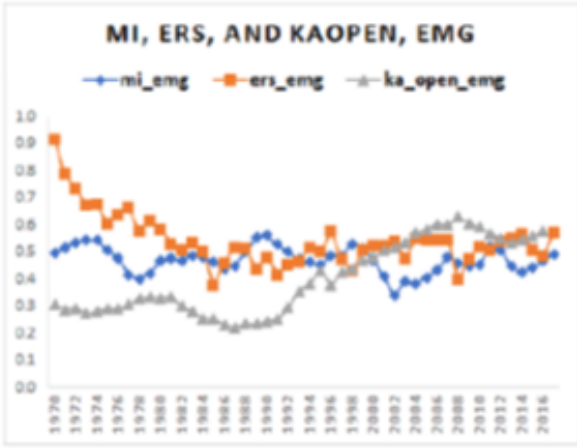
$$i_t \quad \neq \quad i_t^* \uparrow + (E_{t+1} - E_t)/E_t$$

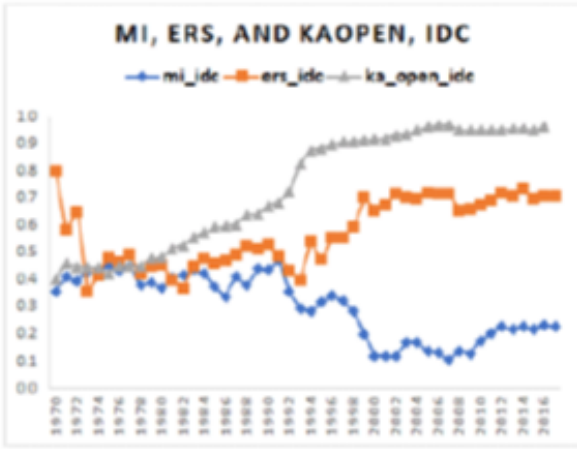


Historical evolution

- The concept has evolved through time (Aizenman 2019).
- Indices of the three dimensions:
  - Exchange rate stability (ERS), inverse of variance.
  - Monetary independence (MI), sensitivity of policy rate to rate in core country (US or Euro).
  - Capital account openess (KAOPEN), "Chinn-Ito" index of capital mobility.
- Evolution through time is contrasted across country groups.
  - Advanced: more KO, more ERS and less MI (driven by Euro).
  - Emerging: more KO, less ERS.
  - Developing: no major changes.

- Evolution of the trilemma choice through time.





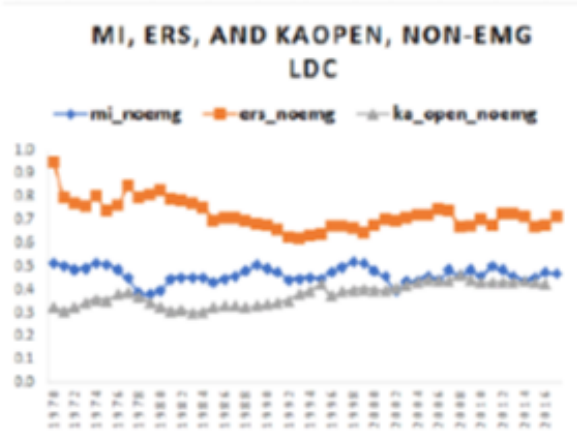


Figure 4. Global trilemma patterns, 172 countries from 1970 through 2017.

The top panel: EMs' average patterns
Middle panel: Industrial countries' average patterns
Bottom panel: Non-EMs less-developed countries' patterns

Aizenman, Joshua (2019). "International Reserves, Exchange Rates, and Monetary Policy: From the Trilemma to the Quadrilemma", Oxford research encyclopedia.

Testing the impact of exchange rate regimes

- Test empirically whether a country with a float or capital controls get more policy autonomy.
- Group countries according to FX regime and capital mobility (Klein and Shambaugh 2015).
  - De jure classification for exchange rate regime, from IMF regular report on regimes (hard pegs, soft pegs, floats).
  - Limits to capital mobility from Chinn-Ito index (closed, open, and intermediate).
- Assess autonomy through a regression of changes in the domestic policy interest rate, ΔR_{it}, on changes in the anchor (US, euro area) policy interest rate, ΔR_{bt}:

$$\Delta R_{it} = \alpha + \beta \cdot \Delta R_{bt} + \mu_{it}$$

- Autonomy is high when the coefficient β is small, or zero.

How to get policy autonomy?

- Four cells depending on exchange rate regime (peg vs. non-peg (floats and soft pegs)) and capital mobility (open capital account vs. non-open (partially or fully closed)).
- For each cell, compute the coefficient β.
- 2x2: exchange rate pegs lead to lower autonomy (higher β), as does capital mobility.
  - Larger effect for the exchange rate regime.
  - Autonomy requires a floating exchange rate and a closed capital account. One alone is not enough (at odds with the trilemma).
- Finer classification with intermediate cases.
  - Autonomy increases as the exchange rate is less restricted and capital flows is more restricted.
  - Partial floating provides partial autonomy, but partial closing does not.

2x2 case

- Higher autonomy with exchange rate flexbility, or capital controls (highest coefficient for peg & open).
- With only a floating FX or a closed capital account, autonomy is partial.

TABLE 2—2 × 2 CLASSIFICATION OF EXCHANGE RATE AND CAPITAL CONTROL REGIMES (OLS)

	Peg		Non-peg		
	Coef. (s.e.)	N [R^2]	Coef. (s.e.)	N [R^2]	Open versus non-open
Open	**0.68*** (0.08)**	**433 [0.28]**	**0.23** (0.10)**	**581 [0.02]**	0.27*** (0.07)
Non-open	**0.40*** (0.06)**	**967 [0.14]**	**0.09* (0.05)**	**1,145 [0.00]**	
Peg versus non-peg	0.33*** (0.06)				

Klein, Michael, and Jay Shambaugh (2015). "Rounding the Corners of the Policy Trilemma: Sources of Monetary Policy Autonomy", *American Economic Journal: Macroeconomics* 7(4), pp. 33-66.

3x3 case

- Even partial exchange rate flexibility helps (peg vs. soft peg, and soft peg vs. float are significant).
- Partial capital controls don't (only open vs. closed is significant).

TABLE 3—3 × 3 CLASSIFICATION OF EXCHANGE RATE AND CAPITAL CONTROL REGIMES (OLS)

	Peg		Soft peg		Float			
	Coef. (s.e.)	N [R^2]	Coef. (s.e.)	N [R^2]	Coef. (s.e.)	N [R^2]	Versus mid-open	Versus closed
Open	**0.68*** (0.08)**	**433 [0.28]**	**0.32** (0.13)**	**301 [0.04]**	**0.17 (0.14)**	**280 [0.01]**	0.06 (0.08)	0.29*** (0.09)
Mid-open	**0.54*** (0.06)**	**438 [0.22]**	**0.38*** (0.08)**	**273 [0.05]**	**0.07 (0.08)**	**250 [0.00]**		
Closed	**0.25*** (0.07)**	**529 [0.07]**	**0.18* (0.10)**	**230 [0.01]**	**−0.06 (0.11)**	**392 [0.00]**	0.22*** (0.06)	
Versus soft peg	0.19*** (0.07)				0.22*** (0.08)			
Versus float	0.41*** (0.07)							

Klein, Michael, and Jay Shambaugh (2015). "Rounding the Corners of the Policy Trilemma: Sources of Monetary Policy Autonomy", *American Economic Journal: Macroeconomics* 7(4), pp. 33-66.