The Macroeconomics of Imperfect Capital Markets

Anton Korinek

University of Maryland

Lecture 12: Capital Controls and Currency Wars

Motivation

Motivation:

- Capital controls and other capital account interventions have significant international spillover effects

$\rightarrow$ concerns about "global currency wars"

Conflict between two views:

1. interventions distort international capital allocation
2. interventions improve efficiency by correcting externalities

Motivation

Main Questions

- *What are the global welfare implications of capital controls and capital account intervention?*
- *Do we need global "rules of the road" for intervention?*

Key Considerations:

1. General equilibrium model of international borrowing/lending
    - study effects of capital controls and capital account intervention
2. Investigate different motives for imposing capital controls:
    - "real" externalities that depend on the trade balance:
        - endogenous growth effects: learning-by-exporting, learning-by-doing
        - aggregate demand effects at zero lower bound
    - "financial" externalities that depend on debt levels
    - "monopolistic" terms-of-trade manipulation
3. Analyze role for global coordination by comparing
    - Nash equilibrium among national planners (NP)
    - optimum implemented by global planner (GP)

Results

Key Findings:

- Capital controls may create significant spillover effects
- Efficiency of unilateral intervention depends on type of externality:
  - unilateral intervention Pareto efficient for “real” externalities
  - global coordination improves outcomes for “financial” externalities
  - “monopolistic” terms-of-trade manipulation is beggar-thy-neighbor
- Global coordination reduces distortions of imperfect policy tools:
  - imperfect targeting
  - controls that are costly to impose

Literature

Existing literature:

- **Desirability of corrective capital controls:** e.g. Korinek (2007, 2010, 2011), Bianchi (2011), Ostry et al. (2010, 2011), Farhi and Werning (2012), ...
- **Terms-of-trade manipulation via distortive capital controls:** e.g. Persson and Tabellini (1995), Obstfeld and Rogoff (1996), Costinot et al. (2011), ...
- **Global coordination for financial externalities:** e.g. Bengui (2011), ...

Benchmark Model

Model setup:

- $N \geq 2$ countries indexed $i = 1, ...N$ of mass m^i each, $\sum_i m^i = 1$
- infinite discrete time $t = 0, 1, ...$
- endowments y_t^i
- bond holdings b_t^i where $\sum_i m^i b_t^i = 0$
- Representative consumer in country i maximizes

$$V^i(b_t^i) = \max u(c_t^i) + \beta V^i(b_{t+1}^i)$$
$$\text{s.t.} \quad c_t^i + (1 - \tau_{t+1}^i) b_{t+1}^i / R_{t+1} = y_t^i + b_t - T_t^i$$

	$\tau_{t+1}^i > 0$	$\tau_{t+1}^i < 0$
lenders $b_{t+1}^i > 0$	outflow subsidy	outflow tax
borrowers $b_{t+1}^i < 0$	inflow tax	inflow subsidy

Equilibrium Conditions

Equilibrium in individual countries:

- Euler equation from FOC(b^i_{t+1}):

$$(1-\tau^i_{t+1})u'(c^i_t) = \beta R_{t+1} u'(c^i_{t+1})$$

- bond demand $b^i_{t+1}(R_{t+1};\tau^i_{t+1})$
- regularity condition delivers $\partial b/\partial R > 0$

General equilibrium:

- sum up to obtain global excess demand for bonds: $B_{t+1}(R_{t+1};\tau_{t+1}) = \sum_{i=1}^N m^i b^i_{t+1}(R_{t+1};\tau^i_{t+1})$
- global market clearing: $B_{t+1}(R_{t+1};\tau_{t+1}) = 0$

Equilibrium Effects of Capital Controls

Proposition (General Equilibrium Effects of Capital Controls)

An increase in the capital control τ^i

- *increases bond holdings b^i_{t+1} in country i*
- *reduces world interest rate R_{t+1}*
- *diverts capital flows to other countries $j \neq i$*
- *increases welfare in borrowing countries ($b^j_{t+1} < 0$) and reduces welfare in lending countries ($b^j_{t+1} > 0$)*

Equilibrium Effects of Capital Controls

Numerical Illustration: changing τ^i_{t+1} from a steady state:

- Effect on world interest rate:

$$\frac{dR_{t+1}/R}{d\tau^i_{t+1}} = -m^i$$

- Effect on capital flows/GDP in country i:

$$\frac{db^i/y^i}{d\tau^i} = \frac{\sigma(1-m^i)}{1+\beta} \approx 0.25(1-m^i)$$

- Effect on capital flows/GDP in other country $j \neq i$:

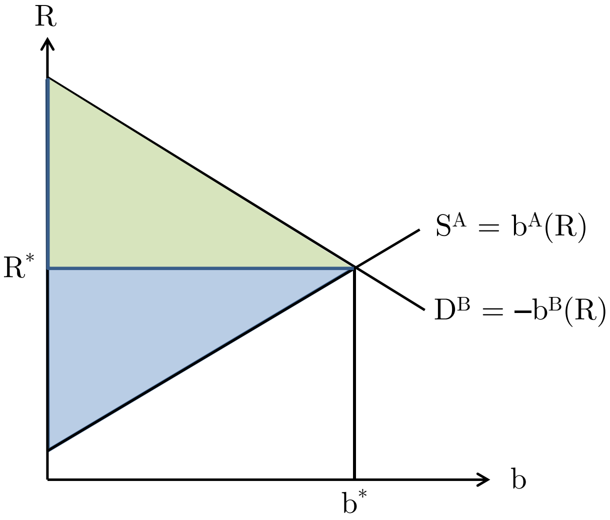
$$\frac{db^j/y^j}{d\tau^i} = \frac{db^j/y^j}{dR} \cdot \frac{dR}{d\tau^i} = \frac{\sigma m^i}{1+\beta} \approx -0.25m^i$$

General Equilibrium Effects

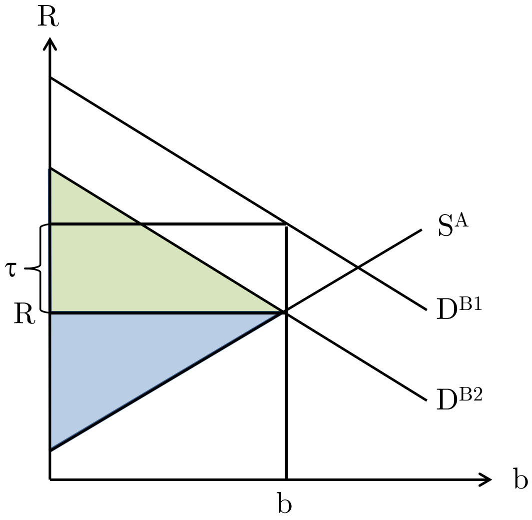
Country	GDP^i	$\$\Delta b^i/R$	$\Delta R/R$
World	$62,634bn	$\cdots$	-1.000%
United States	$14,447bn	$28.4bn	-0.231%
China	$5,739bn	$13.3bn	-0.092%
Brazil	$2,089bn	$5.2bn	-0.033%
Argentina	$370bn	$0.9bn	-0.006%

Table: Effects of 1% increase in capital controls

Two-Country Example: General Equilibrium Effects



Two-Country Example: General Equilibrium Effects



Equivalence Capital Controls / Reserves

Equivalence result:

Proposition (Equivalence Capital Controls / Reserves)

Any capital controls under open capital accounts can be replicated by a commensurate change in reserves under closed capital accounts.

- planner chooses reserve assets $a^i_{t+1} = b^i_{t+1}(R_{t+1}; \tau^i_{t+1})$
- note: if capital account is open, reserve accumulation is undone (Ricardian equivalence)

Factor of equivalence:

$$da^i / y^i = \frac{\sigma(1 - m^i)}{1 + \beta} \cdot d\tau^i \approx 0.25(1 - m^i) \cdot d\tau^i$$

Real Exchange Rate Model

Extended model setup:

- tradable and non-tradable endowments $(y^i_{T,t}, y^i_{N,t})$
- Representative consumer in country i maximizes

$$V(b^i_t) = \max u(c^i_{T,t}, c^i_{N,t}) + \beta V(b^i_{t+1})$$
$$\text{s.t.} \quad c^i_{T,t} + p_t c^i_{N,t} + (1 - \tau^i_{t+1}) b^i_{t+1} / R_{t+1} = y^i_{T,t} + p_t y^i_{N,t} + b_t - T^i_t$$

- Trade-off tradable/non-tradable consumption from FOC($c^i_{N,t}$):

$$p_t \cdot u_T(c^i_{T,t}, c^i_{N,t}) = u_N(c^i_{T,t}, c^i_{N,t})$$

$\rightarrow$ defines real exchange rate $p^i_t = p(c^i_{T,t})$ with $\partial p / \partial c_T > 0$

- increase in capital control τ^i_{t+1} depreciates real exchange rate p^i_t

Real Externalities

Real Externalities: depend on trade balance $tb_t^i = b_{t+1}^i / R_{t+1} - b_t^i$:

- growth externalities from learning-by-exporting:

$$\Delta y_{t+1}^i = f(tb_t^i)$$

- growth externalities from learning-by-doing:

$$\Delta A_{t+1}^i = f(tb_t^i)$$

- aggregate demand externality at zero lower bound:

$$\iota_{t+1}^i = \frac{(1+\pi_{t+1}^i)u'(c_t^i)}{\beta u'(c_{t+1}^i)} - 1 \geq 0 \quad \text{where} \quad c_t^i = \tilde{y}_t^i - tb_t^i$$

Generic Externality Model (NP)

Problem of a National Planner (NP):

- recognize utility $W^i(b_t^i) = u(c_t^i) + x^i(tb_t^i) + V^i(b_{t+1}^i)$
- Euler equation of NP:

$$u'\left(c_t^i\right) - x_t^{i\prime}\left(tb_t^i\right) = \beta R_{t+1}\left[u'\left(c_{t+1}^i\right) - x_{t+1}^{i\prime}\left(tb_{t+1}^i\right)\right]$$

- can be implemented by setting

$$\tau_{t+1}^{i*} = \frac{x_t^{i\prime}\left(tb_t^i\right) - \beta R_{t+1} x_{t+1}^{i\prime}\left(tb_{t+1}^i\right)}{u'\left(c_t^i\right)}$$

Generic Externality Model (GP)

Problem of a Global Planner (GP):

- global planner maximizes:

$$\max_{\{tb_t^i\}_{i,t}} \sum_t \beta^t \left\{ \sum_i \phi^i m^i \left[u\left(y_t^i - tb_t^i\right) + x^i\left(tb_t^i\right)\right] + \nu_t \sum_i m^i tb_t^i \right\}$$

- optimality condition:

$$\phi^i \left[u'\left(c_t^i\right) - x^{i\prime}\left(tb_t^i\right)\right] = \nu_t \quad \forall i$$

- let us pick an arbitrary ν_0 and set

$$\phi^i = \nu_0 / \left[u'\left(c_0^i\right) - x^{i\prime}\left(tb_0^i\right)\right] \forall i$$

$$\nu_{t+1} = \nu_t / \left(\beta R_{t+1}\right) \forall t$$

$\rightarrow$ then NP = GP

Real Externalities

Proposition (Correcting Real Externalities)

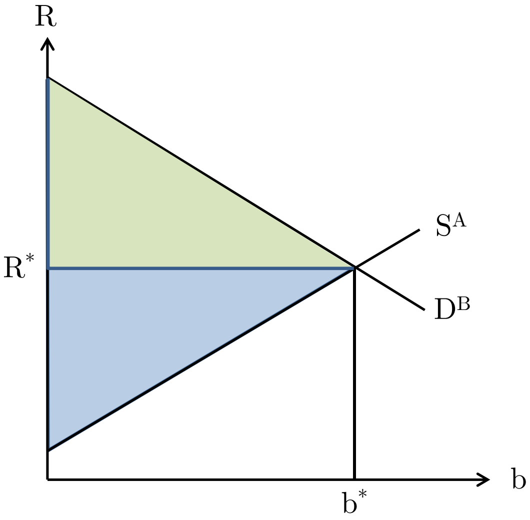
1. *A national planner in country i who acts competitively in world markets finds it optimal to correct domestic real externalities via capital controls* $\{\tau^i_{t+1}\}$*.*
2. *The Nash equilibrium among national planners is globally Pareto efficient.*

Intuition:

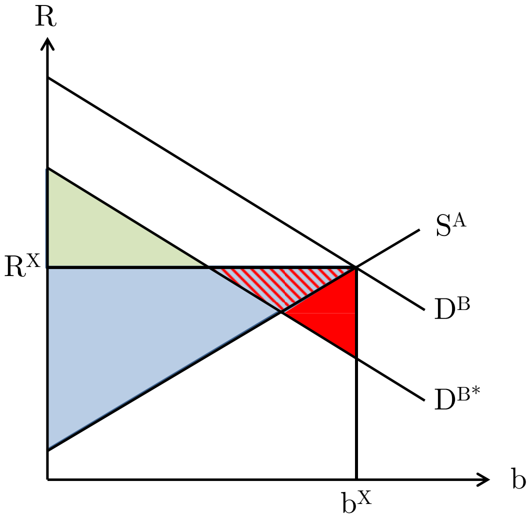
- capital controls entail spillover effects to other countries
- BUT: first welfare theorem applies at the national level

$\rightarrow$ global reallocation of capital is the efficient response of the market to changed demand for capital

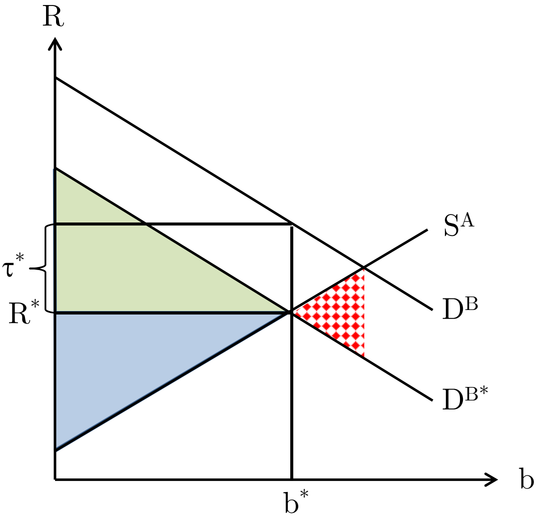
Real Externalities: Two-Country Example



Real Externalities: Two-Country Example



Real Externalities: Two-Country Example



Pareto-Improving Capital Controls

Proposition (Pareto-Improving Capital Controls)

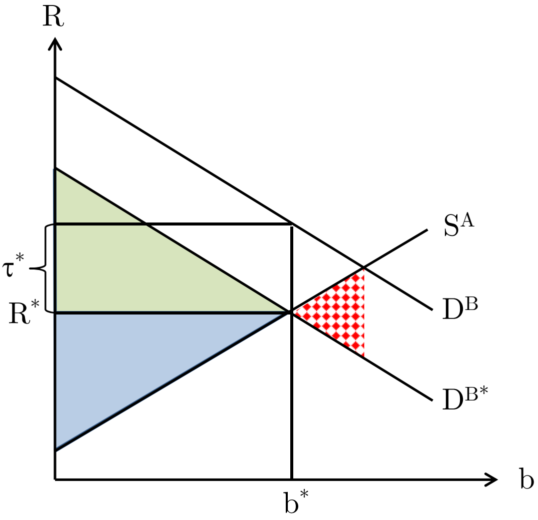
If inflow countries and outflow countries coordinate to control real externalities, capital controls can make everybody better off.

Intuition for Pareto Improvement:

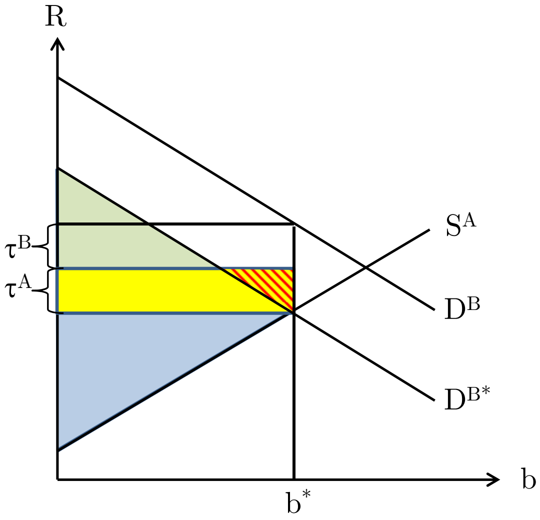
- outflow restrictions reduce global supply of capital
  $\rightarrow$ push up world interest rate
- inflow restrictions increase global supply of capital
  $\rightarrow$ push down world interest rate
- the right combination keeps the world interest rate unchanged

$\rightarrow$ no adverse terms-of-trade effect on other countries

Pareto-Improving Capital Controls



Pareto-Improving Capital Controls



Application: Learning Externalities

Learning-by-Exporting Externalities (see e.g. Rodrik, 2008; Korinek and Serven, 2011):

- assume output growth increases in trade balance tb_t at time t:

$$y_{t+1}^i = y_t^i + \Delta y_{t+1}^i \left(\bar{b}_{t+1}^i / R_{t+1} - \bar{b}_t^i\right)$$

- Euler equation of NP (where $v_{t+1} = \sum_{s=0}^{\infty} \beta^s u'\left(c_{t+s+1}^i\right)$):

$$u'\left(c_t^i\right) = \beta R_{t+1} u'\left(c_{t+1}^i\right) + \beta v_{t+1} \Delta y_{t+1}^{i\prime}\left(tb_t^i\right)$$

- optimal capital control:

$$\tau_{t+1}^{i*} = \frac{\beta v_{t+1} \Delta y_{t+1}^{i\prime}\left(tb_t^i\right)}{u'\left(c_t^i\right)}$$

Real Externalities: Further Results

Arms Race of Capital Controls:

- an increase in externality and control τ^i diverts capital flows from i
- another country j may experience larger externalities
- country j will also increase its controls τ^j
- this may in turn prompt country i to raise τ^i
- ...

$\rightarrow$ this is efficient process of equilibrium adjustment (tatonnement)

$\rightarrow$ not necessarily a sign of inefficiency

Real Externalities: Robustness

Robustness: results continue to apply if we include

- investment and capital
- nontraded goods and a real exchange rate
- uncertainty

Financial Externalities

Financial Externalities: depend on net asset (debt) position

Example: frictions due to exogenous financial constraints:

$$\frac{b^i_{t+1}}{R_{t+1}} \geq -\phi^i_{t+1} \qquad \text{or} \qquad b^i_{t+1} \geq -\phi^i_{t+1}$$

Proposition (Financial Externalities, National Planner)

A national planner who acts competitively cannot alleviate financial constraints.

Intuition:

1. For national planner, constraint is exogenous
   $\rightarrow$ no way around it
2. Rational private agents choose precautionary savings efficiently
   $\rightarrow$ no reason for intervention

Financial Externalities

Proposition (Financial Externalities, Global Planner)

A global planner who observes a country subject to binding financial constraints can restore the first best.

Intuition:

1. A global planner can implement a given real allocation $\{c_t^i, tb_t^i, ...\}$ using a continuum of financial allocations $\{b_{t+1}^i, R_{t+1}\}$
2. Every time period, there are $N+1$ instruments to meet N targets:

$$tb_t^i = \frac{b_{t+1}^i}{R_{t+1}} - b_t^i \quad \text{for } i = 1...N$$

Limitations: coordination and commitment, set of available instruments, bounds on R_{t+1}, ...

Financial Externalities

Financial Stability Externalities (Korinek, 2010, 2012; Bianchi, 2011):

- derive from endogenous constraint linked to exchange rate:

$$\frac{b^i_{t+1}}{R_{t+1}} \geq -\phi p^i_{N,t}(tb^i_t)$$

- if global planner can restore first-best: let's do it!
- otherwise: dependence of exchange rate on trade balance generates pecuniary externalities

→ then it is efficient for national planners to impose unilateral controls

Monopolistic Capital Controls

Monopolistic national planner: internalizes market power over R_{t+1}

- global market clearing requires

$$b^i(R_{t+1}; \tau^i_{t+1}) + B^{-i}(R_{t+1}; \tau^{-i}_{t+1}) = 0$$

- planner internalizes ROW inverse bond demand $R(B^{-i}_{t+1}; \tau^{-i}_{t+1})$

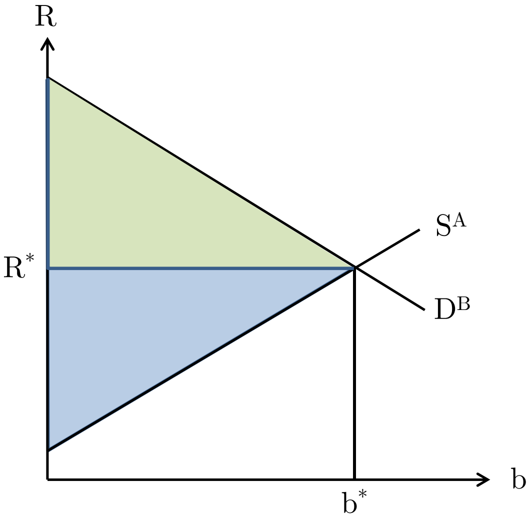
$$\max u\left(y^i_t - b^i_{t+1}/R(-b^i_{t+1}; \tau^{-i}_{t+1})\right) + \beta V^i(b^i_{t+1})$$

$\rightarrow$ optimal monopolistic capital control: $\tau^i_{t+1} = b^i_{t+1} \cdot (-R_B)/R_{t+1}$

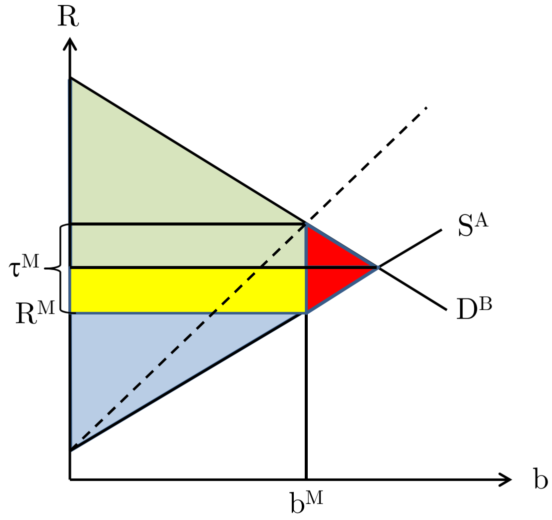
Proposition (Monopolistic Capital Controls)

Monopolistic capital controls that are designed to distort the world interest rate are Pareto inefficient.

Monopolistic Capital Controls



Monopolistic Capital Controls



Costly Capital Controls

Problem of National Planner:

- assume a convex cost $C(\tau)$ such that $C(0) = C'(0) = 0 < C''(\tau)$
- planner's optimization problem:

$$\begin{aligned} &\max u(c^i) + \beta W^i(b^i) \\ \text{s.t.} \quad & c^i + qb^i + C(\tau^i) = y^i \\ & (1-\tau^i) q u'(c^i) = \beta V^{i'}(b^i) \end{aligned}$$

- optimum implies $0 < |\tau^i| < |\tau^{i,*}|$
- global planner shares the burden of regulatory costs between countries

Note: similar mechanism if there exists a targeting problem

Conclusions

Capital Controls and Capital Account Interventions:

- have significant international spillover effects
- global coordination of capital account policies is
  - not necessary if controls offset real domestic externalities
  - powerful to address imperfections in intl. financial markets
  - indispensable if countries manipulate terms-of-trade

    – and –
  - useful to reduce distortions from implementation/targeting problems

$\rightarrow$ important lessons for currency warriors