Currency Wars or Efficient Spillovers?

A General Theory of International Policy Cooperation

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Motivation

- In a globalized world, national economic policies frequently create international spillover effects
- Examples: quantitative easing, devaluation policies, exchange rate & capital flow management, fiscal policy, etc.

→ concerns about “global currency wars”

→ repeated demands for greater global cooperation

BUT: premise for successful cooperation = Pareto inefficiency

Main Questions

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- When are spillovers from national economic policies inefficient?
- If they are, how can cooperation improve welfare?

Key Considerations

- multi-country model of international linkages
- optimizing private agents and national policymaker
- compare national and global optimum

$\rightarrow$ our framework nests a wide range of open economy macro models

Main Contribution

Main Contribution 1:
Inefficient Spillovers arise from three categories of problems:

1. monopoly power
2. imperfect *external* policy instruments
3. international market imperfections

$\rightarrow$ focus policy cooperation on areas where it can bear fruit

Main Contribution 2: If these problems are absent/addressed, the global allocation is Pareto efficient

$\rightarrow$ no further scope for global cooperation

Main Contribution

Main Contribution 3: Provide guidelines for cooperation

Address Three Areas of Inefficiency:

1. ensure competitive behavior
2. deal with incomplete/imperfect policy instruments
   - create new/better instruments
   - use existing instruments more efficiently
3. address imperfections in international markets
   - correct market imperfections
   - use existing markets more efficiently

All successful policy cooperation can be mapped into these areas

Literature

Literature on policy cooperation:

- **Monopolistic behavior:** Adam Smith (1776), ..., Bagwell and Staiger (1999, 2001, etc.), ..., Costinot et al. (2013), ...
- **Imperfect external instruments:** Tinbergen (1952), Theil (1954), ...
- **International market imperfections:** Arrow, Debreu, ..., Geanakoplos and Polemarchakis (1986), Greenwald and Stiglitz (1986), ... , Farhi and Werning (2016), ...

Example I of Spillovers

Real spillovers

- representative private agent in country i with $u(c) = c^{1-\theta}/(1-\theta)$

$$\max U^i = u(c_0^i) + u(c_1^i) \quad \begin{aligned} c_0^i &= y_0^i + m_0^i \\ c_1^i &= y_1^i + m_1^i \\ m_0^i + m_1^i/R &\le 0 \end{aligned}$$

- in vector notation: define $m^i = (m_0^i, m_1^i)^T$, $Q = (1, 1/R)$, etc.

$$\max_{m^i} V\left(m^i\right) = u\left(y_0^i + m_0^i\right) + u\left(y_1^i + m_1^i\right) \quad \text{st.} \quad Q \cdot m^i \le 0$$

Real shock: consider an increase in endowment $dy_0^i > 0$,

$$\left.\frac{dm^i}{dy_0^i}\right|_R = \begin{pmatrix} -s \\ Rs \end{pmatrix} \qquad \text{where} \qquad s = \frac{1}{1 + R^{\frac{\theta-1}{\theta}}}$$

Spillovers: smaller $t = 0$ and greater $t = 1$ inflows/imports

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Spillovers: smaller $t = 0$ and greater $t = 1$ inflows/imports

Example II of Spillovers

Spillovers of current account (CA) intervention

- simple rationale for CA intervention: learning-by-exporting
- extend Example I by assuming $y_1^i = y_1^i(-M_0^i)$ with $y_1^{i\prime}(-M_0^i) > 0$ (upper-case variables represent country-wide aggregates; individual agents do not internalize that $m^i = M^i$ in equilibrium)

Optimal policy: subsidize net exports/capital outflows in period 0

$$\tau_0^i = y_1^{i\prime} \cdot \frac{u'(c_1^i)}{u'(c_0^i)}$$

Spillovers: greater outflows in period 0/inflows in period 1

$$\left.\frac{dm^i}{d\tau_0^i}\right|_Q = \begin{pmatrix} -s \\ Rs \end{pmatrix} \qquad \text{where} \qquad s = \frac{y_0^i + y_1^i/R}{\left(2-\tau_0^i\right)^2}$$

Example III of Spillovers

Spillovers of export stimulus policy at the ZLB:

- consider zero lower bound on the nominal interest rate:

$$\iota_1^i \geq 0$$

- period 0 output is demand-determined: $\tilde{Y}_0^i = C_0^i - M_0^i$ with the usual (New) Keynesian frictions in the background
- if world interest rate high enough: $\left(1 + \pi_1^i\right) R - 1 > 0$ $\rightarrow$ no problem
- if world interest rate too low: $\left(1 + \pi_1^i\right) R - 1 = 0$ $\rightarrow$ imports M_0^i eat into domestic aggregate demand

Optimal policy: CA intervention to increase net exports
Spillovers: greater CA deficit in other countries

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Example III of Spillovers

Spillovers of macroprudential policy or capital controls
following Jeanne and Korinek (AERPP 2010)

- consider a three period economy with a representative agent

$$U^i = u(c_0^i) + u(c_1^i) + c_2^i$$

- each agent owns a tree that trades at date 1 price q
  - tree generates borrowing capacity

$$m_2^i + \phi p^i \left(M_1^i \right) \geq 0$$

$\rightarrow$ price-dependent financial constraint

Optimal policy: imposing macroprudential policy in period 0

Spillovers: lower borrowing in period 0, more borrowing (smaller CA reversal) in period 1

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Example IV of Spillovers

Exchange rate stabilization to insure traded/non-traded sector

- consider a developing economy with two types of agents:
  - financial elite: have access to international capital market
  - workers: live hand-to-mouth: no access to capital markets
    work either in traded or non-traded sector
- all agents value consumption:

$$U^i = \sum \beta^t u(c^i_{T,t}, c^i_{N,t})$$

- under autarky and no shocks: income of workers is stable
  $\rightarrow$ consumption smooth
- under open capital accounts: fluctuations in world interest rate lead to inflows/outflows
  $\rightarrow$ workers suffer positive/negative income shocks

Optimal policy: smoothing CA (leaning against the wind)

Spillover: reduced opportunities to trade for other countries

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Generalized Model Setup

- set of countries $\mathcal{I}$ of total measure $\omega(\mathcal{I}) = 1$
- utility of representative domestic agent in each country $i \in \mathcal{I}$

$$U^i(x^i) \quad \text{s.t.} \quad f^i(x^i, X^i, m^i, M^i) \leq 0$$
$$\frac{Q}{1-\tau^i} \cdot m^i \leq T^i$$

- x^i, X^i ... bundle of domestic variables
- m^i, M^i ... bundle of international transactions
  (upper-case variables denote country aggregates)
- Q ... vector of world market prices of m^i, M^i
- τ^i ... full set of tax instruments on intl transactions rebated via T^i

Mapping into General Model

Example: Canonical open economy macro models:

$$\max_{(c_t^i, b_{t+1}^i)_i} \sum_t \beta^t u(c_t^i) \quad \text{s.t.} \quad c_t^i + (1-\xi_t^i) b_{t+1}^i / R_{t+1} = y_t^i + b_t^i$$

Mapping:

- define net imports $m_t^i = c_t^i - y_t^i = b_t^i - b_{t+1}^i / R_{t+1}$
- domestic variables $x^i = \{c_t^i\}$
  - world market prices $Q_t = 1/\Pi_{s=0}^t R_{s+1}$
  - external policy instruments $(1-\tau_t^i) = 1/\Pi_{s=1}^t (1-\xi_{s+1}^i)$

$\rightarrow$ utility $U^i(x^i) = \sum_t \beta^t u(c_t^i)$
$\rightarrow$ constraints $f_t^i(\cdot) = c_t^i - y_t^i - m_t^i \leq 0 \; \forall t$

Mapping into General Model

Further Examples:

- multiple traded goods and states: $m^i = (m^i_{t,k,s})$ with $k = 1...K$, $s \in \mathcal{S}$
- non-traded goods: $x^i = (c^i_{T,t}, c^i_{N,t}, y^i_{N,t})$ and $f^i_{t,2} = y^i_{N,t} - c^i_{N,t}$
    - labor: $x^i = (c^i_t, \ell^i_t)$ and $U^i(x^i) = \sum_t \left[u(c^i_t) - d(\ell^i_t)\right]$
    - capital: $x^i = (c^i_t, k^i_t)$ and f^i_t includes law of motion
    - domestic market imperfections $\rightarrow$ capture in $f^i(\cdot)$
    - domestic policy measures $\rightarrow$ capture in X^i with constraint $x^i = X^i$
    - multiple types of agents, political preferences $\rightarrow$ capture in $U^i(x^i)$

$\rightarrow$ framework nests a wide range of open economy macro models

Efficient Benchmark

Impose three conditions sufficient to obtain efficient benchmark:

1. policymakers do not have (do not exert) market power
2. policymakers have complete set of external instruments
3. international market is complete

Solution Step 1

Separability

Given the complete external policy instruments, we can separate the domestic and international optimization problems.

Step 1: optimal domestic allocation *for given external* (m^i, M^i)

- representative agent optimizes
- domestic policymaker optimizes

$\rightarrow$ defines reduced-form utility function $V^i(m^i, M^i)$

Example: $V^i(m^i, M^i) = \sum_t \beta^t u(y_t^i + m_t^i)$

Solution Step 1 – Details

Step 1: formal problems *for given external* (m^i, M^i)

- representative agent: takes X^i as given:

$$v^i(m^i, M^i, X^i) = \max_{x^i} U^i(x^i) \quad \text{s.t.} \quad f^i(m^i, M^i, x^i, X^i) \leq 0$$

$$\rightarrow \ FOC(x^i): \quad U^i_x = \lambda^i f^i_x \qquad \rightarrow \qquad \text{obtain } (IC)$$

- domestic planner (for consistent external allocations $m^i = M^i$):

$$\max_{X^i} U^i(x^i) \quad \text{s.t.} \quad (IC),\ x^i = X^i,\ f^i(M^i, M^i, X^i, X^i) \leq 0$$

$$\rightarrow \qquad \text{obtain optimal domestic } X^i(M^i)$$

- define reduced-form utility by combining agent's value function and planner's optimal policies:

$$V^i(m^i, M^i) = v^i(m^i, M^i, X^i(M^i))$$

Solution Step 2

Step 2: determine optimal external allocations M^i in country i:

- planner solves for optimal external allocation M^i,

$$\max_{M^i} V^i(M^i, M^i) \quad \text{s.t.} \quad Q \cdot M^i \leq 0$$

  while internalizing any externalities from flows

$\rightarrow$ determines global competitive equilibrium

Solution Step 2 – Details

Step 2: optimal external allocations M^i:

- representative agent:

$$\max_{m^i} V^i(m^i, M^i) \quad \text{s.t.} \quad \frac{Q}{1-\tau^i} \cdot m^i \leq T^i$$

$$\rightarrow \; FOC(m^i) : (1-\tau^i) V^i_m = \lambda^i_e Q$$

- planner in country *i* that acts competitively:

$$\max_{M^i} V^i(M^i, M^i) \quad \text{s.t.} \quad Q \cdot M^i \leq 0$$

$$\rightarrow \; FOC(M^i) : V^i_m + V^i_M = \Lambda^i_e Q$$

Lemma (Implementation)

The planner's optimal allocation can be implemented by setting

$$\tau^i = -\frac{V^i_M}{V^i_m}$$

General Equilibrium

Global Competitive Equilibrium: feasible allocations (X^i, M^i), external policies (τ^i) and international prices Q such that:

- $x^i = X^i$ and $m^i = M^i$ is optimal for private agents in each country i
- each national planner chooses optimal X^i, τ^i taking Q as given
- global markets for M clear: $\int_{i \in \mathcal{I}} M^i d\omega(i) = 0$

Key Question

Is the Nash equilibrium among national planners efficient?

Global Planning Problem

Global Planning Problem:

- global planner maximizes:

$$\max_{\{M^i\}} \int_{i\in\mathcal{I}} \left[\phi^i V^i(M^i, M^i) + \nu M^i\right] d\omega\,(i)$$

- optimality condition:

$$\phi^i \left[V^i_m + V^i_M\right] = \nu \quad \forall i$$

- if we pick $Q = \nu$ and $\Lambda^i_e = 1/\phi^i$, then the optimality conditions of all national planners $V^i_m + V^i_M = \Lambda^i_e Q$ are satisfied

$\rightarrow$ Nash equilibrium among national planner is Pareto efficient

Global Planning Problem

1st FWT for National Economic Policymaking

The Nash equilibrium among national planners is Pareto efficient.

Note:

- policy interventions (X^i, τ^i) entail spillover effects
- BUT: spillover effects are mediated through global prices Q

$\rightarrow$ first welfare theorem applies at the level of planners

$\rightarrow$ global reallocation of capital/goods is efficient market response

Result = extension of standard **1st FWT** with **two modifications**:

- two layers of optimizing agents: private agents and policymakers
- anything goes in the domestic economy

Scope of Results and Robustness

Efficiency result applies to all our earlier examples

Robustness: result holds under all discussed extensions:

- labor, capital, multiple goods, uncertainty, ...
- any domestic market imperfections
- heterogeneous agents, political preferences, ...

$\rightarrow$ all these affect optimal *level* but *not efficiency* of intervention

Sufficient Conditions for Efficiency:

1. domestic planners are competitive (price-takers)
2. planners have sufficient external instruments to set M^i
3. no international market imperfections

Pareto Improvements

When can we obtain Pareto improvements (rather than just Pareto efficiency)?

$\rightarrow$ generally requires global coordination

Two possible avenues:

1. either lump-sum transfers $\hat{T}^i$
2. or coordinated use of policy instruments (τ^i) to keep Q constant

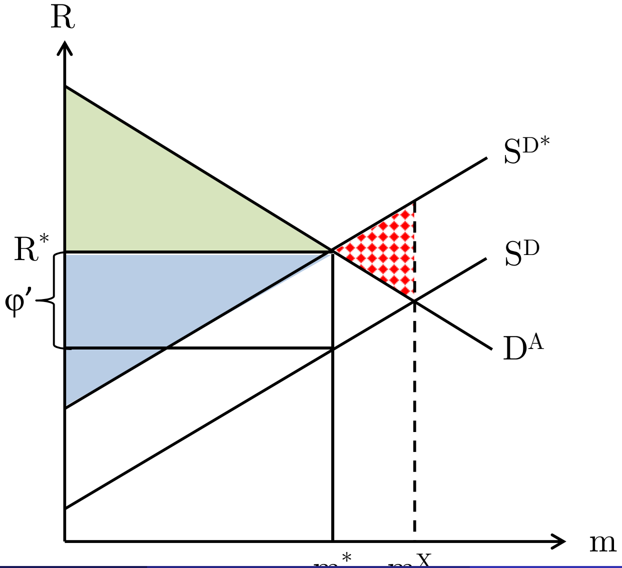
Example:

- N identical countries except different sizes ω^i
- assume exogenous increase in externalities calling for $d\tau^i > 0$
- world prices remain constant if countries set

$$d\tilde{\tau}^i = (1-\omega^i)d\tau^i$$
$$d\tilde{\tau}^j = \omega^i d\tau^i$$

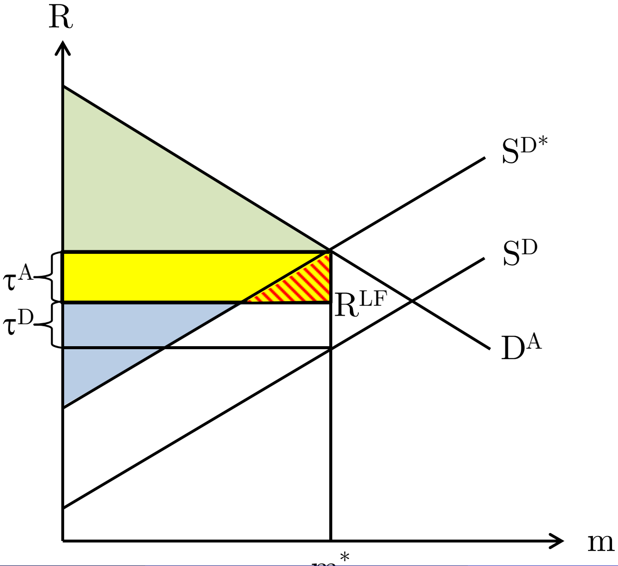
$\rightarrow$ optimal mix of inflow/outflow restrictions

Unilateral Intervention



Pareto-Improving Coordinated Intervention

Coordinated Intervention to Hold World Prices Constant



Correcting Externalities: Further Results

Arms Race of Intervention:

- assume externalities V_M^i are increasing in flow of imports M^i
- shock in one country's may lead to greater intervention τ^i
- this diverts flows to other countries
- other countries experience larger externalities, also increase intervention
- this may in turn prompt initial country to raise τ^i further, etc.

$\rightarrow$ this may be the efficient process of equilibrium adjustment (tatonnement)

$\rightarrow$ "arms race" not necessarily a sign of inefficiency

Case I for Cooperation: Monopolistic Policymakers

Monopolistic policymakers: internalize market power over Q

- global market clearing requires $\omega^i M^i + M^{-i}(Q) = 0$
- monopolistic planner internalizes ROW inv. demand $Q^{-i}(-\omega^i M^i)$

$$\max_{M^i} V^i(M^i, M^i) \quad \text{s.t.} \quad Q^{-i}(-\omega^i M^i) \cdot M^i \leq 0$$

- optimality condition

$$V^i_m + V^i_M = \Lambda^i Q^T \left[I - \mathcal{E}^i_{Q,M} \right] \qquad \text{where} \qquad \mathcal{E}^i_{Q,M} = \omega^i Q^{-i}_M M^i / Q^T$$

$\rightarrow$ "optimal" monopolistic intervention: $1 - \hat{\tau}^i = \dfrac{1 + V^i_M / V^i_m}{1 - \mathcal{E}^i_{Q,M}}$

Proposition: Monopolistic Policy Intervention

Monopolistic policy interventions designed to distort world prices/interest rates are inefficient.

Identifying Monopolistic Policy Intervention

Difficulty: How do we distinguish monopolistic behavior from correcting externalities?

Theory offers a few guidelines:

- small economies in the world market have $Q^i_M = 0$
  $\rightarrow$ no market power over Q
- countries with little cross-country trade have $M^i \approx 0$
  $\rightarrow$ no welfare benefit to manipulating price so $\mathcal{E}^i_{Q,M} \approx 0$
- sign of intervention $\hat{\tau}^i$ = sign of trade position $M^i_{t,k,s}$:
  - country with net inflows will restrict inflows and vice versa
  - with multiple goods, tax imports and restrict exports
  - under uncertainty, reduce insurance because each country has net long position in idiosyncratic risk

Market Power and Imperfect Instruments

1. If external policy instruments τ^i complete, a planner will never distort domestic policies X^i to exert market power
2. If external policy instruments imperfect, then domestic policies will also be distorted to exert market power

Example: Market Power and Domestic Policies

Optimal 'monopolistic' allocation when $\tau^i \equiv 0$:

- assume no external policy instruments available at all ($\tau^i \equiv 0$)

$\rightarrow$ second-best: internalize indirect effect of domestic policy on (m^i, M^i)

- domestic planner:

$$\max_{X^i} U^i(X^i) \quad \text{s.t.} \quad (IC),\ x^i = X^i,\ f^i(M^i, M^i, X^i, X^i) \leq 0$$

$$Q^{-i}(-M^i) \cdot M^i \leq 0$$

$$\rightarrow \qquad \text{obtain optimal } \tilde{X}^i(M^i)$$

- define reduced-form utility by combining agent's value function and planner's optimal policies:

$$\tilde{V}^i(m^i, M^i) = v^i(m^i, M^i, \tilde{X}^i(M^i))$$

Case II: Imperfect External Policy Instruments

Baseline model:

- complete set of external instruments (τ^i)
- allowed planner to implement desired external allocation (critical for argument of the first welfare theorem)

Imperfect Policy Instruments:

- can be captured by a convex cost function $C^i(\tau^i) \geq 0$
- interpretations:
  - costly instruments, e.g. $C^i(\tau^i) = \gamma^i \sum(\tau_t^i)^2/2$
  - missing instruments if $\gamma^i \to \infty$
  - coarse instruments, e.g. $C^i(\tau^i) = \gamma^i \sum(\tau_{t,s}^i - \tau_{t,0}^i)^2/2$ with $\gamma^i \to \infty$
- note: even imperfect set of instruments can be *effectively* perfect, e.g. if there are no externalities $V_M^i = 0$

Imperfect External Policy Instruments

Proposition: Imperfect External Policy Instruments

- The equilibrium among national planners is generically inefficient if at least one country has effectively imperfect instruments.
- Constrained efficiency under imperfect policy instruments requires

$$\sum \omega^i C^{i\prime}(\tau^i)(1-\tau^i) = 0$$

Intuition:

- setting average marginal distortion to zero minimizes total implementation costs
- if this is violated then there is generally scope for regulation

Example 1 of Imperfect Policy Instruments

Example of Wasteful Competitive Intervention:

- consider N identical countries with externalities $V_M^i < 0$
- each country intervenes $\tau^i > 0$ at cost $C^i(\tau^i) > 0$
  - intervention is completely wasteful:
    same allocation but lower cost with $\tau^i = 0 \; \forall i$

Example 2 of Imperfect Policy Instruments

Example of Sharing the Regulatory Burden:

- consider 2 countries $i = A, B$ with cost $C^i(\tau^i) = \gamma^i \sum(\tau_t^i)^2/2$
- exogenous change in externalities calls for $d\tau^A = d\eta$
- in national planning equilibrium, unilateral intervention
- under global coordination,

$$d\tilde{\tau}^A = \frac{\gamma^B}{\gamma^A + \gamma^B} \cdot d\eta \qquad \text{and} \qquad d\tilde{\tau}^B = -\frac{\gamma^A}{\gamma^A + \gamma^B} \cdot d\eta$$

- extreme cases: $\gamma^B = 0$ or $\gamma^A \to \infty$

Further Results on Imperfect Policy Instruments

- If set of *external* policy instruments effectively imperfect, it is optimal to distort *domestic* policies to target external transactions

$\rightarrow$ global coordination needs to also involve domestic policies

Case III: Imperfections in International Markets

Examples:

- Limited risk markets
- Financial constraints
- Price rigidities and AD externalities
- Cross-border externalities

Formal description:

$$\Phi\left(\left(M^i\right)_{i=1}^N, Q\right) \leq 0$$

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Case III: Imperfections in International Markets

Lemma: Use of External Instruments under Imperfect Markets

Cooperation under imperfect intl markets is limited to external policy instruments, provided that the set of such instruments is complete.

Intuition:
Separability results continue to hold

- Fixing international imperfection only requires external instruments
- Otherwise: generally need to coordinate on domestic instruments as well

Conclusions

Intl. policy cooperation indispensable in three problem areas:

1. ensuring competitive behavior
2. dealing with imperfect external policy instruments
3. addressing imperfections in international markets

$\rightarrow$ Any remaining spillover effects are efficient