United we stand, divided we win

Strategic decentralization and the provision of global public goods

Renaud Foucart Cheng Wan

Nuffield College and Department of Economics
University of Oxford
renaud.foucart@economics.ox.ac.uk

Fondazione Eni Enrico Mattei, October 2014

An American story

- The European Union has been successful in centralizing a number of policies with global implications
- This has often been done using transfers and compensation among members
- Example: Common Agricultural Policy and the Fontainebleau agreement

An American story

- The European Union has been successful in centralizing a number of policies with global implications
- This has often been done using transfers and compensation among members
- Example: Common Agricultural Policy and the Fontainebleau agreement
- However, when the topic is military intervention, the EU hardly never acts centrally
- Even on European ground (the Balkans in the nineties)
- Even since the EU has created some capacity to do so (the war on Lybia)

An American story:

"If I want to call Europe, who do I call?"
(attributed to) Henry Kissinger, circa 1973

A European story

- The US is a federal country, successful in centralizing a number of policies with global implications
- This has often been done using transfers and compensation among members

A European story

- The US is a federal country, successful in centralizing a number of policies with global implications
- This has often been done using transfers and compensation among members
- However, when the topic is global environmental issues, the US government is committed to a "bottom up" approach
- This has not been the case for "national" environmental issues (eg. the market for sulfur dioxide)

A European story:

"We expect American leadership. President Obama has created great expectations around the world. Now we urge [the US] to contribute in the way that we have,"

Andreas Carlgren, Swedish environment minister - talking on behalf of the EU presidency (Copenhagen talks, 2009)

Research question

- When does a coalition wants to decentralize decision making on a global public good provision ?
- (later) When is it in the **joint** interest of countries to become an active coalition ?

Coalitions and global public goods:

- Economists have been focused on the question of coalition formation:
- The typical question is: "why does a country" (variant: a group of countries) want to join/leave a coalition? (Bloch, 1996 ; Ray and Vohra, 1997 ; d'Aspremonts et al., 1983)
- Most applications are about the environment (e.g. Barret 1994) or military alliances (e.g. Sandler and Hartley, 2001)
- The typical problem is: free-riding leads to the failure of self-enforcing agreements (e.g. Barret, 2005)
- A solution: transfers within coalitions. The optimal coalition for global public goods, the grand coalition, is sustainable with transfers (Carraro and Siniscalco, 1993 ; Carraro et al., 2006)

Our approach: *Potential coalitions* of countries trusting each other, and wanting to maximize their **joint surplus**

Model:

- A three-stage game, solved by backward induction
- We focus on pure-strategy SPNE
- First stage: members of a potential coalition decide to activate it or not
- Second stage: active coalitions choose to decentralize or not
- Third stage: an emission game (global pollution)

Stage 3: the Emission Game

The emission game

- N players, indexed by $i \in \mathcal{N} = \{1, ..., N\}$
- Each player is equipped with a weight $m_i \in (0, +\infty)$, with $M = \sum_i m_i$
- A player is either an autonomous country or a centralized coalition composed of a finite number of countries
- Each player chooses a level of emissions $q_i \in [0, m_i]$
- The aggregate level of emissions is $Q = \sum_i q_i$, so that $Q \in [0, M]$

- Player i maximizes

$$u_i(\mathbf{q}) = g(\frac{q_i}{m_i}) - f(Q). \tag{1}$$

- f is defined from $[0, +\infty)$ to $\mathbb{R}_+$, is twice differentiable, strictly increasing and strictly convex.
- g is defined on $[0, 1]$ to $\mathbb{R}_+$, is twice differentiable, strictly increasing and strictly concave
- Besides, $\lim_{x \to 0+} g'(x) = +\infty$, $g'(1) > 0$
- Let this emission game be denoted by $\Gamma(\mathcal{N}, (m_i)_{i \in \mathcal{N}}, f, g)$.

Lemma

There always exists a unique Nash equilibrium in emission game $\Gamma(\mathcal{N}, (m_i)_{i\in\mathcal{N}}, f, g)$.

Lemma

The Nash equilibrium $\mathbf{q} = (q_1, \ldots, q_N)$ *of emission game* $\Gamma(\mathcal{N}, (m_i)_{i\in\mathcal{N}}, f, g)$ *satisfies that, for all player* i*, either* $0 < q_i < m_i$ *and* $f'(Q) = \frac{g'(\frac{q_i}{m_i})}{m_i}$*, or* $q_i = m_i$ *and* $f'(Q) \leq \frac{g'(1)}{m_i}$.

Lemma

There exists $\epsilon > 0$ *such that for all player* i*, if* $m_i < \epsilon$*, then* $q_i = m_i$.

Assumption

No country has weight greater than ϵ.

Stage 2: Decentralization

Definition

A coalition i decentralizes if she lets each of its member countries (labeled by $\{i_j \mid j \in J_i\}$ and having weight $\{m_{i_j} \mid j \in J_i\}$) decide her quantity of emissions independently. After decentralization, the new set of players is noted $\mathcal{N}^{(i)} = \mathcal{N} \cup J_i \setminus \{i\}$, and the utility of coalition i is defined as the weighted average utility of its member countries in the induced emission game $\Gamma(\mathcal{N}^{(i)}, (m_k)_{k \in \mathcal{N}^{(i)}}, f, g)$, and denoted by $v_i = \sum_{j \in J_i} \frac{m_{i_j}}{m_i} u_{i_j}$.

Assumption

For all coalition i, for all $j \in J_i$, $m_{i_j} < \epsilon$.

Stage 1: Activation

Definition

A potential coalition i is activated if each of its member countries (labeled by $\{i_j \mid j \in J_i\}$ and having weight $\{m_{i_j} < \epsilon \mid j \in J_i\}$) decide to delegate decision making in the next stage to a single player. All the members of a potential coalition can use any form of transfer among them, so that activation happens in equilibrium if the expected joint payoffs of coalition members are higher by doing so.

In Examples 1 and 2 we assume:

- Two active coalitions 1 and 2 of identical size $m_1 = m_2 = 1$ (play stages 2 and 3)
- No other player

Example 1: moderate taste for the public good

Assume $m_1 = m_2 = 1$, and the (symmetric) per unit payoffs are of the form:

$$u_i(q) = 3q_i^{\frac{1}{2}} - (q_i + q_j)^{\frac{3}{2}} \tag{2}$$

Assume $m_1 = m_2 = 1$, and the (symmetric) per unit payoffs are of the form:

$$u_i(q) = 3q_i^{\frac{1}{2}} - (q_i + q_j)^{\frac{3}{2}} \tag{2}$$

Consider the two groups are active coalitions.

- Each emission subgame has a unique equilibrium.
- If both coalitions are centralized, $q_1 = q_2 = \frac{\sqrt{2}}{2} = 0.71$
- If one coalition is decentralized and produces $q_i = 1$, the other chooses $q_j = \frac{\sqrt{5}-1}{2} = 0.62$.

Hence, the second and third stages of the game are:

		P 2	
		C	D
P 1	C	0.84 0.84	$0.94*$ $0.30*$
	D	$0.30*$ $0.94*$	0.17 0.17

Table 1: Only one coalition is centralized in equilibrium

Example 2: high taste for the public good

We still assume two coalitions of size 1, but the (symmetric) per unit payoffs are of the form:

$$u_i(q) = q_i^{\frac{1}{2}} - (q_i + q_j)^{\frac{3}{2}} \tag{3}$$

We still assume two coalitions of size 1, but the (symmetric) per unit payoffs are of the form:

$$u_i(q) = q_i^{\frac{1}{2}} - (q_i + q_j)^{\frac{3}{2}} \tag{3}$$

- Each emission subgame has a unique equilibrium.
- If both coalitions are centralized, $q_1^* = q_2^* = \sqrt{\frac{1}{18}} = 0.24$
- If one coalition is decentralized and produces $q_i = 1$, the other chooses $q_j = 0.1$.

Hence, the second and third stages of the game are:

		P 2	
		C	D
P 1	C	$0.16*$ $0.16*$	-0.16 -0.84
	D	-0.84 -0.16	-1.83 -1.83

Table 2: Two coalitions are centralized in equilibrium

Example 3:

- An active coalition 1 of size m_1 (plays stages 2 and 3)
- A potential coalition 2 of size $m_2 < m_1$ (plays stages 1, 2 and 3)
- No other player

Assume the same payoff function as Example 1, but two groups of country have asymmetric size, $m_1 = 1.18$, $m_2 = 0.82$. The per unit payoffs are:

$$u_1(q) = 3(\frac{q_1}{1.18})^{\frac{1}{2}} - (q_1 + q_2)^{\frac{3}{2}} \tag{4}$$

$$u_2(q) = 3(\frac{q_2}{0.82})^{\frac{1}{2}} - (q_1 + q_2)^{\frac{3}{2}} \tag{5}$$

Assume the same payoff function as Example 1, but two groups of country have asymmetric size, $m_1 = 1.18$, $m_2 = 0.82$. The per unit payoffs are:

$$u_1(q) = 3(\frac{q_1}{1.18})^{\frac{1}{2}} - (q_1 + q_2)^{\frac{3}{2}} \tag{4}$$

$$u_2(q) = 3(\frac{q_2}{0.82})^{\frac{1}{2}} - (q_1 + q_2)^{\frac{3}{2}} \tag{5}$$

- Each emission subgame has a unique equilibrium.
- If both coalitions are centralized, $q_2^* = m_2 = 0.82$, $q_1^* = 0.60$
- If coalition 2 is decentralized, nothing changes
- If coalition 1 is decentralized, $q_1^* = 1.18$, $q_2^* = 0.66 < m_2$

Hence, the first stage of the game is

Table 3

(a) Coalition 2 is active

		P 2	
		C	D
P 1	C	1.31 0.45	$1.31(*)$ $0.45(*)$
	D	$0.20*$ $0.50*$	0.17 0.17

Hence, the first stage of the game is

Table 3

(c) Coalition 2 is active

P 1 \ P 2	C	D
C	1.31 0.45	1.31(∗) 0.45(∗)
D	0.20∗ 0.50∗	0.17 0.17

(d) Coalition 2 is not active

P 1 \ P 2	D
C	1.31∗ 0.45∗
D	0.17 0.17

Total level of emission in (C,D), Q=1.42. In (D,C), Q=1.84

A "Western" story

- Since 2009, the so-called BRICS (Brazil, Russia, India, China, South Africa) hold annual meetings
- The official objective of those meetings is to enhance cooperation and stimulate joint projects
- The only substantial cooperative institution launched by the BRICS since then is the project of a joint development bank

A "Western" story

"[what] the world needs from the BRICS is not another development bank, but greater leadership on today's great global issues. The BRICS countries are home to around half of the world's population and the bulk of unexploited economic potential. If the international community fails to confront its most serious challenges - from the need for a sound global economic architecture to addressing climate change - they are the ones that will pay the highest price." (Dani Rodrik, 2014)

Example 4:

- An active coalition 1 of size m_1 (plays stages 2 and 3)
- A potential coalition 2 of size $m_2 < m_1$ (plays stages 1, 2 and 3)
- No other player
- Potential coalition 2 has a higher taste for the public good (think of coastal countries and global warming, or of an epidemic such as Ebola)

Assume an asymmetric payoff function and two groups of asymmetric size, $m_1 = 1.4$, $m_2 = 0.6$. The per unit payoffs are:

$$u_1(q) = 3\left(\frac{q_1}{1.4}\right)^{\frac{1}{2}} - Q^{\frac{3}{2}}, \tag{6}$$

$$u_2(q) = 3\left(\frac{q_2}{0.6}\right)^{\frac{1}{2}} - 10Q^{\frac{3}{2}}. \tag{7}$$

Assume an asymmetric payoff function and two groups of asymmetric size, $m_1 = 1.4$, $m_2 = 0.6$. The per unit payoffs are:

$$u_1(q) = 3\left(\frac{q_1}{1.4}\right)^{\frac{1}{2}} - Q^{\frac{3}{2}}, \tag{6}$$

$$u_2(q) = 3\left(\frac{q_2}{0.6}\right)^{\frac{1}{2}} - 10Q^{\frac{3}{2}}. \tag{7}$$

- Each emission subgame has a unique equilibrium.
- If both coalitions are centralized, $q_1^* = 0.84$, $q_2^* = 0.19$
- If coalition 2 is decentralized, $q_1^* = 0.6$, $q_2^* = m_2 = 0.6$
- If coalition 1 is decentralized, $q_1^* = m_1 = 1.4$, $q_2^* = 0.12$

Hence, the first stage of the game is

Table 4

(a) Coalition 2 is active

P 1 \ P 2	C	D
C	-8.75 1.27	-10.09 0.65
D	$-16.35*$ $1.32*$	-25.30 0.17

Hence, the first stage of the game is

Table 4

(c) Coalition 2 is active

P 1 \ P 2	C	D
C	-8.75 1.27	-10.09 0.65
D	$-16.35*$ $1.32*$	-25.30 0.17

(d) Coalition 2 is not active

P 1 \ P 2	D
C	$-10.09*$ $0.65*$
D	-25.30 0.17

- Strategic decentralization may increase the joint surplus of a coalition
- This is because it acts as a commitment to free ride
- Decentralization benefits a coalition if the gain from free-riding among coalitions outweighs the cost of not cooperating within the coalition
- A multipolar world may produce less public good
- If a small group of countries share a high interest for the public good, they are likely to be better off by never starting an alliance

Thank you !