

Coordination failures: a game-theoretic approach

David Bartolini GOV/RDP

Brown bag Seminar
Paris, 13 July 2012

Plan of the talk

1. introduction and scope of the analysis
2. a taxonomy of coordination failures
3. devising instruments to tackle coordination failures
4. possible applications

Introduction

- a coordination **failure** is defined according to the concept of **Pareto efficiency**: i.e., the outcome of the interaction is not Pareto efficient;
- the problem of coordination lies at the base of many economic situations and has been the focus of many disciplines: institutional approach (laws and social norms); business & management (hierarchies and organizations); public finance; economic theory; etc.
- my **aim** is to characterize some basic features that are relevant in any situation where economic agents (strategically) interact

A taxonomy of coordination failures

- I identify coordination failures according to the degree of **alignment of agents' objectives** (which depends on their preferences)
- I refer to *ex-ante* objectives

In decreasing order of alignment we have the following strategic situations:

1. pure coordination game
2. battle of sexes
3. prisoner's dilemma

1. pure coordination game

- this is the case of perfectly aligned objectives
- for instance, in the two-player game, both $\{A, A\}$ and $\{B, B\}$ are Nash Equilibria

	<i>A</i>	<i>B</i>
<i>A</i>	2, 2	0, 0
<i>B</i>	0, 0	1, 1

- objectives are aligned: both agents want to coordinate on $\{A, A\}$;

coordination failure

it may occur because of **strategic uncertainty**, i.e., the risk that one player chooses *A* while the other chooses *B*.

2. battle of sexes

- for instance in a two-player game, both $\{A, A\}$ and $\{B, B\}$ are Nash equilibria

	<i>A</i>	<i>B</i>
<i>A</i>	2,1	0,0
<i>B</i>	0,0	1,2

- both players prefer to coordinate (choosing the same strategy), rather than choosing a different strategy;
- there is scope for negotiation (bargaining theory)

coordination failure

the problem is again strategic uncertainty, but with the twist that each player has **her own preferred** equilibrium strategy.

3. prisoner's dilemma

- for instance, in a two-player game, the strategy $\{NC, NC\}$ is the unique Nash equilibrium (dominant strategy)

	<i>C</i>	<i>NC</i>
<i>C</i>	2, 2	0, 3
<i>NC</i>	3, 0	1, 1

coordination failure

The problem is the presence of an incentive to **free-ride**; i.e., both players have an incentive not to coordinate on the cooperative strategy.

to sum up

R. Weber (2008) "*Organization coordination: a game-theoretic view*" available at <http://repository.cmu.edu/sds/5>, proposes the following terminological distinction:

- problems of coordination: objectives almost aligned (cases 1 and 2)
- problems of cooperation: objectives not aligned (case 3)

In general, we have:

	C	NC
C	2, 2	0, x
NC	x, 0	1, 1

- for $0 \leq x < 2$, we have almost aligned objectives
- for $x \geq 2$, we have the prisoner's dilemma
- the incentive to cooperate decreases with x (it is the difference $\Delta = x - 2$ that matters)

Main message

In the presence of coordination failures:

- it is important to identify the type of failure
- the policy should be devised in order to tackle the specific problem:
 - in the case of aligned preferences (case 1, and 2), we need a mechanism to **facilitate** cooperation
 - in the case of less aligned preferences (case 3), we need a mechanism to **enforce** cooperation

Problem:

- is it possible to identify the *ex-ante* objectives?

(a) Contracts

in case of aligned objectives:

- there is no need of enforcement
- the incentive compatibility constraint is never binding
- focus should be on the *informative* prescriptions even though they are not verifiable

in case of not aligned objectives:

- the possibility to enforce the contract is fundamental
- the incentive compatibility constraint is binding
- focus should be on *verifiable* prescriptions

(b) Repeated interaction — Relationship

in case of aligned objectives:

- a repeated interaction is sufficient to coordinate
- the social “social” norm consists of the information about the past behaviour of the economic agents

in case of not aligned objectives

- it is fundamental that the relationship is repeated a potentially infinite number of times
- a social norm needs a prescription of punishment in case of non compliance

(c) Financial incentives

in case of aligned objectives:

- a temporary monetary incentive can induce a **sustained** cooperation
- likewise an insurance which reduces the strategic risk

in case of not aligned objectives

- a temporary incentive may not induce **sustained** cooperation unless it is maintained through time
- problems of moral hazard are more acute

(d) Dynamic setting

in case of aligned objectives:

- the sequential structure of the interaction is enough to solve the coordination problem

in case of not aligned objectives

- credibility (and commitment) assumes a fundamental role
- the sequential structure of the interaction would not assure coordination, because of lack of credibility (hold-up problem)

the fundamental trade-off **credibility vs flexibility** can be solved in favour of flexibility the more objectives of the involved players are aligned

Example 1: inter-sectoral complementarities

a simultaneous expansion of many sectors can be self-sustaining through mutual demand support, even if by itself no sector can break even

Murphy, Shleifer, Vishny, *Industrialization and the big push* Journal of Political Economy, 1989

- a subsidy (or an insurance for the firm(s) that invest) can be enough to solve the coordination failure
- however, if there is an incentive to free ride, than the subsidy maybe not enough to sustain cooperation in time
 - this is the case in which firms investment is non-rival (for example, irrigation and cooperation in India, Bardhan “Scarcity, conflict, and cooperation” 2005)

Example 2: multilevel governance

several OECD works have identified **gaps**, which represent obstacles for coordination among levels of government (see Charbit C., *Governance of Public Policies in Decentralised Context*, OECD RDP working paper 2011/04)

the way to deal with those gaps may depend on the degree of alignment of players' objectives

for instance:

- *information gap*: the more objectives are aligned the more a mechanism should aim at transferring information rather than solving a moral hazard problem
- *policy gap*: sectoral fragmentation creates problems of coordination, however, the more objective are aligned the less important is commitment with respect to leadership

- *accountability gap*: the importance of accountability (and monitoring) may decrease with the degree of alignment (electoral accountability is crucial when the incumbent politician is rent-seeking)
- *objective gap*: the possibility and way to align objectives *ex-post*, may depend on their *ex-ante* degree of alignment
- *funding gap*
- *capacity gap*

Public Investment at sub-national level

From a recent OECD workshop on *Effective Public Investment at Sub-national Level* (Paris 21/6/2012), it emerges the importance of objectives alignment

- many presentations showed that one of the most important factor of success is the alignment of objectives among the institutional actors
- the way in which this is reached depends on the initial degree of alignment. For instance,
 - when they are not ex-ante aligned a crucial role is played by the enforcement and credibility, thus it should be better to use a less flexible but more credible instrument
 - evaluation and audit is the more important the less aligned are the objectives

in general it seems that:

- **vertical coordination** is likely to take place among players with aligned objectives (public investment, public sector management, etc.)
- **horizontal coordination** is likely to take place among players with not aligned objectives (redistribution of resources, partnerships among municipalities, etc.)

Example 3: Asymmetric information

This is a typical case in many real world situations. It can represent an obstacle to cooperation.

- if agents objectives are not perfectly aligned it arises a problem of adverse selection or moral hazard (or both)
- the solution can be a contract or a signaling mechanism
- the degree of alignment of the players' objectives makes a difference
 - in contracts, it affects the amount of information rent
 - in signaling games, it affects the “cost” of the signal (Farrel and Rabin *Cheap Talk*, Journal of Economic Perspectives, 1996, 10(3))

Example 4: Multiple agents

In this case the issue of coordination becomes more complex: agents' objectives may be aligned only with a subset of players (partial coordination, collusion, etc.)

- coalition formation literature (partial coordination)
- cooperation inside groups (contest literature)
- hierarchical structure: multiagent moral hazard and collusion, vertical information transmission

Coalition formation models

The aim of this literature is to explain the emergence of coalitions

- Ray and Vohra *Coalitional power and public goods* Journal of Political Economy, 2001, 109(6)
 - forward looking players
 - concept of equilibrium different than NE
- the possibility to form partial agreements (partial cooperation) reduces the possibility to reach a global efficient agreement (the Coase theorem is valid only for the two agent case)
- message: allowing partial agreement introduces flexibility in the relationship, but may prevent the formation of global coordination

Esteban and Sakovics *Olson vs Coase: coalitional worth in conflicts*

- Consider 3 agents who compete for a prize (rival good), which they all value 1; an agreement of cooperation is reached between B and C , so that two groups form $\{A\}$ and $\{B, C\}$
- the probability of winning depend on the effort of the players

$$p_A = \frac{x_A}{(x_A + x_B + x_C)} \quad p_{\{B,C\}} = 1 - p_A$$

- if the group $\{B, C\}$ wins they need to allocate the prize between them, we assume that they do another contest
- equilibrium outcome:

$$x_A^* = \frac{4}{25} \quad \pi_A^* = \frac{16}{25} \quad (x_B + x_C)^* = \frac{1}{25} \quad \pi_{\{B,C\}}^* = \frac{3}{50}$$

- but if they do not form a group they get: $\pi = \frac{1}{9}$ each

Hierarchical structure — complete contract approach

In a principal-agent structure, the aim of the principal is to devise a mechanism that provides the right incentive for the agents to act. (reference: Bolton and Dewatripont (2005) “Contract Theory”, ch. 8)

- problem if individual effort is not observable: free rider, like in the contest game;
- problem of cooperation and competition (when individual effort is observable); tournaments can lead to “sabotage”; while cooperation may be promoted with the inclusion in the reward mechanism of the payoff of colleagues (although it increases risk for the agents)

Moral hazard with multiple tasks

- Holmström and Milgrom (1991) *Multitask principal agent analysis*, in *Journal of Law, Economics, and Organization*, 7.
- the problem relates to the fact that the agents may choose the tasks they want to devote more effort, hence incentives depends on the cost complementarity between tasks and the cost of monitoring each task
- public officials are usually asked to perform many tasks