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A dynamic game for fiscal federalism with non-local externalities

Pierre Cartigny [a], Luc Champarnaud [b,*]

[a] INRA, Campus Supagro, 2 place Viala, 34060 Montpellier cedex 2, France
[b] EQUIPPE, Université Lille 3, BP149, 59653 Villeneuve d'Ascq cedex, France, and Université d'Artois, France

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ABSTRACT

We address the questions of the patterns and the efficiency of public intervention in a dynamic game model between public agencies in charge of a non-local externality. We give two examples: pollution spreading between water basins (negative externality), and non-uniform contributions from the elite and from the mass to a cultural background (positive externality). We define two extreme cases, depending on whether or not the receiving end of the externality balances the transmitting end. When both balance, the reactivity of the agency structure is strong and the need for redistribution between them is weak. When they do not balance, the externality is more markedly non-local and redistribution is required to balance the fiscal burden (or product) from pigouvian instruments among all beneficiaries. We show that, with a static rule of redistribution that allows them to compute transfers between them as a function of their own strategies, the decentralized agencies' reactivity is somewhat slowed, but they still react faster and more efficiently than a static central agency.

1. Introduction

In a variety of cases, the *reactivity* of public intervention is a major concern of public policy. This is the case, for instance, each time not very probable, but “sudden”, events are the source of a dynamic externality, *i.e.* when new initial conditions arise, infrequently but with great impact over a long period. Examples would be new sources of environmental damage, whose exact nature may be very difficult to predict (location, new detrimental products or decisions), or even positive impacts such as sudden rises in creativity and innovation, generated for instance by the formation of clusters in different fields, acting as a public knowledge resource. Actually, assuming that a planner is unlikely to know *where and when* a source of dynamic external effect is likely to occur implies that he will have to react fast afterwards, and moreover, that the *reaction*, *i.e.* the transition period, once this source is clearly identified, may need careful planning, just like the long-term policy itself.

Furthermore, the literature aimed at comparing these dynamic externalities with static ones is unanimous in finding the former more likely to occur *non-locally*, that is, between rather than within classes of identical agents or areas.[1] This means that the organization of public intervention needs to combine a capacity to adjust the best transition policy through time with a capacity to organize interventions between local jurisdictions, each in charge of an area or a type of agent. Usually

* Corresponding author. Tel.: +33 3 20 41 64 89; fax: +33 3 20 41 64 60.
E-mail address: luc.champarnaud@univ-lille3.fr (L. Champarnaud).

[1] Glaeser et al. (1992) studied dynamic knowledge spillovers among industries. They conclude that Marshall–Arrow–Romer (MAR means local) externalities are less consistent with empirical evidence, than those addressed by Jacobs (1969), which are non-local. Partridge and Rickman (1999) show further that Jacobs' non-local externalities are dynamic, unlike MAR ones.

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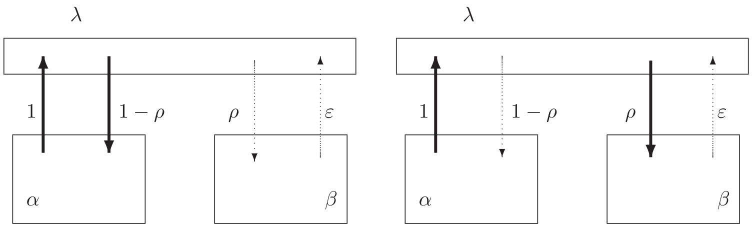

Fig. 1. Asymmetry of contribution and exposure to λ. (a) Contribution and Exposure Well-Balanced, CEWB case (low ρ). (b) Contribution and Exposure UnBalanced, CEUB case (high ρ).

both capacities go hand in hand, which pleads strongly for decentralizing such interventions. However a coordination problem arises, a well-known case from the literature on fiscal federalism: in this paper, we give one solution to solve this case dynamically, and show how it relates to designs with additional lower administration layers implemented in real.

2. Externalities

2.1. A dynamic form of non-local externalities

In order to address the question of administrative bodies' *reactivity* in the managing of public affairs, it is necessary to consider externalities which extend over broad swaths of time, and to create a dynamic model of the interaction between the administrative bodies coping with these externalities. Thus assume that in every period t, there are two distinct groups of short-lived non-altruistic individuals α and β. The agents of each group consume a specific good denoted, respectively, by a and b. We assume that the aggregate consumptions of the two types, $a(t)=\sum_{\alpha} a$ and $b(t)=\sum_{\beta} b$, have a cumulative effect on a state variable $\lambda(t)$, which affects the welfare of the individuals belonging to both groups, living after t. Furthermore, we assume that $a(t)$ and $b(t)$ have a non-symmetrical impact on $\lambda(t)$. With no loss of generality, when individuals α, who have the greatest impact, are the "upstream" agents, the variation $\dot{\lambda}(t) \equiv d\lambda(t)/dt$ may be represented by

$$\dot{\lambda}(t) = a(t) + \varepsilon b(t) - \delta\lambda(t), \tag{1}$$

where ε is "very small", and δ is a constant which captures the negative impact of the stock on the flow $\dot{\lambda}(t)$. Furthermore, we assume that the agents of each population consume, respectively, a numerary good denoted by $x_{\alpha}(t)$ for the individuals in group α and $x_{\beta}(t)$ for the others. Finally we assume that the utilities for each group can be described by a separable utility $v(x_{\alpha}(t), a(t)) + (1-\rho)u(\lambda(t))$ and $v(x_{\beta}(t), b(t)) + \rho u(\lambda(t))$, for upstream and downstream agents, respectively. Then $\rho \in [0,1]$ typifies the exposure of individuals β, and $1-\rho$ that of individuals α, to λ.

Obviously, when ε is given, the most intricate case is the CEUB case, when those who contribute greatly, suffer or benefit little from the externality, whilst others are highly exposed to it, while contributing little (high value of ρ). In this case, $\lambda(t)$ embodies a *non-local* externality from group α on group β. Otherwise, in the CEWB case, the externality remains of local concern (Fig. 1).

2.2. Implementation

This simple framework can be applied to many cases requiring a model of asymmetrical impacts between neighboring and successive individuals in cohorts. Two cases can be distinguished, depending on whether the externality consists in a negative or a positive impact on welfare.

2.2.1. Accumulating pollution stock

A very topical and important case of asymmetrical *negative* externalities is that of the transborder water interactions among neighboring countries. There are more than 250 river basins, shared in the world by at least two countries.[2] Management of these basins, including the sustaining of underground water quality, is a well-documented source of potential conflict between countries. The constraint that agents are ordered according to water flux is a cause of strong consumption impact asymmetry: up-stream individuals α have a much *greater* capacity to harm downstream individuals β's welfare than the reverse.[3]

The case of sharing water is strongly affected by dynamic externality when considering low biodegradation pollution, in freatic groundwater for instance, and may be extended to many other cases of pollution. The asymmetry between α's and β's

[2] Wollebæk Toset et al. (2000).

[3] Ambec (2002) addressed the question in an axiomatic approach and gave a solution that combines a "secure level" (the core) and an "aspiration level".