Games and Economic Behavior 76 (2012) 420–438

Contents lists available at SciVerse ScienceDirect

Games and Economic Behavior

www.elsevier.com/locate/geb

Smooth multibidding mechanisms ☆

David Pérez-Castrillo [a,*], Nicolas Quérou [b]

[a] Dept. of Economics & CODE, Universitat Autònoma de Barcelona and Barcelona GSE, 08193 Bellaterra (Barcelona), Spain
[b] CNRS, UMR 5474 LAMETA, F-34000 Montpellier, France

ARTICLE INFO

Article history:
Received 5 July 2011
Available online 20 July 2012

JEL classification:
D78
D72

Keywords:
Mechanism design
NIMBY

ABSTRACT

We propose a *smooth multibidding mechanism* for environments where a group of agents have to choose one out of several projects. Our proposal is related to the *multibidding mechanism* (Pérez-Castrillo and Wettstein, 2002) but it is "smoother" in the sense that small variations in an agent's bids do not lead to dramatic changes in the probability of selecting a project. This mechanism is shown to possess several interesting properties. First, the equilibrium outcome is *unique*. Second, it ensures an *equal sharing of the surplus* that it induces. Finally, it enables reaching an outcome as close to efficiency as is desired.

1. Introduction

1.1. Contribution

A mechanism designed to help agents reach (efficient) decisions on contentious issues typically requires information about agents' preferences for each possible decision. The *multibidding mechanism*, proposed by Pérez-Castrillo and Wettstein (2002) allows the agents to express their relative preference for projects. It proceeds as follows. Each agent submits a vector of bids, one for each project, with the sole restriction that the sum of each agent's bids is zero. Therefore, bids measure relative rather than absolute valuation. Each agent also nominates one of the projects specifically. The project with the highest aggregate bid (sum of bids made for this project) is chosen. In case there is more than one such project, there is a rule that gives priority to projects that have been nominated by some agent. The winning project is carried out, agents pay the promised bid corresponding to this project, and any surplus is shared among the agents, so that the mechanism is budget-balanced.

The main property of the multibidding mechanism is that all its Nash (and strong Nash) equilibrium outcomes are efficient. However, in general environments, the mechanism has one major weak aspect that we address in the current paper. Specifically, the set of equilibrium outcomes is quite large, as it consists of all the outcomes where each agent's payoff is at least the expected payoff he would obtain in a situation where all the projects have the same probability of being developed. Therefore, almost any ("reasonable") sharing of the surplus is an equilibrium outcome.

☆ We thank Inés Macho-Stadler, Pedro Rey-Biel, Robert Veszteg, David Wettstein and two referees for helpful remarks and suggestions. Part of this research was conducted while the second author visited the Institute of Economic Analysis (IAE) and the INRA-LAMETA. The hospitality of these institutions is greatly appreciated. The first author acknowledges the financial support from ECO2009-7616, Consolider-Ingenio CSD2006-16, 2009SGR-169, and ICREA Academia. He is MOVE fellow.

* Corresponding author. Fax: +34 935813767.
E-mail addresses: david.perez@uab.es (D. Pérez-Castrillo), querou@supagro.inra.fr (N. Quérou).

0899-8256/$ – see front matter
http://dx.doi.org/10.1016/j.geb.2012.07.003

In the present paper, we tackle the issue highlighted above by proposing a *smooth multibidding mechanism*. It is close to the original proposal but ours is "smoother" in the sense that small variations of an agent's bids do not lead to dramatic changes in the probability of selecting a project. In the smooth mechanism, each agent only submits a vector of bids, without nominating any project. All projects can be selected, with each project's probability being a function of its aggregate bid as well as the aggregate bids of the rest of the projects. Projects with a negative aggregate bid have a very low, but positive, fixed probability of being selected (a function of some parameter ε). Each project with a positive aggregate bid is selected with a probability that is a function of the level of its (and others') positive aggregate bid. We highlight that the present mechanism does not require the use of a tiebreaking rule. Such a rule plays a crucial role in the initial mechanism. As such, the smooth multibidding mechanism is immune to the criticism raised by Ehlers (2009).[1]

We first show that, for a given value of ε, *the equilibrium outcome is unique*. Therefore, there is no coordination issue with respect to agents' expectation about the final outcome. We then characterize the equilibrium outcome. Although there may be several equilibrium strategies, the differences among them only concern bids for those projects that, at equilibrium, end up with negative aggregate bids. We identify the set of projects with positive equilibrium bids as well as each agent's bids to any project in this set. Only projects that are efficient, or whose total valuation is very close to the efficient one, ultimately receive a positive aggregate bid. In case some non-efficient project receives a positive aggregate bid, its level reflects the degree of inefficiency.

Second, the smooth multibidding mechanism ensures an *equal sharing of the surplus* that it induces. Indeed, an agent's equilibrium payoff in the mechanism is the sum of the value of the average project plus his fair share of the remaining surplus. That is, agents obtain at least the same lower-bound level of utility as in the original multibidding mechanism, and the surplus is divided in equal parts among the agents. Since efficiency and equity often have the same importance in collective decision-making, this fairness property is a sensible advantage of the present mechanism.

We also show that each agent's expected payoff increases as the value of the parameter ε decreases; therefore, the distance to efficient outcomes decreases as well. Moreover, the probability of choosing an inefficient project converges to zero as the value of the parameter ε becomes small. We can bound the level of expected inefficiency as a function of the parameter ε: the maximum level of inefficiency of a project that receives a positive aggregate bid is a linear function of the square root of ε. Therefore, the smooth multibidding mechanism *gets as close to efficiency as one wishes*.

To summarize, the present mechanism exhibits the interesting properties of uniqueness and fairness of its equilibrium outcome. Moreover, it gets as close to an efficient outcome as wished. Therefore, this mechanism constitutes an interesting alternative to the original multibidding mechanism in situations where efficiency and equity are policy objectives.

1.2. Applicability of the mechanism and related literature

There are many economic situations where the smooth multibidding mechanism can be successfully used. A first case concerns the complex problem of the location of noxious facilities, such as prisons, dump sites, nuclear waste repositories, or airports. Many authors address this type of problem; we can refer among other papers to Kunreuther and Kleindorfer, 1986; Rob, 1989; O'Sullivan, 1993; Ingberman, 1995; Pérez-Castrillo and Wettstein, 2002; Minehart and Neeman, 2002; and Laurent-Lucchetti and Leroux, 2011.[2] Whereas the construction of such facilities may provide large global benefits, their cost is usually borne by the hosting agent. The sitting problems are so severe and so common that an acronym is used to refer to them: NIMBY (Not In My Back Yard).

Another sensitive decision problem concerns the location of large international research infrastructures. The decision about the city that should host such a facility is always the subject of hot debate among the candidates and other interested countries and institutions. In 2002, the European Commission started the European Strategy Forum on Research Infrastructures (ESFRI) to support and facilitate multilateral initiatives leading to a better use and development of research infrastructures, including biological archives, communication networks, research vessels, satellite and aircraft observation facilities, telescopes, synchrotrons, and particle accelerators. Although its 2006 Report presented a first roadmap identifying 35 projects with the scientific needs for the next 10–20 years, ESFRI is silent about how the interested countries should determine the location of the facility. However, this is a very difficult decision that involves many scientific, economic, and social issues. For each project, supporting countries should work out a procedure to choose the host of the facility. Therefore, they must first decide on a mechanism and then use the procedure to elect the hosting city.

The previous examples belong to a general class of problems in which a group of agents has to choose one out of several projects. In some situations, the set of projects coincides with the set of agents, as is the case if a group of municipalities

[1] At the equilibrium of the mechanism developed by Pérez-Castrillo and Wettstein (2002), the tiebreaking rule is always used because all projects' equilibrium aggregate bids are zero. Ehlers (2009) points out that without tiebreaking rules equilibria may fail to exist.

[2] Kunreuther and Kleindorfer (1986) showed that sealed-bid mechanisms lead to efficient outcomes in incomplete information environments where each agent is indifferent as to all the outcomes, as long as he is not the host, when agents use max–min strategies. O'Sullivan (1993) proved that efficiency is also reached in Bayes–Nash equilibria when there are two agents whose cost parameters are independently drawn. Ingberman (1995) highlighted the impossibility of reaching efficient majority decisions through an auction when cost to the agents of using a common facility is related to their distance from it. Rob (1989) studied mechanisms where a randomized decision rule and an expected compensation for each location are associated to each cost vector reported by the locations. He showed that the resulting mechanism could lead to inefficient outcomes. In a complete information scenario, Laurent-Lucchetti and Leroux (2011) proposed a two-stage mechanism that selects the efficient site and any individually rational division of the hosting provided the profile of benefits is known to the planner (otherwise, the mechanism should be extended to a more complex action space).