

# Are you Going to Do That? Contingent-Payment Mechanisms to Improve Coordination

Hongyao Ma  
SEAS, Harvard University  
33 Oxford Street, Cambridge, MA  
hongyaoma@seas.harvard.edu

David C. Parkes  
SEAS, Harvard University  
33 Oxford Street, Cambridge, MA  
parkes@eecs.harvard.edu

Reshef Meir  
SEAS, Harvard University  
33 Oxford Street, Cambridge, MA  
reshef24@gmail.com

James Zou  
Microsoft Research  
1 Memorial Dr # 1, Cambridge, MA  
jazo@microsoft.com

## ABSTRACT

In this extended abstract, we consider simple coordination problems, such as allocating the right to use a shared sports facility in a way that maximizes its usage, or picking the time of a meeting in a way that maximizes attendance. More generally, an alternative is selected by a mechanism in period zero based on reports from agents. This induces a decision problem facing agents in the next period (e.g., to use a resource, or to attend a meeting.) Outcomes are designated as either *good* or *bad*, and the design goal is to maximize the probability of good outcomes. For example, a good outcome may be the resource being used, or having enough people attend a meeting.

Agents are self-interested, and are uncertain at period zero about their future value for different outcomes. For example, a participant may have uncertainty about her value for using a sports facility when making a request, depending on alternative activities and future opportunities (e.g. unexpected work, an interesting TV show, etc.). For meeting scheduling, people may naturally have uncertainty about availability (e.g. another meeting, illness). In particular the value realization may be negative, meaning that the agent prefers a different activity at period one, *ceteris paribus*. In both scenarios, we view a bad outcome as a *coordination failure*: In retrospect, the resource could have been allocated to someone else, or the meeting could have been scheduled at a better time.

This problem is different from the standard setting of utilitarian welfare maximization. In particular, the design goal is to maximize the probability of a good outcome. Similar to other common design problems such as revenue maximization, agents' preferences need to be considered only as they affect their behavior: whether to participate in the mechanism, what report to make, and then what action to take in response to the alternative selected by the mechanism based on reports. In our examples, a good outcome for the designer is that the sports facility is used, or the meeting is attended by enough people, regardless of the participants' satisfaction.

We introduce a new class of *coordination mechanisms* based on *contingent payments*, where the principal's decision must be based

on the reports collected in period zero, but payments may also depend on the publicly observed actions of agents in period one. In this sense, the reports of agents in period zero, along with the mechanism, shape the coordination environments in period one. For example, we can set a penalty for an agent to pay if a resource goes unused or if she does not show up to a meeting time. However since we assume voluntary participation in the mechanism, penalties that are too high may violate individual rationality in expectation, and thus deter agents from participating at all.

We introduce and analyze the *contingent second price mechanism* (CSP) under two simple but illustrative settings: resource allocation and meeting scheduling. In the single resource allocation scenario, each agent is submitting a single bid at period zero, and the CSP mechanism awards usage privileges to the agent with the highest bid, who pays the second highest bid only if she does not use the resource. We prove that under a mild assumption on agents' value distributions, CSP mechanisms are *straight-forward*, meaning that each bidder has a dominant strategy. Further, we prove that a full revelation version of CSP mechanisms (which behaves the same as CSP except for some tie-breaking cases that are unlikely to appear) maximizes utilization within a broad class of mechanisms that allow agents to submit arbitrary reports (e.g. several bids or even their full type), as long as the mechanism is: (1) dominant strategy incentive compatible, (2) individually rational, (3) deterministic, (4) anonymous, (5) budget balanced (does not pay agents in expectation), and (6) always allocates the item if there is at least one agent participating. Most of these take their usual meaning, and (2) is defined to hold for reports given that agents are rational in subsequent periods and (5) is defined to hold in expectation over the actions of agents for every decision made by the mechanism.

In the meeting scheduling setting, agents submit a bid for every time slot, as in the VCG mechanism. We show that the dominant strategy equilibrium of CSP (where agents pay the VCG payment but only if they do not show up for the meeting) continues to hold if there are only two time slots. Interestingly, this is no longer the case for three or more time slots.

## Categories and Subject Descriptors

I.2.11 [Distributed Artificial Intelligence]: Multiagent Systems;  
J.4 [Social and Behavioral Sciences]: Economics

## General Terms

Algorithms, Theory, Economics

## Keywords

Coordination, Incentives, Contingent payments, Mechanism design