



# Optimal stopping with private information <sup>☆</sup>

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## Abstract

Many economic situations are modeled as stopping problems. Examples include job search, timing of market entry decisions, irreversible investment or the pricing of American options. This paper analyzes optimal stopping as a mechanism design problem with transfers. We show that under a dynamic single crossing condition a stopping rule can be implemented by a transfer that only depends on the realized stopping decision if and only if it is a cut-off rule. We characterize the transfer implementing a given stopping rule using a novel technique based on constrained stochastic processes.

As an application we prove that in any Markovian optimal stopping problem there exists a welfare maximizing mechanism that does not require any communication. We discuss revenue maximization for separable processes.

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## 1. Introduction

In an optimal stopping problem information arrives over time and a decision maker decides at every point in time whether to stop or continue. The stopping decision is irreversible. Thus, stopping today implies losing the option to stop later with a potentially larger return.

This paper analyzes the question how the behavior of an agent in an optimal stopping problem can be influenced through transfers. Our model can be understood as a dynamic principal–agent model. The agent privately observes a discrete time Markov process and chooses a stopping rule. The principal observes the stopping decision of the agent, but not the realization of the process. In order to influence the agent’s stopping decision the principal commits to a transfer.

For example, the agent could be an unemployed worker who receives job offers until she stops the process and accepts an offer. The principal could be the unemployment agency who wants the agent to accept certain offers, but who does not observe the offers that the agent receives. Alternatively, the agent could be a firm that developed a new technology and has to decide when to introduce it to the market place. The firm observes private signals regarding the demand, and this knowledge changes over time. The principal is a social planner who also takes the consumer surplus into account and has, hence, different preferences over stopping decisions than the firm.

### 1.1. Contribution of the paper

This paper shows that under a dynamic single-crossing condition all cut-off rules can be implemented without communication. A cut-off rule is a strategy that stops the first time the value of the process exceeds a time-dependent threshold. Implementation without communication means that the transfer depends only on the time the agent stops and does not require her to report any private information.<sup>1</sup> This feature resembles a posted-price mechanism and makes our result especially appealing from an applied perspective. We provide a closed form solution for the transfer as the expectation over a new type of stochastic process, we call *constrained process*.

The aim of our article is different from most articles in the literature as it does not focus on implementing a specific policy (i.e. the welfare or virtual valuation maximizing one), but characterize the set of policies that can be implemented in the class of mechanisms without communication. However, this characterization can then be used to implement specific policies. To illustrate this point we show that the welfare maximizing policy in a principal agent problem with interdependent values can always be implemented. Due to the interdependent value structure this case is to the best of our knowledge not covered by any of the existing results in the literature. Furthermore, we show that revenue can be maximized using mechanisms with communication only at time zero in the case of additive random walks.

For example, those results imply in the context of unemployment benefits that for one-dimensional Markovian search processes it is without loss of generality from a welfare perspective to restrict attention to mechanisms in which the worker does not report rejected offers to the mechanism and the benefits paid to her depend only on the time she has been unemployed.

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<sup>1</sup> In this sense we understand a contract which offers the agent a menu of time-dependent transfers to choose from as a mechanism with communication since the transfer conditions on the choice made (message sent) by the agent.

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