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# Scenes from a Monopoly: Renewable Resources and Quickest Detection of Regime Shifts

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## Abstract

We study the stochastic dynamics of a renewable resource harvested by a monopolist facing a downward sloping demand curve. We introduce a framework where harvesting sequentially affects the resource's potential to regenerate, resulting in an endogenous ecological regime shift. The monopolist encounters two sources of uncertainty in the resources dynamics. The first takes the form of natural randomness of the environmental conditions (variance) and the other in the *timing* of this regime shift. In a multi-period setting, the firm's objective is to find the profit-maximizing harvesting policy while simultaneously detecting in the quickest time possible the change in regime. The resource dynamics are assumed to be monitored by the monopolist through sequential observations and we model the firm's detection process based on *quickest detection* methods. These build on solving the classical sequential detection problem as an optimal stopping problem with the aim to detect a change in the resource growth, if one occurs, as quickly as possible. Solving analytically, we show that a negative regime shift induces an aggressive extraction behaviour due to shorter detection periods, creating a sense of urgency, and higher markup in prices. Precautionary behaviour can result due to decreasing resource rent. Utilizing daily hydrological data from one of the largest water reservoirs in the world, the Cantareira system, which serves the Metropolitan Area of São Paulo and experienced a regime shift, we aim to validate our model results.

**Keywords:** Uncertainty, Risk, Regime Shift, Renewable Resource, Monopoly

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