Discontinuous Demand Functions: Estimation and Pricing

Arnoud V. den Boer
Korteweg-de Vries Institute for Mathematics, University of Amsterdam
a.v.denboer@uva.nl

N. Bora Keskin
Fuqua School of Business, Duke University
bora.keskin@duke.edu

We consider a dynamic pricing problem with an unknown and discontinuous demand function. There is a seller who dynamically sets the price of a product over a multi-period time horizon. The expected demand for the product is a piecewise continuous and parametric function of the charged price, allowing for possibly multiple discontinuity points. The seller initially knows neither the locations of the discontinuity points nor the parameters of the demand function, but can infer them by observing stochastic demand realizations over time. We measure the seller's performance by the revenue loss relative to a clairvoyant who knows the underlying demand function with certainty. We first demonstrate that ignoring demand discontinuities in dynamic pricing can be extremely costly. Then, we construct a dynamic estimation-and-pricing policy that accounts for demand discontinuities, derive the convergence rates of discontinuity- and parameter-estimation errors under this policy, and prove that it achieves near-optimal revenue performance. We also extend our analysis to the cases of time-varying demand discontinuities and inventory constraints.