Simulation-based Estimation of Dynamic Hotel Pricing

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Abstract

This paper studies the dynamic price setting behavior of a focal luxury hotel (Hotel0) in a major US city with a confidential database of Hotel0’s daily operations over a 37-month period. Hotel pricing is a challenging high-dimensional problem since hotels must not only set prices for each current date, but also quote prices for a range of future dates, customer types and room types. We formulate a computationally-tractable dynamic programming (DP) model for Hotel0’s pricing decision. The DP model captures major factors underlying revenue management (RM) practice, i.e. competition, inventory dynamics, market segmentation, etc. The data records full path of Hotel0’s occupancy but not that of competing hotels, which constitutes the major censoring problem in the estimation of aggregate demand dynamics. To overcome this issue, we maintain the assumption that Hotel0 has been pricing optimally and implement Method of Simulated Moments (MSM). The estimated model is successful in fitting Hotel0’s observed pricing behavior and booking dynamics. We further compare revenue earned by Hotel0 under different pricing schemes. Optimal dynamic pricing scheme delivers 11% more revenue than constant pricing scheme; 9% more than if pricing above optimal level by 20%; 3% more than if pricing below optimal level by 20%.

Keywords dynamic programming, price discrimination, revenue management, method of simulated moments

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