Hangcheng Zhao
University of Pennsylvania, The Wharton School

Algorithmic Collusion of Pricing and Advertising on E-commerce Platforms

ABSTRACT:

Firms have been adopting learning algorithms to drive automatic decision making such as setting product prices and setting bids in online ad auctions. One concern that arises when firms compete using such algorithms is that of tacit collusion—the algorithms learn to settle on higher than competitive prices which increase firm profits, but hurt consumers. We investigate the impact of such learning algorithms to determine if they are always harmful to consumers, but in a setting with two-dimensional decisions, because many firms need to decide on pricing and bidding together. Our analysis uses a multi-agent reinforcement learning simulation of the Q-learning algorithm that is compared to analytical results from a game theoretical model. Our main findings are that algorithms can facilitate outcomes that are beneficial for both consumers, sellers, and even the platform when consumers have heterogeneous search costs. The intuition is that algorithms learn to coordinate on lower bids, which lowers advertising costs, leading to lower prices for consumers and enlarging the demand on the platform. We also analyze a large-scale product dataset from Amazon.com and find robust evidence of substantial consumer search costs, suggesting that the beneficial outcomes of algorithmic pricing can hold for most, if not all product markets we analyze. We show that even if the platform responds strategically by adjusting the ad auction reserve price or the sales commission rate, the beneficial outcomes for both sellers and consumers are likely to persist.