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## **Sponsored Link Auctions with Consumer Search** (Job Market Paper)

I study a sponsored link auction game in which consumers sequentially search one set of products (the top spots on a webpage, or the first page) before the other (lower spots on a webpage, or the second page), and sellers compete in bid to place their product links at a higher position. I define a set of products as a *block* and assume consumers search optimally in each block according to Weitzman (1979). I introduce the role of product position by modeling consumers to search the first block before the second, and update the current best option during the search. The block-by-block search deviates from Weitzman's well-known solution in two ways: First, the search order gives higher priorities to products in the first block than Weitzman's solution would do, because a consumer is unaware of any product in the second block at the start of the search. Second, the search in the second block stops earlier than Weitzman's solution does, because the consumer's fallback value is larger due to the search in the first block. These make the demand of any product larger if its link is in the first block and hence a sponsored link position is valuable. I characterize consumers' shopping outcome by adapting Choi et al.'s (2018) eventual purchase condition with the block-by-block searching behavior. By letting sellers choose product prices and auction bids together, I characterize the equilibrium of the complete information second price auction with two payment schemes: fixed payment and per-transaction payment. A comparative static analysis shows the auction revenue increases when the effective value of products becomes more dispersed. Auction revenues and consumer surplus are larger under fixed payment, and seller surplus is larger under per-transaction payment, because the latter payment scheme distorts the winner's pricing strategy and increases the equilibrium price. In the case that a social planner runs the platform, I find the consumer-optimal positioning of products if sellers commit to their prices before the position is allocated. Optimal positioning requires placing into the first block products with high expected values and low uncertainty in match values, because the latter decreases the number of costly searches.

## **Pareto Optimal Hierarchies** (with Charles Zheng, Revision requested by *Economic Theory*)

We consider a large market of individuals entitled to equal shares of a limited resource, each allowed to buy or sell the shares given quasilinear preferences. We characterize the interim (incentive-constrained) Pareto frontier subject to market clearance and budget balance, featuring endogenous formation of buyers and sellers. Given any continuous welfare weight distribution for the underlying social welfare criterion, at most two prices—partitioning the type space into at most three tiers—are needed to attain optimality. Under robust conditions of the primitives, the optimal allocation is unique, and a single price—without the help of rationing or redistribution—implements the optimal allocation even when the virtual surplus function is non-monotone. The finding suggests a market-like mechanism to distribute Covid-vaccines optimally.

## **Pareto Optimality of Allocating the Bad** (with Charles Zheng)

Given quasilinear independent private values, this paper proves a necessary and sufficient condition for all interim Pareto optimal mechanisms to allocate a commonly undesirable item with positive probabilities despite that not allocating it at all is part of an ex ante incentive efficient mechanism. The condition holds when types near the low end carry sufficiently high welfare densities. Replacing the welfare weight distribution by a second-order stochastically dominated one improves the prospect of the condition. The Kuhn-Tucker method in the literature is inapplicable because when our condition holds, the monotonicity constraint the method sets aside is binding unless the method suffers indeterminacy in admitting a continuum of solutions to the relaxed problem. Our finding suggests a new perspective on universal coverage of benefits such as healthcare, postal service and internet access. Policymakers who care about low types should let them opt out of the coverage.