

My primary research field is econometrics. I have two main lines of research. First, I study various methods for causal inference, including regression discontinuity designs and local/marginal treatment effect models with instrumental variables. For these topics, I develop new identification results for the causal object of interest, propose implementable estimation strategies, and derive the theoretical properties of the proposed estimators. Second, I study topics at the intersection of statistics, econometrics, and microeconomic theory. I bring tools and perspectives from statistics and econometrics into the classical economic theory, including auctions, price discrimination, and robust mechanism design.

In the following, I briefly explain my eight research projects, including one job market paper, one publication, two papers currently under revision for resubmission to journals, three working papers published on arXiv, and one ongoing project. Unless stated otherwise, the papers are single-authored by myself.

Causal inference: job market paper

My job market paper studies regression discontinuity designs with a continuous treatment variable. In this setting, the causal object of interest is the structural function, which fully describes the causal relationship between the treatment and the outcome. For the first time in the literature, I propose a method to directly identify and estimate the structural function in the regression discontinuity design. The identification assumptions are shape restrictions, including monotonicity and smoothness conditions. The proposed three-step semiparametric estimator is consistent and asymptotically normal. As an empirical application, I estimate the causal effect of sleep time on health by using the discontinuity in natural light timing at time zone boundaries.

There are immediate plans for further studies on regression discontinuity designs: (1) partial identification of the structural function when the current assumptions are violated, (2) extrapolation of the identification result away from the regression discontinuity cutoff, and (3) extending the current framework to encompass regression kink designs. Some identification results are already obtained along these plans.

During the derivation of the statistical properties of the new estimator proposed in the job market paper, I have discovered new mathematical results regarding the uniform convergence of the conditional distribution estimator. These results are organized into a separate paper. This paper is currently under a third-round review at *Statistics & Probability Letters*.

Causal inference: other papers

Besides regression discontinuity, I am also interested in other causal inference methods, such as treatment effect models with instrumental variables. There are three relevant papers. The first paper is under revision for a second-round review by *Journal of Business & Economics Statistics*. This paper is about the efficient estimation of the generalized local average treatment effect model, where the treatment and instrument are multi-valued. I derive the semiparametric efficiency bound for relevant causal parameters and propose efficient estimators that are suitable for high-dimensional data. This paper was

my third-year paper in the PhD program, for which I was awarded the *Clive Granger research fellowship*.

The second (co-authored) paper has been published in *Oxford Bulletin of Economics and Statistics* in August 2022. We find that in the local average treatment effect model, if the directions of the monotonicity condition are the same across all values of the conditioning covariate, then the treatment choice equation has to satisfy a separability condition between the instrument and the covariate.

The third (co-authored) paper studies personalized subsidy rules in the marginal treatment effect framework. We show that subsidies result in better welfare than directly mandating the encouraged behavior because subsidy rules implicitly target individuals through unobserved heterogeneity in the behavioral response. When there is positive selection, the optimal subsidy rule achieves the first-best welfare. We then provide methods to (partially) identify the optimal subsidy rule when the marginal treatment effect is (partially) identified.

Papers integrating statistics and econometrics with economic theory

My other line of research is the interdisciplinary study of statistics, econometrics, and economic theory. There are three relevant projects. The first (co-authored) paper is about robust mechanism design for public goods. We propose a class of incentive compatible and individually rational mechanisms that can balance the budget and approximate the optimal welfare when the number of agents is large. The proposed mechanism is robust as it depends only on the first moment of the valuation distribution. This result is achieved by using the Berry-Esseen theorem in statistics, which helps make rigorous previous findings in the public goods literature.

The second (co-authored) paper studies the gap between classical and data-based pricing theories. We characterize sharp lower bounds for the revenue discrepancy between data-based pricing strategies and the theoretical optimal third-degree price discrimination. We then propose easy-to-implement data-based price discrimination strategies that achieve the minimax optimal rate in terms of revenue.

The third project is currently in progress. This project examines the density estimation of private values from second-price auctions. I propose a tuning-parameter-free non-parametric estimator by utilizing Myerson's regularity condition as a shape restriction on the valuation distribution. This finding brings a statistical perspective to Myerson's regularity condition. I derive the cube root consistency and a non-normal asymptotic distribution for the estimator under mild assumptions. This project is nearly complete and can be finished immediately after the job market.