I am an econometrician whose research focuses on microeconomic heterogeneity and its implications for the macroeconomy. Develop new estimation methods for panel models regarding time–invariant unobserved heterogeneity. Propose new testing methods that are robust to unobserved heterogeneity across markets. Structural estimation to micro–founded R&D models based on new facts about how firms react differently to a negative profit shock. I also develop software packages to facilitate usage of a new method that shows how partial effects are heterogeneous based on people's observable characteristics. All methodology papers contain at least one empirical application to actual data.

1 Panel Data Models with Fixed Effects

Indirect Inference FE Estimators. Simulation–based methods are increasingly used to estimate complex economic models, but simulations require a fully specified model for data generation. This paper shows that indirect inference, a particular simulation–based method, can be applied to a class of semiparametric models, namely nonlinear panel models, to obtain consistent estimators.

Estimation of nonlinear panel data with fixed effects suffers from incidental parameter problem. Previous bias–correction methods assume that the exogenous covariates are stationary. However, covariates can have trends (ages, income) or structural breaks (emergency policies). In long panels this is increasingly important. In **Crossover Jackknife Bias Correction** (with Victor Chernozhukov, Iván Fernández-Val, Hiroyuki Kasahara and Paul Schrimpf), we propose a new bias–correction method that allows for such nonstationary covariates. Two calibrated Monte Carlo simulations show that the new method is better than current methods in terms of bias reduction and RMSE.

Mastering Panel Metrics: Causal Impact of Democracy on Growth (with Victor Chernozhukov and Iván Fernández-Val, *American Economic Association Papers and Proceedings*, 2019). Many instruments and high–dimensional FE estimation lead to biased estimate, and we show that split sample can reduce bias significantly. An application is shown to the democracy data.

Dynamic Discrete Choice Models with Fixed Effects Incorporating unobserved heterogeneity into dynamic discrete choice model is an active area of research. Starting from Heckman and Singer (1984), the main approach has been a random–effect type argument that treats unobserved heterogeneity as an unobserved state variable with discrete distribution and finite support. We consider a fixed effect approach and explore the identification, estimation and inference. The estimation suffers from incidental parameter problems because the individual fixed effects show up in two places of the criterion function: per period utility function and

continuation value. The goal of the project is to propose split–sample jackknife methods to remove the resultant bias. A simulation study will be Rust (1987) model with bus–specific replacement cost. An application will be dynamic labor supply by Duflo, Hanna and Ryan (2012).

2 Incomplete Econometric Models

A model becomes incomplete when the researcher is willing to stay agnostic about parts of the model.

In **Robust Score Test for Incomplete Models with Nuisance Parameters** (with Hiroaki Kaido). We consider subvector inference of a class of incomplete models. Namely, we require that the model is complete when the parameter components of interest are set to their null value. As an example, we test the presence of strategic interactions in 2–player complete information entry game with unknown equilibrium selection mechanisms and nuisance parameters. Using the ideas of least favorable pairs and Neyman orthogonality, we propose a robust test based on the sup of orthogonalized score functions and explore its size and power properties. Monte Carlo simulations confirm the performance of the method. We apply the method to data by Kline and Tamer (2016).

3 Heterogeneity and Innovations

R&D Heterogeneity and Countercyclical Productivity Dispersion (with Yang Ming). What causes the countercyclicality of productivity dispersions? Empirically, we construct a negative profit shock and show that (1) within-industry R&D intensity (RDI) and productivity become more dispersed in response to the negative profit shock, (2) in response to the shock, high-R&D-intensity firms increase R&D intensity while low-R&D-intensity firms reduce the intensity. Theoretically, we build a quality-ladder model such that heterogeneous R&D costs determine the gap of technology levels between two firms in the stationary equilibrium. Quantitatively, we estimate the parametrized model by GMM and demonstrate that the estimated model predicts productivity dispersion in response to a profit shock. Counterfactually, we consider a policy in which government changes technology spillover rate via patent protection and argue that a mild increase encourages R&D competitions and thus R&D efforts, while a big increase dampens incentive for innovations.

4 Econometrics Packages

Also work on coding to promote the usage of new conometric methods to practitioners.
Heterogeneous partial effects are common in nonlinear regression models due to variation in covariates, but often tiems only average partial effects (APE) are reported. Chernozhukov, Fernández-Val and Luo (2018) propose the sorted effect methods to formally estimate heterogeneous partial effects and quantify uncertainty of estimation. Instead of the average, the sorted effect estimator can report the entire set of partial effects sorted in increasing order and indexed by a ranking with respect to the distribution of the covariates in the population of interest.
In **SortedEffects: Sorted Causal Effects in R** (with Victor Chernozhukov and Iván Fernández-Val and Ye Luo, *The R Journal*, 2020), we introduce the R package *SortedEffects* that implements the estimation and inference methods therein and allows user to conduct classification analysis on population of interest and visualize the heterogeneity among populations of interest.