Inference on Strongly Identified Functionals of Weakly Identified Functions

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Abstract

In a variety of applications, including nonparametric instrumental variable (NPIV) analysis, proximal causal inference under unmeasured confounding, and missing-not-at-random data with shadow variables, we are interested in inference on a continuous linear functional (*e.g.*, average causal effects) of nuisance function (*e.g.*, NPIV regression) defined by conditional moment restrictions. These nuisance functions are generally weakly identified, in that the conditional moment restrictions can be severely ill-posed as well as admit multiple solutions. This is sometimes resolved by imposing strong conditions that imply the function can be estimated at rates that make inference on the functional possible. In this paper, we study a novel condition for the functional to be strongly identified even when the nuisance function is *not*; that is, the functional is amenable to asymptotically-normal estimation at $\sqrt{n}$-rates. The condition implies the existence of debiasing nuisance functions, and we propose penalized minimax estimators for both the primary and debiasing nuisance functions. The proposed nuisance estimators can accommodate flexible function classes, and importantly they can converge to fixed limits determined by the penalization regardless of the identifiability of the nuisances. We use the penalized nuisance estimators to form a debiased estimator for the functional of interest and prove its asymptotic normality under generic high-level conditions, which provide for asymptotically valid confidence intervals. We also illustrate our method in a novel partially linear proximal causal inference problem and a partially linear instrumental variable regression problem.[1]

Keywords: Weak Identification, Debiased Machine Learning, Instrumental Variables, Proximal Causal Inference, Penalized Minimax Estimation

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