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Econometrics

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2013 (Oral): Econometrics, Industrial Organization

2012 (Written): Microeconomics, Macroeconomics

Dissertation Title: *Advances in Robust Inference for Generically Identified Models*

Committee:

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Expected Completion Date: May 2017

Degrees:

Ph.D., Economics, Yale University, 2017 (expected)

M.Phil., Economics, Yale University, 2014

M.A., Economics, Yale University, 2013

B.A., Economics and Mathematics, *Summa Cum Laude*, Columbia University, 2011

Fellowships, Honors and Awards:

University Dissertation Fellowship, Yale University, 2016-2017

Ethel Boies Morgan Fellowship, Yale University, 2015-2016
Falk Foundation Fellowship, Yale University, 2013-2015
University Fellowship, Yale University, 2011-2013
Cowles Fellowship, Yale University, 2011-2015
Raymond Powell Teaching Prize, Yale University, 2014-2015
Sanford S. Parker Prize, Columbia University, 2011
Phi Beta Kappa, Columbia University, 2010

Teaching Experience:

Econometrics I (graduate, instructor Donald Andrews), Fall 2013, Fall 2014, Fall 2015
Econometrics III (graduate, instructor Yuichi Kitamura), Spring 2014
Econometrics and Data Analysis I (undergraduate, instructor Samuel Kortum), Spring 2015

Research and Work Experience:

Research Assistant to Peter Phillips, Summer 2014
Research Assistant to Yuichi Kitamura, Fall 2014

Working Papers:

“Weak Identification in a Class of Generically Identified Models with an Application to Factor Models” (November 2016), *Job Market Paper*

“SM1: Limit Theorems for an Extremum Estimator in a Class of Generically Identified Models” (November 2016), *Supplemental Materials for Job Market Paper*

“SM2: Robust Inference for a Weak Factor” (November 2016), *Supplemental Materials for Job Market Paper*

“SM3: Robust Inference for Entangled Factors” (November 2016), *Supplemental Materials for Job Market Paper*

“Generic Uniqueness of a Global Minimum” (March 2016)

“A Higher-Order Stochastic Expansion of M- and Z- Estimators” (January 2016)

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Dissertation Abstract

My dissertation establishes tools for valid inference in models that are only generically identified with a special focus on factor models.

Weak Identification in a Class of Generically Identified Models with an Application to Factor Models (Job Market Paper)

This paper considers inference for models under a general form of identification failure, by studying microeconomic applications of factor models. Factor models postulate unobserved variables (factors) that explain the covariation between observed variables. For example, school quality can be modeled as a common factor to a variety of school characteristics. Observed variables depend on factors linearly with coefficients that are called factor loadings. Identification in factor models is determined by a rank condition on the factor loadings. The rank condition guarantees that the observed variables are sufficiently related to the factors that the parameters in the distribution of the factors can be identified. When the rank condition fails, for example when the observed school characteristics are weakly related to school quality, the asymptotic distribution of test statistics is nonstandard so that chi-squared critical values no longer control size.

Calculating new critical values that do control size requires characterizing the asymptotic distribution of the test statistic along sequences of parameters that converge to points of rank condition failure. This paper presents new theorems for this characterization which overcome two technical difficulties: (1) non-differentiability of the boundary of the identified set and (2) degeneracy in the limit stochastic process for the objective function. These difficulties arise in factor models, as well as a wider class of generically identified models, which these theorems cover. Non-differentiability of the boundary of the identified set is solved by squeezing the distribution of the estimator between a nonsmooth, fixed boundary and a smooth, drifting boundary. Degeneracy in the limit stochastic process is solved by restandardizing the objective function to a higher-order so that the resulting limit satisfies a unique minimum condition. Robust critical values, calculated by taking the supremum over quantiles of the asymptotic distributions of the test statistic, result in a valid robust inference procedure.

This paper demonstrates the robust inference procedure in two examples. In the first example, there is only one factor, for which the factor loadings may be zero or close to zero. This simple example highlights the aforementioned important theoretical difficulties. For the second example, Cunha, Heckman, and Schennach (2010), as well as other papers in the literature, use a factor model to estimate the production of skills in children as a function of parental investments. Their empirical specification includes two types of skills, cognitive and noncognitive, but only one type of parental investment out of a concern for identification failure. I formulate and estimate a factor model with two types of parental investment, which may not be identified because of rank condition failure. I find that for one of the four age categories, 6-9 year olds, the factors are close to being unidentified, and therefore standard inference results are misleading. For all other age categories, the distribution of the factors is identified.

Generic Uniqueness of a Global Minimum

Many important statistical objects can be defined as the global minimizing set of a function, including identified sets, extremum estimators, and the limit of a sequence of random variables (due to the argmax theorem). Whether this minimum is achieved at a unique point or a larger set is often practically and/or theoretically relevant. This paper considers a class of functions indexed by a vector of parameters and provides simple transversality-type conditions which are sufficient for the minimizing set to be a unique point for almost every function.

A Higher-Order Stochastic Expansion of M- and Z- Estimators

Stochastic expansions are useful for a wide variety of stochastic problems, including bootstrap refinements, Edgeworth expansions, and identification failure. Without identification, the higher order terms in the expansion may become relevant for the limit theory. Stochastic expansions above fourth order are rarely used because the expressions in the expansion become intractable. For M- and Z- estimators, a wide class of estimators that maximize an objective function or set an objective function to zero, this paper provides smoothness conditions and a closed-form expression for a stochastic expansion up to an arbitrary order.