



**University
of Victoria**

Graduate Studies

Notice of the Final Oral Examination
for the Degree of Doctor of Philosophy

of

FAN WU

MSc (University of Victoria, 2008)
BA Hons (University of Western Ontario, 2005)

“The Extended Empirical Likelihood”

Department of Mathematics and Statistics

Friday April 17, 2015
10:00 A.M.
Hickman Building
Room 120

Supervisory Committee:

Dr. Min Tsao, Department of Mathematics, University of Victoria (Supervisor)
Dr. Mary Lesperance, Department of Mathematics, UVic (Member)
Dr. Farouk Nathoo, Department of Mathematics, UVic (Member)
Dr. David Giles, Department of Economics, UVic (Outside Member)

External Examiner:

Dr. Changbao Wu, Department of Statistics and Actuarial Science, University of Waterloo

Chair of Oral Examination:

Dr. Carl Mosk, Department of Economics, UVic

Abstract

The empirical likelihood method introduced by Owen (1988, 1990) is a powerful nonparametric method for statistical inference. It has been one of the most researched methods in statistics in the last twenty-five years and remains to be a very active area of research today. There is now a large body of literature on empirical likelihood method which covers its applications in many areas of statistics (Owen, 2001).

One important problem affecting the empirical likelihood method is its poor accuracy, especially for small sample and/or high-dimension applications. The poor accuracy can be alleviated by using high-order empirical likelihood methods such as the Bartlett corrected empirical likelihood but it cannot be completely resolved by high-order asymptotic methods alone. Since the work of Tsao (2004), the impact of the convex hull constraint in the formulation of the empirical likelihood on the finite sample accuracy has been better understood, and methods have been developed to break this constraint in order to improve the accuracy. Three important methods along this direction are [1] the penalized empirical likelihood of Bartolucci (2007) and Lahiri and Mukhopadhyay (2012), [2] the adjusted empirical likelihood by Chen, Variyath and Abraham (2008), Emerson and Owen (2009), Liu and Chen (2010) and Chen and Huang (2012), and [3] the extended empirical likelihood of Tsao (2013) and Tsao and Wu (2013). The latter is particularly attractive in that it retains not only the asymptotic properties of the original empirical likelihood, but also its important geometric characteristics. In this thesis, we generalize the extended empirical likelihood of Tsao and Wu (2013) to handle inferences in two large classes of one-sample and two-sample problems.

In Chapter 2, we generalize the extended empirical likelihood to handle inference for the large class of parameters defined by one-sample estimating equations, which includes the mean as a special case. In Chapters 3 and 4, we generalize the extended empirical likelihood to handle two-sample problems; in Chapter 3, we study the extended empirical likelihood for the difference between two p -dimensional means; in Chapter 4, we consider the extended empirical likelihood for the difference between two p -dimensional parameters defined by estimating equations. In all cases, we give both the first- and second-order extended empirical likelihood methods and compare these methods with existing methods. Technically, the two-sample mean problem in Chapter 3 is a special case of the general two-sample problem in Chapter 4. We single out the mean case to form Chapter 3 not only because it is a standalone published work, but also because it naturally leads up to the more difficult two-sample estimating equations problem in Chapter 4.

We note that Chapter 2 is the published paper Tsao and Wu (2014); Chapter 3 is the published paper Wu and Tsao (2014). To comply with the University of Victoria policy regarding the use of published work for thesis and in accordance with copyright agreements between authors and journal publishers, details of these published work are acknowledged at the beginning of these chapters. Chapter 4 is another joint paper Tsao and Wu (2015) which has been submitted for publication.