1. Research

My recent research is on providing inference methods for nonlinear and/or high-dimensional time series models. One line of my research is to apply the coupling technique in probability theory to develop strong approximation of sample averages of heterogeneous and serially dependent random vectors with dimensions growing with the sample size. The strong approximation can be used to construct uniform inference procedures based on the series estimator. This line of research is a continuation of my research agenda on the semi/nonparametric estimation and inference, and machine learning (see, e.g., Liao (2013), Ackerberg, Chen, Hahn and Liao (2014), and Schorfheide, Cheng and Liao (2016)). The other line of my current research is on extending and applying the most recent econometrics tools to provide valid and powerful inference methods for many popular empirical macroeconomic and finance models.

One of my recent publications, Li and Liao (2020) provide a strong approximation theory for mixingale arrays. This result is used to justify the asymptotic validity of a uniform confidence band for series estimators. We show that it can also be used to conduct nonparametric specification test for conditional moment restrictions. The new strong approximation is applied in Horvath, Li, Liao and Patton (2022) to develop a new specification test for the dynamic quantile models. We propose a novel bootstrap method in this paper and show that it significantly outperforms the benchmark asymptotic approximation in finite samples, especially for tail quantiles such as Value-at-Risk (VaR). We use the proposed new test to study the VaR and CoVaR of a collection of US financial institutions.

The results in Li and Liao (2020) are further extended in two of my recent papers. Li, Liao and Quaedvlieg (2022) develops a new strong approximation theory which substantially improves the theory of Li and Liao (2020) by allowing the dimension of the mixingale arrays grow much faster with the sample size. In this paper, we apply the new approximation to construct a test for the conditional superior predictive ability (CSPA) of a family of forecasting methods with respect to a benchmark. The usefulness of the method is demonstrated in empirical applications on volatility and inflation forecasting. Li, Liao and Zhou (2021a) extends the strong approximation in Li and Liao (2020) and proposes uniform functional inference method in a panel-data setting that features general unknown forms of spatio-temporal dependence. The usefulness of the new inference method is illustrated in two applications. One is on the nonparametric relationship between asset price volatility and trading volume, and the other is on testing the information rigidity among professional forecasters.

The strong approximation also has many potentially applications in continuous time series models. For example, it can be used to construct uniform inference for the spot volatility process in financial econometrics. Jacod, Li and Liao (2021) establish a uniform inference theory for the volatility process, through the development of a new coupling result for the spot volatility estimators. We also extend the theory to a multivariate setting for constructing uniform confidence bands for the nonlinear functionals of spot volatility process, such as the beta and idiosyncratic variance processes. Consistent estimation the spot volatility process requires the block size (or bandwidth), say k
diverges with the sample size. However, the inference based on the divergent-k theory may suffer size distortion in finite samples, since \( k \) is always finite in practice. Bollerslev, Li and Liao (2021) provide a fixed-\( k \) asymptotic theory for the spot volatility process. While the resulting spot volatility estimator is no longer consistent, our fixed-\( k \) theory permits the construction of valid uniform confidence bands for the volatility process. An empirically realistically calibrated simulation study underscores the practical reliability of the new inference procedures.

Many semi/nonparametric estimation and inference methods need to determine a tuning parameter in practice. For the series method, the tuning parameter is the set of series approximating functions. One way of determining this tuning parameter is through machine learning algorithms, such as the LASSO. One of my recent publications, Chetverikov, Liao and Chernozhukov (2021) studies the cross-validated LASSO estimator of high-dimensional linear regression models. For models with Gaussian noise, we show that the cross-validated LASSO estimator achieves the optimal convergence rate up to a logarithm term. When the noise is not Gaussian, the cross-validated LASSO estimator is shown to have a convergence rate not slower than the square root of the optimal rate up to a logarithm term. My recent work, Li, Liao, and Zhou (2021b) develops a new test for conditional moment restrictions through nonparametric series regression with series approximating functions selected by LASSO. Machine-learning the main features of the unknown conditional expectation function beforehand enables the test to seek power in a targeted fashion. The data-driven selection, however, also tends to distort the test’s size nontrivially, because it restricts the (growing-dimensional) score vector in the series regression on a random polytope, and hence, effectively alters the score’s asymptotic normality. We provide a novel critical value to account for this truncation effect. We establish the size and local power properties of the proposed test under a general setting for heterogeneous serially dependent data.

In addition to the work on functional inference using the strong approximation, I have also been working on developing inference procedures for a general class of semiparametric models. Hahn, Liao, and Ridder (2022) revisit the assumptions that ensure the identification of the production function in Olley and Pakes (1996). We show that an index restriction plays a crucial role in the identification, especially if the capital stock is measured by the perpetual inventory method and derive the influence function and the asymptotic variance of Olley-Pakes estimator. Hahn, Liao, Ridder, and Shi (2021) derive the influence function of semiparametric estimator based on the control variable approach, and the asymptotic variance of the sieve estimator studied in Hahn, Liao and Ridder (2018).

The second line of my recent research is on developing valid and powerful inference methods for many popular empirical macro and finance models. One of my recent paper, Cheng, Dou and Liao (2022) studies evaluating the validity of many influential macro asset pricing models through testing their moment conditions. The main challenging is on how to use the valid but possibly weak information to improve the power of the test and at the same time maintain its size control. We propose a new test which controls size regardless the identification strength of the valid information and becomes the optimal Chi-square test when the valid information is strong. The new test also shows power improvement over the traditional J test when the valid information is weak. In my recent work, Liao and Liu (2022) studies the cross-sectional regression which is one of the most popular methods for estimating the linear asset pricing models. The cross-sectional regression is conducted in a two-step procedure and is computationally attractive since the estimators in both steps have the closed-form expressions. On the other hand, one may worry that the cross-sectional regression loses efficiency since the unknown parameters are not estimated simultaneously. In this
paper, we show that the optimally weighted cross-sectional regression estimator is as efficient as the one-step estimator which is computationally intensive. Our findings justify the widely used cross-sectional regression methods in the literature.

In addition to the above works, I have also worked on a project on the bootstrap inference. Asymptotic justification of the bootstrap often takes the form of weak convergence of the bootstrap distribution to some limit distribution. Theoretical literature recognized that the weak convergence does not imply consistency of the bootstrap second moment or the bootstrap variance as an estimator of the asymptotic variance, but such concern is not always reflected in the applied practice. The bootstrap variance is usually used in the empirical studies to conduct hypothesis test. Hahn and Liao (2021) show that such common bootstrap based standard error in fact leads to a potentially conservative inference.

2. Teaching

Since my employment at UCLA in 2011, I have taught 5 different courses. Two of them are the undergraduate level, one is the master level and the rest two are the graduate level.

I taught the undergraduate course, Econ 41: Statistics for Economists from 2012 to 2017. This course aims at providing the students with economics major elementary knowledge of statistic concepts and principles. In the last 5 years, the average enrollment of this course is 238 and my average teaching evaluation is 6.3/9.0 with an average response rate 43%.

I taught Econ 203C: Econometrics III from 2011 to 2019 at UCLA. The goal of this course is to teach first-year graduate students in economics basic techniques in the classical time series analysis. Many topics are covered in this course. For example, the ARMA processes, frequency domain analysis, martingale limit theory, B-N decomposition and asymptotic theory for linear processes, model selection, auto-correlation robust inference, economic forecasting and forecasting evaluation, GMM, the unit-root and cointegration theory. These topics provide our graduate students useful tools for empirical research in their later years of the Ph.D. program. In the last 5 years, the average enrollment of this course is 26 and my average teaching evaluation is 8.4/9.0 (with an average 71% response rate).

From 2018, I have been teaching Econ 147: Financial Econometrics for the undergraduate students at UCLA. In this course, I introduce many popular financial econometric models and teach students how to analyze financial data using the statistical software R. Many interesting topics were discussed in this course. For example, the constant expected return model, the conditional volatility models, basic time series analysis and the efficient portfolio choice theory and CAPM. I received many encouraging and constructive feedbacks from the students. The students liked this course since they learned both the methods for financial data analysis and the direct way of implementing these methods through R. The average enrollment of this course is 72 in the last 5 years and my average teaching evaluation is 8.1/9.0 (with an average 48% response rate). I was awarded the Warren C. Scoville Distinguished Teaching Award in 2018 for my teaching in Econ 147.

In the master level, I have been teaching Econ 432: Data Science for Financial Engineering at the MQE program of UCLA in 2020 and 2021. This course overlaps some material in my Econ 147, but it covers some more advanced topics such as the factor pricing models, bootstrap and machine learnings in financial time series analysis. Econ 432 is one of the most popular courses at MQE with very high enrollment: 61/80 in 2020 and 143/180 in 2021. My teaching evaluation of this course is
also high: 8.5/9.0 (with a response rate 71%) and 8.3/9.0 (with a response rate 50%) in 2020 and 2021, respectively.

From 2019, I have been teaching Econ 231B: Advanced Econometrics II for the second-year graduate students at UCLA. This course is on nonparametric estimation and inference based on the series method. The topics in this course include nonparametric series regression, convergence rate and asymptotic normality of the series estimator, uniform inference and applications to the time series models. The average enrollment of this course is 6, and my average teaching evaluation is 8.7/9.0 with a response rate 82%.

3. Service

I have been an associate editor for two journals: Econometric Theory (since 2017) and Journal of Business and Economic Statistics (since 2021). I have served as a referee for many economics journals such as Econometrica, Review of Economic Studies, Journal of Political Economy, Journal of Econometrics, Review of Economic Statistics and Quantitative Economics. I have also been a reviewer for Hong Kong Research Grant Council, Ministry of Science and Technology of Taiwan, National Science Foundation and Social Sciences and Humanities Research Council of Canada.

In the economics department of UCLA, I have been in the graduate admission committee since 2011, the MQE admission committee since 2016 (files reviewed for MQE in recent years: 398 in 2020, 385 in 2021, 235+ in 2022), the Math/Econ committee since 2020, the graduate committee since 2020, the undergraduate new major committee in 2020 and the MQE curriculum reform committee in 2021. In the university level, I have been in the graduate fellowship review committee in 2019 and the global classroom faculty advisory committee since 2021. From the Fall of 2022, I will serve the undergraduate council of UCLA.

I have served in the dissertation committee for more than 17 graduate students in the economics department of UCLA, supervised 20+ master students in the MQE program for their projects since the Fall of 2021. Over the 2018-2021 academic years, I have written letters for 40+ undergraduate and master students and for their applications to the graduate program.