

Zhouyu Shen

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Booth School of Business, University of Chicago, Chicago, US

EDUCATION

University of Chicago (UCHICAGO)— *Chicago, IL, US*

Ph.D. in Econometrics and Statistics, Booth School of Business

Advisor: Dacheng Xiu

September 2020 – Present

University of Science and Technology of China (USTC) — *Hefei, Anhui, China*

B.Sc. in Statistics, School of the Gifted Young

September 2016 – June 2020

- **National Scholarship** (2018, top 1%)
- **National Scholarship** (2019, top 1%)
- **First-Class Scholarship**, School of the Gifted Young (2017, top 5%)

RESEARCH INTERESTS

Machine Learning Theory, Factor Analysis, Asset Pricing, High-Dimensional Statistics, Nonparametric Regression, Time Series

DISSERTATION COMMITTEE

Dacheng Xiu (Chair)

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RESEARCH

On the Theory of RNNs

Working Paper — Joint with Xiao Chen, Yu Chen, and Dacheng Xiu.

Recurrent Neural Networks (RNNs) are a class of neural networks designed for sequential data, including time series. This paper explores RNNs' mechanisms by providing theoretical guarantees within time series models. We analyze a nonlinear autoregressive and moving-average model (NARMA) and establish a statistical error bound for RNN predictions. The bound includes approximation and estimation errors, influenced by the RNN's architecture and process properties. Simulations demonstrate that RNNs outperform ARMA and deep neural networks (DNNs) in prediction accuracy.

On the Theory of Deep Autoencoders

Working Paper — Joint with Dacheng Xiu.

Autoencoders are widely used for dimensionality reduction and signal denoising. This study provides non-asymptotic guarantees for deep autoencoders within a nonlinear factor model. We show that deep autoencoders recover common components from inputs with diminishing error as dimensionality and sample size increase. The recovered factors converge to the true latent factors through functional transformation. Applications include nowcasting GDP growth, asset return pricing, and program evaluation.

Can Machines Learn Weak Signals?

Submitted — Joint with Dacheng Xiu.

Winner of the 2024 Bates-White Prize for Best Paper at SoFiE Annual Conference.

We evaluate machine learning algorithms in high-dimensional regression with low signal-to-noise ratios. Ridge regression performs better than Lasso under weak signals. Simulations show Random Forest generally outperforms Gradient Boosted Trees, and Neural Networks with L_2 -regularization excel in capturing nonlinear functions of weak signals. Empirical results suggest signal weakness limits Lasso's performance in economic predictions.

Modeling Tail Index with Autoregressive Conditional Pareto Model

Published in Journal of Business & Economic Statistics, Volume 40 (2022) — Joint with Yu Chen and Ruxin Shi.

We propose an autoregressive conditional Pareto (AcP) model to dynamically model the tail index in financial markets using an exponential function for greater interpretability. The model is superior to GARCH for volatility estimation, especially during market turmoil. The estimated tail index reflects stock market risk and may serve as an early warning indicator. We also calculate tail connectedness, showing it increases during turbulent periods, aligning with score-based methods.

TEACHING EXPERIENCE

University of Chicago, Booth School of Business

Teaching Assistant

- Statistical Inference, Ph.D. Course — 2024
- Statistical Inference, Ph.D. Course — 2023

University of Science and Technology of China

Teaching Assistant

- Stochastic Process, Undergraduate Course — 2019
- Probability Theory, Undergraduate Course — 2019
- Time Series Analysis, Undergraduate Course — 2020

PROFESSIONAL SERVICE

Journal Reviewer for *Journal of Econometrics* and *Journal of the American Statistical Association*.

Presentations

- Poster presentation at the *Statistical Foundations of Data Science and their Applications* conference, Princeton University, USA, May 2023.
- Presented the paper *Can Machines Learn Weak Signals?* at the *Asian Meeting of the Econometric Society*, Zhejiang University, China, June 2024.
- Presented the paper *Can Machines Learn Weak Signals?* at the *Second JCSDS 2024*, Yunnan University, China, July 2024.