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SPECIAL ISSUE ARTICLE

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# A pulse check on recent developments in time series econometrics

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**Abstract**

This article motivates and summarizes the contributions of the special issues on Recent Developments in Time Series Econometrics.

**KEYWORDS**

ARDL, Bayesian State Space, Bubbles Testing, House Price, Insider Trading, Time Varying Moments

*I touch his heart but it does not beat at all. — Gilgamesh c. 2600 BC*

In 2003, two pioneers in time series econometrics, Professor Sir Clive W.J. Granger and Professor Robert F. Engle, were awarded the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel, commonly known as the Nobel Memorial Prize in Economic Sciences. The award signaled the importance of time series analysis in our understanding of economic phenomena. Twenty years later, it seems timely to take another pulse check to examine the current state of time series analysis, its importance, its role relative to other emerging fields such as machine learning, and its diverse applications facilitated by recent development in computing hardware and infrastructure. This special issue contains seven significant contributions, where each summarizes and extends the current state-of-the art technologies in the various branches of time series analysis. They reflect on present developments and provide insights into the future directions of research.

The present, as reflected in this special issue, highlights significant branching of time series analysis in terms of both theoretical developments and empirical applications. It ranges from expanding our understanding of the dynamics of stochastic processes to the development of

an early warning system for price bubbles. These contributions, as shown in this special issue, continue to intersect and complement, harmoniously, with other field.

While there are some old friends that time series analysis has known for a long time, such as economics and finance, it also made some new friends due to the dedication of researchers from diverse disciplines. This includes machine learning, high dimensional data analytics, and housing research.

For existing branches, the special issue draws on inspiration from the two co-recipients of the 2003 Nobel Memorial Prize in Economic Sciences. Professors Sir Clive W.J. Granger and Robert F. Engle who shared the prestigious prize through their seminal work on co-integration analysis and volatility modeling, respectively. The innovative concept of co-integration, as defined by Professor Granger, provided a path-breaking approach to understand the relation between nonstationary processes and opened-up a new branch of time series econometrics that continues to fuel research in econometrics. This ranges from more powerful unit root tests, such as Kwiatkowski et al. (1992) and Phillips and Perron (1988), and their panel data extensions such as, Im et al. (2003), Pesaran (2007), and Westerlund et al. (2022) to optimal inferences in the presence of nonstationary processes, such as Phillips (1991) and Toda and Yamamoto (1995). Among these outstanding contributions, the autoregressive distributed lag (ARDL) approach pioneered by Pesaran et al. (2001) proved to be particularly popular among empirical researchers. Several extensions of the ARDL models have been proposed and Cho et al. (2023) provided a timely survey on the origin of ARDL and its most recent development in the context of modeling the relation between nonstationary processes.

Since the seminal work of Engle (1982), the dynamics of higher-order moments beyond the variance have attracted much attention with diverse applications. Accurate descriptions of the dynamics of skewness and kurtosis of financial returns affect the pricing of assets and their derivatives, including options. Soltyk and Chan (2023) summarizes the latest developments in modeling the dynamics of higher-order moments. Financial researchers should find Soltyk and Chan (2023), an informative contribution to help understand the capabilities and challenges in modeling time-varying higher order moments.

As time series become longer, wider, and denser, estimation of such big data continues to pose theoretical and numerical challenges. These challenges are often framed in the language of high-dimensional statistics. Through the rapid improvement in computation power, two related, but distinct, disciplines now offer practically feasible solutions to these challenges. While often sharing a hidden nexus, both Bayesian and Machine Learning techniques have proven to be particularly useful in estimating large systems with complex data. Chan and Strachan (2023) provide a comprehensive survey on recent developments of the Bayesian approach to State Space modeling in the context of macroeconomics. In their contribution, Professors Joshua Chan and Rodney Strachan dedicate the paper to the estimation of large systems with a focus on dimensional reduction. Such an approach facilitates the ease of computation as well as interpretation of the estimation outputs. Researchers will benefit from the concise description of the estimation theory and the explanations of various algorithms whose applications become increasingly common in the era of machine learning.

The algorithmic approach also highlights the timely contributions of Masini et al. (2023) by Professors Ricardo Masini, Marcelo Medeiros, and Eduardo Mendes, which summarizes the recent applications of machine learning techniques to time series forecasting. It covers concepts such as deep neural network and tree-based techniques from the perspective of econometric applications. Such an approach is similar in spirit to Chan and Màtyàs (2022) where it aims to bridge the gap between machine learning techniques and econometric analysis. Readers will appreciate

their econometrically friendly approach to machine learning. Such an approach is in contrast to other contributions from the machine learning literature where terminologies and presentations are often the most significant barriers for applied economists and applied econometricians.

Forecasting and prediction are arguably the most signifiant functions of time series econometrics. Recent studies move away from traditional point forecast and focus on forecasting and predicting scenarios that represent greater economic significance. One such example is the identification of insider trading. The applications of concepts such as martingale and mixingale are not limited to unit root testing or modeling nonstationary processes. They also facilitate the developments of theoretical models on insider trading, as shown in Bennett and Hu (2023). Professor Wei Hu and Mr. Luke Bennett applied filtration enlargement, a concept derived from the study of martingales, to develop a theoretical model of insider trading. The significant of their approach is that the theoretical model can be applied empirically via extremely simple econometric techniques. This greatly facilitates the practical usefulness of this theoretically complex model and provides the first identification strategy of insider trading behavior. While not necessarily perfect, the paper laid the important foundation of the literature and provides an important avenue to investigate the detection of insider trading activities.

The contribution to developing warning systems does not stop with insider trading. The seminal work by Phillips et al. (2011) created a significant branch of time series research based on testing for bubbles. Building upon the existing work on unit root testing, bubble testing is a contribution that truly stands on the shoulders of giants. Dr Yang Hu provides a much needed survey on bubble testing in Hu (2023) and gently introduces the technically complex subject in a manner that is accessible by empirical researchers without sacrificing technical rigor. Following an historical introduction, Shi and Phillips (2023) demonstrate the practical usefulness of this branch of research by developing a new bubble test for the housing market. By decomposing the housing market into fundamental and nonfundamental components, the proposed test is able to detect potential bubbles by accommodating their fundamental economic drivers. The mastery of techniques demonstrated by the authors should provide an encouraging example for other researchers to push further the application of this important concept.

Contrary to the quote at the beginning of this article, which is often considered the earliest record of a pulse check, the heart of time series econometrics is not only beating, it is beating strongly. As shown in this special issue, not only does the development of time series econometrics continue to facilitate our understanding of economic phenomena, it also acts as a nexus between econometrics and other emerging fields. As a result, the toolbox for applied economists and econometricians becomes richer, providing significant improvements to our ability to analyze data with increasing complexity.

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