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Authors

Elliott, Graham
Taylor, AM Robert

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Editorial

Annals issue of *Journal of Econometrics* "Recent Advances in Time Series Econometrics" Guest Editors' introduction☆

1. Background

This annals issue of *Journal of Econometrics* collects together papers presented at a conference held at the University of Nottingham on May 24–25, 2010. This conference, run jointly by the Granger Centre for Time Series Econometrics and the Department of Economics at UCSD, was held as a memorial event to celebrate the life, career and legacy of Sir Clive Granger after his passing in 2009. A small number of additional papers were also invited from highly respected researchers with links to Clive but who were unable to attend the conference.

Almost 80 conference delegates from around the globe came to share in this very stimulating and special event. Participants included present and former colleagues of Clive, a number of Clive's Ph.D. students and co-authors, together with other researchers keen to join in the celebration of Clive's life and legacy. Clive's wife, Lady Patricia Granger, and their daughter and son-in-law, Claire and Paul Snowball, were also in attendance. Twenty-six papers were presented at the conference, 17 of which were in poster sessions and nine in key-note invited sessions. The latter were given by: Marcus Chambers, Graham Elliott, Jesus Gonzalo, Sir David Hendry, Cheng Hsiao, Hashem Pesaran, James Stock, Norman Swanson, Mark Watson and Halbert White. Laudations were also given at the start of the conference by Robert Taylor, Sir David Hendry, Kenneth Wallis, Peter Phillips, James Stock, Cheng Hsiao, Hal White and John Bates. Some rather less formal reflections on Clive were also given at the conference dinner by Graham Elliott, Jesus Gonzalo and Normal Swanson. Further details on the conference and a conference program can be found at the website http://www.nottingham.ac.uk/economics/grangercentre/grangerconference/.

Clive Granger was born in Wales in 1934. In 1955 he obtained an undergraduate degree in Mathematics from the University of Nottingham, before continuing to study for a Ph.D. in Statistics at Nottingham under the supervision of Harry Pitt. He completed his Ph.D. thesis, titled "Testing for Non-stationarity" in 1959. His first academic posts were at the University of Nottingham, culminating with a professorship in econometrics in 1965. During this period he was awarded a Harkness Scholarship to study in the US. He joined a team working under the direction of Oskar Morgenstern at Princeton. He left Nottingham in 1974 for a research professorship in the Department of Economics at UCSD where he remained until his retirement in 2003. Clive Granger was awarded (jointly with Robert Engle) the Sveriges Riksbank Prize in Economic Science in Memory of Alfred Nobel (popularly known as the Nobel Prize for Economics) in October 2003. He was knighted in 2005. Clive Granger has had a profound influence in almost all areas within the discipline of time series econometrics. He will perhaps be best remembered for his contributions in the areas of non-stationary time series and co-integration, frequency domain methods, model selection, causality, seasonality, fractional integration, aggregation of time series and forecasting. In addition to this Clive Granger was an excellent colleague to all in the profession, always available to econometricians around the world for discussions about econometrics. Further details on the life and research career of Clive Granger can be found in these excellent recent biographies:

Hendry, D.F. and Terasvirta, T. 'Sir Clive William John Granger 1934–2009', forthcoming Proceedings of the British Academy, 2013.

Hendry, D.F. (2102) 'Sir Clive William John Granger (1934–2009)', Oxford Dictionary of National Biography, doi:10.1093/ref:odnb/101749.

Our goal with this annals issue is to bring together a group of papers which provide innovations in time series econometrics and build on the work of Clive thereby providing a lasting celebration and recognition of the huge contributions made by Clive Granger in time-series econometrics. To give a theme to such an issue was therefore no easy task, given the huge variety of topics he researched on. Accordingly, we settled on the theme of "Recent Advances in Time Series Econometrics". As Guest Editors we adopted the usual rigorous editorial procedures and standards of the *Journal of Econometrics*. The contribution to this issue by Chambers, Ercolani and Taylor was handled by John Geweke. Fourteen papers survived the reviewing and revision process. These appear in this issue in the order of their final acceptance date.

We dedicate this annals issue of the *Journal of Econometrics* to the memory of Sir Clive Granger.

2. Contents

In the opening paper of this special issue, "Optimal estimation of co-integrated systems with irrelevant instruments", Peter

☆ We are very grateful to the co-editors for accepting our proposal for an annals issue of the *Journal of Econometrics* arising from the Clive Granger Memorial Conference held in Nottingham in May 2010, in particular John Geweke who served as Coordinating Editor for this issue. We would like to thank all of the conference delegates who contributed their papers to this special issue. We are also extremely grateful to those individuals who agreed to serve as referees for the papers submitted to this special issue. The Memorial Conference would not have been possible without the generous financial support provided by the University of Nottingham, to whom we are extremely grateful.

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Phillips shows that "irrelevant" deterministic trend instruments may be systematically used to produce asymptotically efficient estimates of a co-integrated system, paralleling his earlier work with Bruce Hansen, which showed that similar results can be obtained with "irrelevant" stochastic trend instruments. Phillips shows that these new estimators are simple to compute, requiring only linear instrumental variables [IV] estimation. Simulations show that the proposed method works well in practice and can outperform many of the commonly used co-integrating regression procedures. These results provide a stark contrast with those seen for IV estimation in stationary systems where relevance of the instruments is critical to asymptotic efficiency and can even jeopardize consistency when the instruments are weak. Moreover, these results also highlight the fact that the "problem" of spurious correlation among trending variables can in fact be exploited to produce useful results.

Peter Robinson, in his paper "The estimation of mis-specified long memory models", discusses the log-periodogram regression estimation of a long memory time series in cases where the spectrum does not necessarily follow a power law in the neighborhood of the zero frequency. This set-up is consistent with a broad definition of "long memory" where one requires only that the spectrum is unbounded as the frequency approaches zero, consistent with Granger's (1966) characterization of the "typical spectral shape" of an economic variable. In practice this generalization is obtained by augmenting the power law in the spectrum by a slowly varying function. Robinson shows that the log-periodogram estimate of the memory parameter is still consistent, but that the slowly varying function may result in increased bias. This in turn requires that a very short bandwidth is used. Robinson provides several useful examples, and conjectures about the performances of other semiparametric estimates, including the well-known local Whittle estimate.

Affine term structure models are widely used in macroeconomics and finance. Such models invariably entail some form of measurement or specification error and this is usually assumed to be independent and identically distributed [IID]. In their paper "Testable implications of affine term structure models", James Hamilton and Jing Cynthia Wu show that the assumption that certain specified yields are priced without error is testable, and indeed find that the IID assumption on the measurement error is rejected in a variety of US yield data. They also find that the predictions of these models for the average levels of different interest rates are inconsistent with the observed data, and propose a more general specification that is not rejected by the data.

Combining elements of Clive Granger's research on seasonal unit root testing and frequency domain regression methods, Marcus Chambers, Joanne Ercolani and Robert Taylor, develop new semi-parametric tests for the seasonal unit root hypothesis in their paper "Testing for seasonal unit roots by frequency domain regression". These tests are shown to be valid under weaker conditions on the shocks than the familiar fully parametric OLS-based regression tests of Hylleberg et al. (1990) [HEGY] and to avoid the non-pivotal limiting distributions seen with the original HEGY tests when weak dependence is present in the shocks. Using Monte Carlo simulation methods they compare the size and power properties of their proposed frequency domain tests with the corresponding HEGY tests and find a useful complementarity between the two approaches.

In their paper "Is there an optimal forecast combination?" Cheng Hsiao and Shui Ki Wan follow up on the seminal paper of Bates and Granger (1969). As that paper noted, the optimal combination approach requires estimation of weights which can hamper performance. Hsiao and Wan suggest, for situations where the number of forecasts is large, to use instead weights estimated from an eigenvector. They suggest a trimmed eigenvector approach and show in Monte Carlo experiments that this approach has some advantages over previous approaches.

Addressing a topic which greatly interested Clive Granger in the last few years of his life, Giuseppe Cavaliere and Fang Xu investigate the impact that natural bounds on time series data can have on tests for a unit in their paper "Testing for unit roots in bounded time series". These bounds occur either by construction (e.g. the unemployment rate in an economy is necessarily bounded between zero and one) or through policy controls (e.g. target zone exchange rates). Cavaliere and Xu show that such bounds change the large sample distributions of conventional unit root tests and that in practice this leads to tests which over-reject the unit root null hypothesis. They propose a range of new unit root tests, based on familiar functional forms, valid in the presence of bounds and provide an illustrative application using US interest rate data.

In the next paper, "Aggregation in large dynamic panels" Hashem Pesaran and Alexander Chudik consider the issues that arise when economic relationships are investigated using macro data when the data is generated by micro units that are interrelated through cross-sectional dependence in innovations and through feedbacks across the units over time. An optimal aggregate function is derived and related back to Granger (1980). They also use this to show which distributional features of the micro parameters can be identified from the aggregate model and which cannot. Impulse response functions are derived for the aggregate variables, distinguishing between the effects of composite macro and aggregated idiosyncratic shocks. An empirical analysis of price inflation in Germany, France and Italy, comparing models based on economy-wide measures against models based on industrially disaggregated measures is provided.

In much of his work Clive Granger discussed the problems that surround model selection in practice. The next paper, "Model selection in under-specified equations facing breaks", by Jennifer Castle and David Hendry considers the empirically relevant problem of how to perform model selection in under-specified settings when variables may have location shifts and where relevant variables are omitted. Castle and Hendry investigate the impact of mean shifts in the omitted variables and of mean shifts in the included variables showing that the former induce intercept shifts in the so-called local data generation process [LDGP] but do not contaminate the slope parameters, while under misspecified models the latter result in shifting intercepts in the LDGP, and non-constant estimated slopes, in each case resulting in estimation problems. They show that a good degree of robustness to these problems can be achieved by using the impulse-indicator saturation method which they show can also provide an automatic intercept correction to improve forecasts following location shifts.

One of Clive Granger's greatest achievements is the Granger Representation Theorem, published in Engle and Granger (1987). This result showed, for a vector moving average process in the changes of the variables, the various representations the data could have, including the error correction model (which is the model Granger was trying to understand when he made this contribution). In their paper "An asymptotic invariance property of the common trends under linear transformations of the data", Søren Johansen and Katerina Juselias examine rotations of common trends in vector autoregressions [VARs]. They show that the limits of common trends for a VAR in one rotation generated by a set of residuals are linear functions of the limit of common trends of a rotation of the model.

Clive Granger introduced the extremely useful notion of Granger causality to econometrics in his seminal (Granger, 1969) paper. This paper led to a great deal of discussion regarding the meaning of causality and how it can be practically understood with data. Clive himself was influenced by philosophical thought regarding the need for causes to occur prior to effects and showed how this idea can be made practical through the comparison of conditional distributions. In the paper "Granger causality, exogeneity, co-integration, and economic policy analysis", Davide Pettanuzo and Hal White extend these ideas by showing in a general dynamic model (including allowing for co-integration) the relationships between structural causality and Granger causality. They show the conditions under which these two notions are equivalent.

Throughout Clive Granger's work, he has sought to generalize his methods so that they are applicable to real data. In "Summability of stochastic processes a generalization of integration for nonlinear processes". Vannessa Berenguer-Rico and Jesús Gonzalo seek to extend notions of I(1) to nonlinear models. In linear models the notions are somewhat straightforward, however in nonlinear models notions such as summability are not particularly useful. The authors extend notions of summability to nonlinear models, introducing a new concept of summability with dependence measured by an estimable parameter.

The issues of aggregation and the properties of data were of great interest to Clive Granger. In Granger (1980) he showed that the aggregation of processes that had exponentially declining persistence could result in a process that displayed long memory. In "The aggregation of dynamic relationships caused by incomplete information" Michael Thornton extends our knowledge of the effects of aggregation on dynamic processes. He shows that the aggregation of processes that follow random walks can result in processes that display long memory other than a simple random walk. This helps further our understanding of how such long memory processes might occur.

Clive Granger was keenly interested in practical solutions to econometric problems. In "Forecasting financial and macroeconomic variables using data reduction methods: new empirical evidence" Hyun Hak Kim and Norman R. Swanson examine model combination in the context of forecasting. In an extensive empirical investigation they show that rather than average models, which is a common approach, a hybrid method of combining factor weights and shrinkage can outperform in terms of mean squared forecast error.

In his work, Clive Granger returned again and again to the practical issues of forecasting. In their paper "Estimating turning points using large data sets" James Stock and Mark Watson introduce definitions of turning points in data series and develop methods that allow estimation of these turning points. The methods allow for the understanding of the statistical sampling error of their estimates. The methods are applied to a very wide range of data, and show that averaging over similar series after using the individual series to estimate the turning points provides numerous gains in precision.

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Graham Elliott
Department of Economics, UCSD, United States
E-mail address: grelliott@ucsd.edu.

A.M. Robert Taylor *
Essex Business School, University of Essex, UK
E-mail address: rtaylor@essex.ac.uk.

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* Correspondence to: Essex Business School, University of Essex, Colchester, CO4 3SQ, UK.