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Introduction to *Studies in Nonlinear Dynamics & Econometrics* Issue in Honor of James B. Ramsey

DOI 10.1515/snde-2016-6001

This issue is dedicated to James B. Ramsey, whose research has had a profound influence on the field of econometrics and whose indefatigable efforts in support of the Society for Nonlinear Dynamics and Econometrics (SNDE) have been fundamental to the society's success. To borrow from a famous metaphor, those of us who work in nonlinear time series analysis and benefit from the SNDE's activities stand on James's shoulders.

1 Specification testing and beyond

In graduate school at the University of Wisconsin in the mid-1960s, James was interested in developing procedures for addressing a bold null hypothesis: the regression model is correctly specified. He received a great deal of negative feedback. His advisor, Arnold Zellner, did not think he would succeed, and argued that, even if he accomplished what he wanted to do, no one would believe it. Arthur Goldberger threw James out of his office.

Ramsey (1969) pioneered the area of specification testing in regression analysis. This paper focused on testing procedures for the presence of specification errors due to omitted variables, incorrect functional form, simultaneous equation problems, and heteroskedasticity. Of the four tests introduced, the RESET test became the most well known and frequently used in applied work. In the original formulation, the tests were based on the use of BLUS residuals. Ramsey and Schmidt (1976) modified the RESET test for use with OLS residuals and showed that this modification was equivalent to the running the test with BLUS residuals. Given the relative ease of obtaining OLS residuals, this likely was a factor behind the RESET test's subsequent popularity. The test became a part of the standard toolkit for testing the adequacy of estimated regression models, often with the goal of examining evidence for departures from a linear functional form; see, e.g. Lee, White, and Granger (1993). James's important work on specification testing also includes Ramsey (1970), Ramsey and Zarembka (1971), Ramsey and Gilbert (1972), Ramsey (1974a,b).

Quandt and Ramsey (1978) developed the moment generating function (MGF) estimator for use as an alternative to maximum likelihood estimation of the parameters of finite mixtures of normal distributions. Maximum likelihood methods are difficult to apply to such problems due to the matrix of second partial derivatives of the likelihood function being singular. Quandt and Ramsey designed the MGF estimator to solve this estimability problem. Their approach provided an important advance in the estimation of switching regression models, and this paper received the American Statistical Association's 1978 Paper of the Year award.

In the 1980s, researchers in nonlinear science discovered examples in nature, e.g. in physical, chemical, biological, and climatological systems, of nonlinear difference equations which generate time series that appear to be random using standard statistical tools. Such deterministic processes were labeled "deterministic chaos." At the same time a new economics literature on chaotic dynamics showed that chaos and

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deterministic cycles were possible in standard business cycle models; see, e.g. Benhabib and Day (1982), Day (1983), Grandmont (1985), and Boldrin and Montrucchio (1986). Using the Grassberger and Procaccia (1983) correlation dimension algorithm and other methods, economists soon began to test whether key macroeconomic and financial time series were generated by deterministic chaotic systems; see, e.g. Barnett and Chen (1987), Frank, Gencay, and Stengos (1988), and Scheinkman and LeBaron (1989).

By the mid-to-late 1980s, the question of chaos and economic behavior was receiving considerable attention outside of academic research circles. A good example is Gleick (1987). In the wake of the “Black Monday” stock market crash of 1987, this *New York Times* article focused on whether that massive financial gyrations may have reflected chaos-induced instability. By then a specialist in chaos and nonlinear dynamics, James was prominently featured in Gleick’s discussion.

Relative to those used in applications of the Grassberger and Procaccia (1983) procedure in the natural sciences, data sets used in economics in this pre-big-data era were extremely small. Ramsey and Yuan (1989, 1990) showed that the Grassberger and Procaccia (1983) estimator is strongly biased in small samples and developed a regression-based approach to evaluate this bias as a function of embedding dimension and sample size. Ramsey, Sayers, and Rothman (1990) applied the Ramsey and Yuan (1989, 1990) procedure to reevaluate dimension calculations done by economists on economic and financial data. They found no evidence of simple chaotic attractors of the sort that had been discovered in the natural sciences. By the spring of 1991, following the Gulf War, Buz Brock was known to say in his chaos talks that economists making claims of the existence of chaos in economic time series were in danger having Ramsey, Sayers, and Rothman fire a Scud missile at them.

Roughly 90 years ago, Mitchel (1927) asserted that business cycles are asymmetric in that, “Business contractions appear to be a briefer and more violent process than business expansions.” Neftçi (1984) opened the modern literature on testing the symmetry of business cycles by using a statistical framework based on finite-state Markov chains; other important early contributions include DeLong and Summers (1986), Falk (1986), and Sichel (1989). I was introduced to this literature through a two-semester seminar on nonlinear dynamics and time series analysis James ran that I attended in graduate school at NYU. James suggested it would be fruitful to cast the question of business cycle symmetry within the context of time reversibility. The main outcome of this avenue of research was Ramsey and Rothman (1996), in which we related the concept of time reversibility to various notions of business cycle asymmetry in the literature, i.e. steepness, deepness, sharpness, and asymmetric transition probabilities, and introduced a time-domain test of time reversibility based on bicoariances.¹ Applying our test we found that time irreversibility was the rule rather than the exception for a wide range of US and international business cycle variables.

In the mid-1990s, James pioneered the use of wavelets in economics and finance and has remained a leader in the field. Ramsey, Usikov, and Zaslavsky (1995) applied wavelet analysis to investigate self-similarity and quasi-periodicity in daily stock return data. They found weak evidence of the former and strong evidence of the latter. Ramsey and Zhang (1996, 1997) used a generalization of wavelet analysis through waveform dictionaries to study, respectively, daily observations of stock market data and tic-by-tic foreign exchange rate data for a year. In this approach time-frequency distributions are examined for evidence of power at particular frequencies. Ramsey and Lampart (1998a,b) used wavelets to generate both an orthogonal time-scale decomposition of the data and a non-parametric representation of each series examined. They found that the relationship between economic variables varies strongly across time scales. Ramsey (1999) investigated the distributional properties of the regression estimators and residuals in the context of regressions between time-scale decompositions. Ramsey et al. (2010) showed that structural components obtained through wavelet analysis yield nearly ideal instrumentals in some common cases confronted in practice. Gallegati et al. (2011) applied wavelet analysis to study the frequency-dependent relationship between wage inflation and unemployment.

¹ The Ramsey and Rothman (1996) test and the Hinich and Rothman (1998) frequency-domain test of time reversibility require finite sixth moments of the distributions examined, whereas the characteristic function based test of Chen, Chou, and Kuan (2000) does not have any moment restrictions.

2 SNDE

The first five symposia of the SNDE took place as a conference-within-a-conference by piggybacking off the annual conference of the Eastern Economic Association (EEA). Sufficiently binding financial and logistical constraints prevented the executive board of the fledgling SNDE from organizing a stand-alone conference, e.g. funds, which the society lacked, were required to become legally established as a non-profit organization. At the 1997 meeting of the board, which took place at the bar of the conference hotel in Arlington, Virginia, James – who was not then a board member but who was at the bar – asked why the SNDE conference was always a sub-conference of the EEA conference. I answered, “James, one non-EEA option would be for you to arrange for next year’s conference to be held at NYU.” James generously said he would look into this. He did and soon informed the SNDE board that, yes, the next conference could be held at NYU.

So the first independent SNDE conference was hosted by NYU in 1998. The main task to be resolved at the board meeting held in James’s NYU office the evening before that conference began was to determine where the following year’s conference would be held. Someone said, “New York is a great place for a conference, so perhaps next year we can meet again at NYU.” James charitably agreed to once again set things up at NYU the next year. So NYU was the venue of the 1999 SNDE conference and James was the local organizer for the second year in a row.

James eventually served as president of the SNDE. Without his relentless and steadfast commitment to the society over many years, it would not be the successful international organization it has become. He led SNDE through its Rostow-like take-off stage and drive to maturity. It is a great understatement to say that SNDE has been lucky to have been the beneficiary of such a creative scholar and magnanimous individual.

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