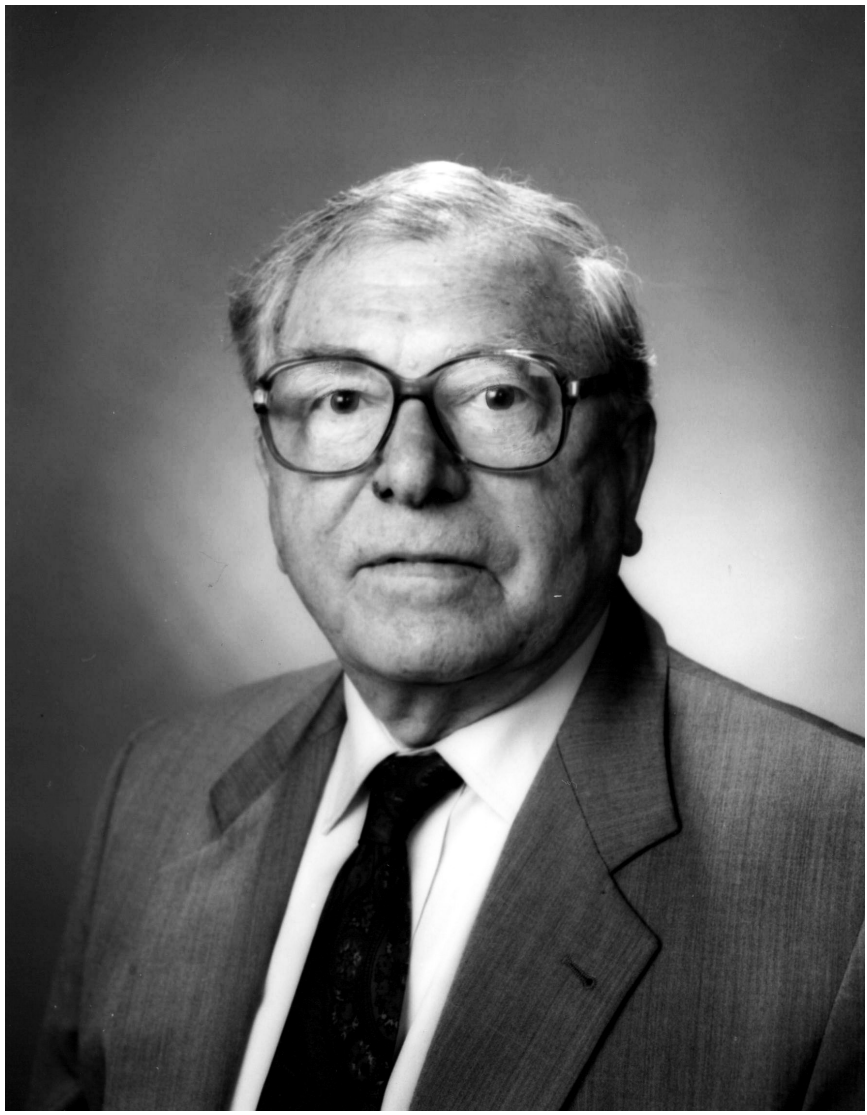

JAMES DURBIN

James Durbin
1923–2012

Professor James Durbin died on 23 June 2012 in London, at the age of 88. 'Jim', as he was universally known except in the most formal circumstances, was born into a non-academic family in Widnes on 30 June 1923. He showed considerable promise at school, where he excelled in most subjects, except physics. However, he developed strength in mathematics and it was in that subject that he obtained a scholarship to St John's College, Cambridge, which he entered in 1942. This was in the middle of the Second World War when special arrangements were in force for those eligible for war service. Jim completed five terms of residence after which he worked in the Army Operational Research Group until 1945. On the strength of this he was awarded a 'wartime' BA which was subsequently turned into an MA in the usual Cambridge fashion. He then spent a period (1946–7) working for the British Boot, Shoe and Allied Trades Research Association. On returning to Cambridge in 1948 it was Jim's intention to take Part II of the Economics Tripos. This would have taken two years but he was advised by his College tutor, an Economics lecturer, that his time would be better spent taking the one-year Diploma in Mathematical Statistics. He therefore completed his formal university education in a little under three years which, as he later used to point out, must have been a shorter time than for any of his peers.

Jim joined the newly created Department of Applied Economics (DAE) at Cambridge in 1948. Richard Stone was Director. A good deal of research was done on time series problems with researchers such as Guy Orcutt and Don Cochrane but also with passing visitors, including Hendrik Houthakker, Larry Klein, Michael Farrell and Ted Anderson. In

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the summer of 1949 a young Australian researcher, Geoffrey Watson, arrived in Cambridge for a year to do some work for his PhD. He and Jim started to discuss testing of serial correlation in regression residuals. The idea of a bound test came rather quickly and the mathematical details were developed in the following months. This work led to the famous Durbin–Watson test statistic, which had a big impact on applied econometrics because of its role in assessing the fit of an estimated regression equation.

The next step in Jim's career was determined when, in 1950, Sir Maurice Kendall wrote to Henry Daniels at Cambridge enquiring whether he knew of anyone suitable to fill a post of Assistant Lecturer in Statistics at the London School of Economics (LSE). With the apparent ease and speed with which such appointments were handled in those days, Jim was duly appointed. Thus began his life-long association with the LSE where he rose through the ranks to become professor in 1961 and from which he retired in 1988. In his interview with Jim, published in *Econometric Theory* in 1988, the distinguished econometrician Peter Phillips wrote: 'In 1950, Jim Durbin joined a newly established statistical research unit at LSE and, in retrospect, it is clear that his appointment broke a new dawn for the LSE … Jim Durbin's research has had an extraordinary impact on the application of statistics.'[1]

Unusually, perhaps, for someone who later travelled the world and greatly valued his international connections, Jim's academic base was firmly fixed in the LSE, as his domestic life was centred on his home in North London where he and his wife, Anne, brought up their three children. He became an Emeritus Professor at the LSE after his retirement, and from 2007 he was an Honorary Professor at University College London (UCL) and a Fellow in the Centre for Microdata Methods and Practice (CeMMAP).

Jim took his turn as Convenor (LSE's name for rotating headship of department in those days) but he firmly held to the traditional LSE view that the professors of a department were collectively responsible and that the Convenor merely acted only with their consent and on their behalf. He had no liking or particular aptitude for administration, and he did not fill any of the many managerial offices which often come the way of academics in their employing institutions nor in the many academic societies in

[1] P. C. B. Phillips, 'The ET interview: Professor James Durbin', *Econometric Theory*, 4 (1988), 125–57 at 125. This contains a full list of Durbin's publications up to 1988; a list of his later papers is provided in an appendix to this memoir.

which he took a leading part. Jim was a forceful character who was at his best as a leader or advocate of causes which were near to his heart. He often served as Council member or chairman of committees but never as secretary or in any other organising capacity. His strength was in advocating a course of action rather than as the patient negotiator and 'fixer'. He was not in sympathy with many of the trends in university management that had already become apparent before his retirement. He enjoyed the cut and thrust of debate on all manner of subjects, much of which took place in the LSE Senior Common Room. His own position was never left in doubt but there was no sense of superiority or superciliousness in his forays. He would often hold forth on such things as the declining economic position of university staff as evidenced by their inability to afford various cuts of meat or the skiing holidays which were easily attainable in his younger days.

Jim had the physique of a sportsman and one might have envisaged him as a rugby player, but as a young man mountaineering was his interest. After marriage he decided that this was not a suitable family activity and he turned instead to skiing. But in his late fifties he climbed Kilimanjaro, the highest mountain in Africa. A few years later and only after three months of preparation that mainly consisted of cycling between his home in Hampstead and his work in central London, he climbed Mont Blanc to celebrate his 60th birthday. He is alleged to have seen one of the attractions of academic life as the opportunity which it offered for such activities.

Jim carried out editorial work for a number of statistics journals. He assisted with *Biometrika* for many years, starting in 1960 as an editorial assistant, then as Deputy Editor in 1962 and finally, from 1964 to 1967, as Associate Editor. He was on the editorial committee of the *International Statistical Review* from 1958 to 1962 and served as an Associate Editor of the *Annals of Statistics* from 1973 to 1975 and the *Journal of the Royal Statistical Society, Series B* from 1978 to 1981.

He had a strong commitment to the Royal Statistical Society (RSS). He was also active for the Institute of Statisticians (as member of the Council, 1960–3) before it merged with the RSS. His involvement with the RSS culminated in the award of the Society's Guy Gold Medal in 2008 for a lifetime's achievement in statistics. (He had been awarded the Bronze Medal in 1966 and the Silver Medal in 1976.) This medal, named in honour of Sir William Guy, is 'awarded to fellows or others who are judged to have merited a signal mark of distinction by reason of their innovative contributions to the theory or application of statistics'. The citation read:

> The Guy Medal in Gold is awarded to Professor James Durbin FBA for a lifetime of highly influential contributions which have given him outstanding international recognition as a leader in our field, taking particular account of his pioneering work on testing for serial correlation in regression, on estimating equations, on Brownian motion and other processes crossing curved boundaries, on goodness of fit tests with estimated parameters, and on many aspects of time series analysis especially in areas relevant to econometrics, and also his remarkable service to the wider statistical profession on the international stage.

Within the Royal Statistical Society Jim held a number of offices but his main interest and contribution was to the Research Section on whose committee he served on three occasions before becoming its chairman in 1972–3. He was a natural choice for President of the Society several years later in 1986–7.

With his great interest in statistics at the international level he was active in the International Statistical Institute, of which he became President in 1983. From its origins the Institute had catered mainly for official statisticians, and many mathematical statisticians did not find it their natural home. With the growth of mathematical statistics there was an obvious need for a focus for this aspect outside the USA. Although the Institute of Mathematical Statistics professed to be international, it was largely seen as an American organisation and could not easily meet the needs of statisticians in other parts of the world. The vacuum was initially filled by a European region of the Institute of Mathematical Statistics; this then became a new section of the International Statistical Institute. Finally it developed into a fully fledged European Society in 1975 called the Bernoulli Society for Mathematical Statistics and Probability. Jim was Treasurer from 1975 to 1981.

In the course of time Jim acquired a whole string of Fellowships. These included the Institute of Mathematical Statistics (1958), the American Statistical Association (1960), the Econometric Society (1967), the London School of Economics (1993) and, of course, the British Academy (2001). His somewhat belated election to the Academy probably stemmed partly from the fact that it was never entirely clear what kind of statistician he was. Was he a mathematical, economic or social statistician? At various stages of his career a good case could have been made for any of these designations, and it is not entirely clear where Jim, if pressed, would have placed himself. However, by the late 1990s it was recognised that econometricians had a firm place in the Economics section of the British Academy and, on this basis, Jim was duly elected. In 2001 he was awarded an honorary doctorate from the National University of Tucuman, Argentina.

Jim's research in Statistics and Econometrics covered a wide range of topics, including time series analysis, sample survey methodology, goodness-of-fit tests, probability theory, simultaneous equations models and the philosophy of statistics. Many of his papers appeared in top journals such as *Biometrika*, *Journal of the Royal Statistical Society*, *Journal of Applied Probability*, *Econometrica*, *Journal of the American Statistical Association*, *Annals of Mathematical Statistics* and *Annals of Statistics*. Although he is best known to academic statisticians and econometricians for his theoretical contributions, he was always concerned with the way in which statistical methods could be applied in practice and used to influence policy. His early work on testing for serial correlation was done in response to problems encountered in fitting regression models by members of Richard Stone's group at the DAE and later work on seasonal adjustment and the effect of the car seat belt law stemmed from his contacts in the civil service. More generally an underlying theme in much of Jim's work was the development of statistical methods that would be useful in practice. In reading his papers one never feels that he is using mathematics just for the sake of it. It is there for a purpose because there is an important problem to be solved. Similarly his talks and lectures did not dwell on unnecessary detail but rather tried to present the bigger picture and convey an intuitive understanding of what was going on.

As already noted, the Durbin–Watson test was developed at the beginning of Jim's research career when he was at the DAE.[2] The test is designed to detect first-order serial correlation in regression residuals. If such serial correlation is found, it might be 'corrected' by modelling the error as a first-order autoregressive process, a technique that had recently been proposed by Cochrane and Orcutt who were colleagues at the DAE. Alternatively the equation could be modified in other ways, perhaps by introducing more explanatory variables or changing the functional form. The von Neumann ratio had been developed a few years earlier to test against first-order serial correlation in a time series which, under the null hypothesis, is assumed to be normally distributed and serially uncorrelated. However, when applied to regression residuals its distribution depends on the explanatory variables used. The ingenious idea of Durbin and Watson was to develop a bounds test for which they were able to derive and tabulate the upper and lower limits for the critical values.

[2] J. Durbin and G. S. Watson, 'Testing for serial correlation in least squares regression, 1', *Biometrika*, 37 (1950), 409–28; J. Durbin and G. S. Watson, 'Testing for serial correlation in least squares regression, 2', *Biometrika*, 38 (1951), 159–78.

After joining the LSE, Jim worked on sample survey theory. For example, his 1953 *Journal of the Royal Statistical Society* article develops a general form for the estimation of sampling variances in multi-state samples with unequal probabilities.[3] He also collaborated with Alan Stuart, his closest colleague at the LSE, in producing papers on experimental surveys and on rank correlations.

Jim returned to time series testing in 1957, with the publication of an article in *Biometrika*.[4] In it he adapted the Durbin–Watson test for use in a system of simultaneous equations. Such systems had only recently been introduced into econometrics, and estimation by the method of two-stage least squares was not yet in widespread use. Jim's approach is based on the method of limited information maximum likelihood, which is technically more demanding, and what he did illustrated his capacity for devising a clever solution to a difficult problem. The intuition for his thinking may well have come from his ability to think in geometric terms, an approach which is now somewhat out of fashion.

The Durbin–Watson test was arguably the first diagnostic statistic to be routinely used by applied economists to assess the adequacy of their regressions. Unfortunately its success led to its being used for models where the underlying statistical assumptions did not hold. In particular it began to be quoted for regressions containing a lagged dependent variable. Although Jim's papers clearly excluded this situation, he felt a responsibility to put matters right and this led to his important 1970 *Econometrica* article on the h-statistic.[5] In order to encourage its use by applied researchers, the h-statistic was presented as a modification of the Durbin–Watson statistic that could be easily calculated from standard computer output. The general principle of this test was later recognised as a Lagrange multiplier procedure.

The Durbin–Watson test is concerned with first-order serial correlation. One way of testing higher order serial correlation is based on the cumulative periodogram. This, and the desire to get a distribution theory for it, provided the motivation for his work on boundary crossing problems

[3] J. Durbin, 'Some results in sampling theory when the units are selected with unequal probabilities', *Journal of the Royal Statistical Society, Series B*, 15 (1953), 262–9.

[4] J. Durbin, 'Testing for serial correlation in systems of simultaneous regression equations', *Biometrika*, 44 (1957), 370–7.

[5] J. Durbin, 'An alternative to the bounds test for testing for serial correlation in least-squares regression', *Econometrica*, 38 (1970), 422–9.

and the weak convergence of the empirical distribution function.[6] It further led to the development of a limiting distribution theory of Cramér-von Mises statistics for cases where parameters are estimated. This work was joint with Martin Knott of the LSE and appeared as two papers in the *Journal of the Royal Statistical Society*.[7] However, Jim was not satisfied with the underlying weak convergence theory. He therefore developed a new theory of weak convergence of stochastic processes and published this material in his Society for Industrial and Applied Mathematics book of 1973.[8]

Jim's 1975 paper with Brown and Evans proposed another regression diagnostic, this time for detecting structural change in a time series regression.[9] The test statistics are based on cumulating recursive residuals or their squares, and the underlying distributional theory has features in common with that of the cumulative periodogram. They are widely used in econometrics computer packages. The recursive residuals are the standardised one step ahead prediction errors obtained by running a regression recursively, with each observation added one at a time. The algorithm for computing the recursive residuals turns out to be a special case of a more general filtering algorithm, known as the Kalman filter. The application and generalisation of the Kalman filter was to play a central role in Jim's later work with Andrew Harvey and Siem Jan Koopman.

Jim's paper on errors in variables, published in 1954 in the *International Statistical Review*,[10] describes the construction of a test statistic that is a basic version of an exogeneity test in econometrics. A more general test was later developed by Jerry Hausman in a 1978 *Econometrica* article.[11]

[6] J. Durbin, 'Boundary-crossing probabilities for the Brownian Motion and Poisson processes and techniques for computing the power of the Kolmogorov–Smirnov test', *Journal of Applied Probability*, 8 (1971), 431–53; J. Durbin, 'The probability that the sample distribution function lies between two parallel straight lines', *Annals of Mathematical Statistics*, 39 (1968), 398–411.

[7] J. Durbin and M. Knott, 'Components of Cramér-von Mises statistics, 1', *Journal of the Royal Statistical Society Series B*, 34 (1972), 290–307; J. Durbin, M. Knott and C. C. Taylor, 'Components of Cramér-von Mises statistics, 2', *Journal of the Royal Statistical Society Series B*, 37 (1975), 216–37.

[8] J. Durbin, *Distribution Theory for Tests Based on the Sample Distribution Function* (Philadelphia, PA, 1973).

[9] J. Durbin, R. L. Brown and J. M. Evans, 'Techniques for testing the constancy of regression relationships over time (with discussion)', *Journal of the Royal Statistical Society, Series B*, 37 (1975), 149–92.

[10] J. Durbin, 'Errors in variables', *Review of the International Statistical Institute*, 22 (1954), 23–32.

[11] J. A. Hausman, 'Specification tests in econometrics', *Econometrica*, 46 (1978), 1251–71.

This test, which is widely used, is now usually referred to as the Durbin–Hausman test.

In 1963, Jim gave a presentation at the European meeting of the Econometrics Society in Copenhagen that showed how the full information maximum likelihood estimator in a simultaneous system of equations can be interpreted as an instrumental variable estimator. Although Jim did not publish his results at that time (partly because he could not find the assistance in producing a numerical example), it nevertheless had an impact on the econometric profession. The work was discussed in the econometrics textbook of Edmond Malinvaud and in an important paper by Sir David Hendry.[12] The Copenhagen paper was published twenty-five years later in *Econometric Theory*.[13]

The dominant time series paradigm during the 1970s and early 1980s centred on the Box–Jenkins methodology. Jim became convinced in the mid-1980s that the methodology based on structural or unobserved components time series models was the way forward in applied work. He was very supportive of the work being carried out at the LSE by one of us (Andrew Harvey). This research programme developed a complete methodological framework for unobserved components models, based on state space models and the Kalman filter. When Jim was asked by the UK Department of Transport if he was interested in carrying out a statistical investigation of the newly introduced seatbelt law he jumped at the opportunity to collaborate with Andrew Harvey in developing unobserved components models for this purpose. This led to an article in the *Journal of the Royal Statistical Society* describing the new methodology and a Report for the Department of Transport. The seatbelt law had been initially introduced for a three-year trial period and the Report had a strong influence on the decision to make it permanent.[14]

The seatbelt project included an analysis of time series of small counts, such as the number of van drivers killed each month. It sparked an interest in Jim to develop methods for the treatment of time series with non-Gaussian features. He started to collaborate with Siem Jan Koopman

[12] E. Malinvaud, *Statistical Methods of Econometrics* (Amsterdam, 1966); D. F. Hendry, 'The structure of simultaneous equations estimators', *Journal of Econometrics*, 4 (1976), 51–8.

[13] J. Durbin, 'Maximum likelihood estimation of the parameters of a system of simultaneous regression equations', *Econometric Theory*, 4 (1988), 159–70.

[14] J. Durbin and A. C. Harvey, 'The effects of seat belt legislation on road casualties in Great Britain: report on assessment of statistical evidence', Annexe to *Compulsory Seat Belt Wearing Report. Department of Transport* (London, 1985); J. Durbin and A. C. Harvey, 'The effects of seat belt legislation on British road casualties: a case study in structural modelling (with discussion)', *Journal of the Royal Statistical Association, Series A*, 149 (1986), 187–227.

who, having completed a PhD with Andrew Harvey, had moved on to become a lecturer at the LSE. The collaboration led to a series of important publications on nonlinear and non-Gaussian state space models from the mid-1990s onwards. Notable examples include the papers on importance sampling for state space models published in *Biometrika* in 1997 and *Journal of Times Series Analysis* in 2000.[15] Following on from this work, Jim was keen to write a book on state space methods with the aim of promoting the unobserved components alternative to the Box–Jenkins methodology and showing how the methods could be extended to deal with non-linear models. The book was published by Oxford University Press in 2001 with a second edition appearing in May 2012, just before Jim died.[16]

Although Jim's research interests had been sharply focused for most of his career, he latterly developed a broad interest in statistics and, beyond that, into science and philosophy. His reading convinced him that one could not understand the philosophical foundations of mathematics apart from the evolutionary origins of human reasoning. There is no doubt that he would have liked to have pursued these ideas further.

When Jim retired from the LSE, after nearly thirty-nine years of active service in the Department of Statistics, a special seminar was organised for him on 15 December 1988.

ANDREW HARVEY
Fellow of the Academy
DAVID BARTHOLOMEW
Fellow of the Academy

Note. In preparing this memoir we have drawn on the 1988 interview with Peter Phillips in *Econometric Theory* (see footnote 1), Siem Jan Koopman's obituary in *Journal of the Royal Statistical Society, Series A*, 175 (2012), 1060–4, the speech of Alan Stuart at Jim's retirement seminar at the LSE in 1988 and our own recollections as Jim's colleagues at the LSE. We would like to thank Siem Jan Koopman for comments on an earlier version.

[15] J. Durbin and S. J. Koopman, 'Monte Carlo maximum likelihood estimation for non-Gaussian state space models', *Biometrika*, 84 (1997), 669–84; J. Durbin and S. J. Koopman, 'Fast filtering and smoothing for multivariate state space models', *Journal of Time Series Analysis*, 21 (2000), 281–96.

[16] J. Durbin and S. J. Koopman, *Time Series Analysis by State Space Methods* (Oxford, 2001).

Appendix

The following is a list of Durbin's papers not included in the 1988 interview (see footnote 1):

J. Durbin, 'Statistics and statistical science (Presidential Address)', *Journal of the Royal Statistical Society, Series A*, 150 (1987), 177–91.

J. Durbin, 'Is a philosophical consensus for statistics attainable?', *Journal of Econometrics*, 37 (1988), 51–61.

J. Durbin, 'Optimal estimating equations for state vectors in non-Gaussian and non-linear estimating equations', in I. V. Basawa, V. P. Godambe and R. L. Taylor (eds.) *Selected Proceedings of Athens, Georgia, Symposium on Estimating Functions* (Hayward, CA, 1997).

J. Durbin, 'The state space approach to time series analysis and its potential for official statistics (The Foreman Lecture)', *Australian and New Zealand Journal of Statistics*, 42 (2000), 1–23.

J. Durbin, 'State space models', in A. Harvey, S. J. Koopman and N. Shephard (eds.), *State Space and Unobserved Component Models* (Cambridge, 2004), 3–25.

J. Durbin and S. J. Koopman, 'Monte Carlo maximum likelihood estimation of non-Gaussian state space models', *Biometrika*, 84 (1997), 669–84.

J. Durbin and S. J. Koopman, *Time Series Analysis by State Space Methods (2nd edition)* (Oxford, 2012: first edition 2001).

J. Durbin and S. J. Koopman, 'A simple and efficient simulation smoother for state space time series analysis', *Biometrika*, 89 (2002), 603–16.

J. Durbin and B. Quenneville, 'Benchmarking by state space models', *International Statistical Review*, 65 (1997), 23–48.

J. Durbin and B. Quenneville, 'Bayesian prediction mean squared error for state space models with estimated parameters', *Journal of Time Series Analysis*, 21 (1997), 219–36.

J. Durbin and D. Williams, 'The first-passage density of the Brownian motion process to a curved boundary', *Journal of Applied Probability*, 29 (1992), 291–304.

S. J. Koopman and J. Durbin, 'Fast filtering and smoothing for multivariate state space models', *Journal of Time Series Analysis*, 21 (2000), 281–96.

S. J. Koopman and J. Durbin, 'Time series analysis of non-Gaussian observations based on state space models from both classical and Bayesian perspectives', *Journal of Royal Statistical Society, Series B*, 62 (2000), 3–56.

J. R. Magnus and J. Durbin, 'Estimation of regression coefficients of interest when other regression coefficients are of no interest', *Econometrica*, 63 (1999), 639–43.

S. J. Koopman and J. Durbin, 'Filtering and smoothing of state vector for diffuse state space models', *Journal of Time Series Analysis*, 24 (2003), 85–98.