

Professor James Durbin has died on Saturday afternoon, 23 June 2012 in London, at the age of 88.

James Durbin was born in 1923, in Wigan, England. He was educated at St John's College, Cambridge. From 1950, he worked at the London School of Economics and Political Science until his retirement in 1988; he started as Assistant Lecturer, became Reader in 1953 and succeeded in 1961 Sir Maurice Kendall in the Chair as Professor of Statistics; Jim remained an Emeritus Professor of Statistics after his retirement. From 2007 he was Honorary Professor of University College, London (UCL), and Fellow to the Centre for Microdata Methods and Practice (CeMMAP at UCL). In 2001 he became Fellow of the The British Academy and in 2008 he received the Royal Statistical Society's Guy Medal in Gold (in Bronze, 1966 and in Silver, 1976) for a lifetime's achievement in statistics. He was President of the International Statistical Institute (1983-1985, elected honorary member since 1999) and President of the Royal Statistical Society (1986-1987). Furthermore, he was elected fellow of the Institute of Mathematical Statistics (since 1958), American Statistical Association (since 1960) and Econometric Society (since 1967). He was also Treasurer of the Bernoulli Society for Mathematical Statistics and Probability in the years 1975-1981. His various editorial duties included his role as Associate Editor for *Biometrika* (1964-1967), *Annals of Statistics* (1973-1975) and *Journal of the Royal Statistical Society, Series B* (1978-1981).

During his years at the LSE, he was also active for the Institute of Statisticians (as member of the Council, 1960-1963) before it merged with the Royal Statistical Society (RSS). Apart from being President of the RSS in 1986-1987, he was member of the Council for 15 years in the period 1957-1989 and was given the role of Vice President for a number of years. Also he was a member of the RSS Examinations and the RSS Research Section Committees for many years. He was a member of the International Statistical Institute (ISI) since 1955 and, during the years between 1981 and 1987, he was President-Elect, President and member of the Council of the ISI, successively. He was also a Chairman for various ISI Committees during a number of years.

His research work has made numerous contributions in Statistics and Econometrics; in particular, in the research fields of serial correlation (13 publications), general time series (31), econometrics (4), sample survey methodology (9), goodness-of-fit tests and sample distribution functions (13), probability (8), general statistical theory (8) and philosophy of statistics (3). His publications appeared in journals such as *Biometrika* (14 publications), *Journal of the Royal Statistical Society* (8 in Series A, 7 in Series B), *Journal of Applied Probability* (4), *Econometrica* (3), *Journal of the American Statistical Association* (2), *Annals of Mathematical Statistics* (2) and *Annals of Statistics* (1).

Jim Durbin started his academic education at Cambridge University as an undergraduate student, a member of St. John's College during the war years of WWII with his undergraduate contemporaries Denis Sargan and David Cox. He obtained a war-time degree in mathematics that included national service which Jim undertook at the Army Operational Research Group. After the war he did a diploma mathematical statistics at Cambridge with Henry Daniels as his supervisor; Denis Lindley, John Wishart, Frank Anscombe and David Cox were there as well. In 1948 Jim joined the new Department of Applied Economics (DAE) at Cambridge with Richard Stone as Director. At the DEA much 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, Theodore Anderson and Geoffrey Watson. In the summer of 1949 the young Australian researcher Geof 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 celebrated Durbin-Watson test statistic. In the same period, in 1950, Jim Durbin moved to the London School of Economics (LSE).

Professor Maurice Kendall had just been appointed as Professor of Statistics at the LSE and with his appointment an extra post of lecturer became available. Kendall phoned Daniels and Jim was given the job without any further formalities. During the first months of his position at the LSE, the work with Geof Watson was continued and they met in London and Cambridge to finish the two papers on testing for serial correlation that were published in *Biometrika*. The Durbin-Watson test has had an extraordinary impact, particularly on applied econometrics. Even now, a time series regression that does not quote the Durbin-Watson test value is a rare event. The impact of the Durbin-Watson test on regression analysis and on applied econometric work has been enormous throughout the years. Jim was pleased by it as he always believed that it was important to check whether the assumptions on which inference is based are satisfied.

The Durbin-Watson test is designed to detect first-order serial correlation from regression residuals. The ordinary least squares estimator has optimal properties when particular assumptions underlying the regression model are valid. These assumptions imply that the regression residuals are serially uncorrelated. The von Neumann ratio is designed to test for first-order serial correlation in a series. However, when applied to regression residuals its distribution depends on explanatory variables used in the regression. 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.

Although the Durbin-Watson test and his related work on testing for serial correlation has attracted much attention, Jim's earlier work concentrated on sample survey theory. For example, his *JRSS, Series B* article in 1953 develops a general form for the estimation of sampling variances in multi-state samples with unequal probabilities. During the early years at the LSE, Alan Stuart was his closest colleague and since the teaching load was low in those days, there was sufficient time for collaborative work. Their joint work on experimental surveys and on rank correlations were published as *JRSS, Series A* and *B* articles.

Later in the 1950s, Jim returned to time series problems. In 1957, his *Biometrika* article appeared in which he developed a version of the Durbin-Watson test for use in a system of simultaneous equations. It is a landmark paper and it typically shows the clever treatment of a difficult problem and Jim's intellectual capabilities. The success of the Durbin-Watson test also led to its use under circumstances where it was incorrect; for example, in regressions based on dynamic models with lagged dependent variables which became fashionable in the early 1960s. Jim felt that he ought to put this right. As a result, he developed the *h*-statistic for testing for serial correlation with lagged dependent variables as regressors in his 1968 *Econometrica* article. The general principle of this test was later recognised as a Lagrange multiplier procedure.

From his interests in testing for higher order serial correlation and the role of the Kolmogorev-Smirnov distribution theory for the cumulative periodogram (as developed by Maurice Bartlett in his 1955 book), Jim became interested in boundary crossing problems and published a series of papers on this topic in the *Journal of Applied Probability*. The cumulative periodogram and the desire to get an exact theory for it also provided the inspiration to work on the weak convergence of the empirical

distribution function. This work was published in 1973, in the Annals of Statistics. 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 JRSS, Series B (in 1972 and, also joint with Dr. Taylor, in 1975). 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 SIAM book of 1973, "Distribution Theory for tests based on the Sample Distribution Function".

Jim's paper on errors in variables, published in 1954 in the International Statistical Review (ISR), 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 Professor Jerry Hausman from MIT in a 1978 *Econometrica* article. This test has become known as the Hausman test or, more appropriately, the Durbin-Wu-Hausman test. Another ISR paper of Jim's, in 1960, enhanced a procedure in linear algebra for recursively computing the solution to an equation involving a Toeplitz matrix. This fast algorithm "of order  $n$ -squared" is widely known as the Durbin-Levinson method and is implemented in most time series software packages. 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 formally in a paper (because he could not find the assistance in producing a numerical example), it nonetheless had an impact on the econometric profession. The results have been exploited by Sir David Hendry in his work on full information maximum likelihood and by Professor Hausman in his *Econometrica* article of 1975 (in which he acknowledges Jim's contribution). The results were also discussed in the *Econometrics* textbook of Professor Malinvaud. The Copenhagen paper was published 25 years later in *Econometric Theory*.

Although almost all of Jim Durbin work was driven by theory, he always felt that his work mostly arose because of the desire to solve specific problems; he was keen to obtain solutions that applied workers in statistics and econometrics could implement. He therefore found it important to present a numerical example in his paper (although he had no interest whatsoever in computing work). His important JRSS, Series B paper from 1985 with Brown and Evans, on recursive residuals and detecting structural changes in a time series, is a nice illustration of how Jim identified the importance of a practical problem that was not recognised at the time but received much attention years later. Practical empirical problems were also taken seriously by Jim which is evidenced by his work on the seasonal adjustment of time series in separate projects with Murphy and Kenny. His influential empirical work with Andrew Harvey, his colleague at the LSE in the Department of Statistics for many years, about the effects of seat belt legislation on road casualties in Great Britain was particularly dear to him. He wanted to show how time series methods should be used to analyse problems in the real world that matter and that are important in policy analysis.

Although Jim liked to teach the time series courses at LSE which were partly based on the Box-Jenkins methodology (he particularly liked the "clean" algebra of it) for time series analysis, he was convinced that the methodology based on structural or unobserved components time series models was the way forward in applied work. Andrew Harvey developed a complete methodological framework for this model class while at the LSE. This time series methodology relies on state space models and the associated Kalman filter; a detailed treatment is given in Harvey's 1989 monograph. Jim was very supportive of these developments.

The seatbelt project with Andrew Harvey included an analysis of time series of small counts (number of monthly serious accidents with vans in Great Britain). It sparked an interest in Jim to develop methods for the treatment of time series with non-Gaussian features. Jim also liked the research that was taking place in the early 1990s under the supervision of Andrew Harvey. He was therefore eager to participate and we started to collaborate during my post-doctoral research at the LSE. The collaborations with me and others have led to his publications on state space models from the mid 1990s. Moreover, Jim was keen to write a book on state space methods with the aim to present an alternative to the Box-Jenkins methodology of time series analysis. Our book was published by Oxford University Press and appeared in 2001. In the last years we have worked on the second edition of the book that has appeared in May 2012. He was very joyful when the second edition came out and he offered me to drink some glasses of champagne at his home. Unfortunately, we have not been given the time to do this.

Jim had a broad interest in science and philosophy but he also had interests in politics and sports. He read many books on science. In particular, he followed developments in molecular biology and ecology; research fields in which his children Richard and Joanna play leading roles. A nice illustration of Jim's original thinking is highlighted in the RSS Significance (September 2009) interview by Julian Champkin where Jim reflects upon his 1985 paper "Evolutionary origins of statisticians and statistics" that was published in a book to mark the centennial year of ISI: *It appears self-evident to me that if you want to understand the philosophical foundations of mathematics you have to start with the evolutionary origins of human reasoning ... I formed the view that the whole of philosophy should be based on biological, Darwinian evolution. I thought that a university degree course in philosophy should start with a good course on biological evolution and should begin by asking the question where does the human intellect come from.*

Professor Durbin's achievements have been praised by many. For example, Professor Peter C. B. Phillips wrote as an introduction to his ET interview with Jim in 1986: *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. All of his work has been guided by an unswerving principle of relevance, commencing with his famous collaboration with Geof Watson; and it has found empirical application throughout the social sciences. His contributions, more than any others, have helped to turn professional attention to the importance of diagnostic testing in regression. His early work on testing for serial correlation stands as an established landmark and his later work on the same subject has opened up fresh fields of research for econometricians ... In the English and in the international communities of statisticians, Jim Durbin is a distinguished and honored scientist.*

When Jim retired from the LSE, after 38 and 2/3 years of active service in the Department of Statistics, a special seminar was organised on 15 December 1988, Sir Maurice Kendall attended the seminar amongst many others. Alan Stuart praised the clarity of language in his papers and his teaching skills: *In all the discussions that I have had with students and others no one has ever complained to me that he could not understand what Jim wanted to do. Of course, understanding the mathematics with which he did it was sometimes a different matter.* At the same seminar, Andrew Harvey praised Jim's originality in research but also: *Jim's contributions have been primarily theoretical. However, underlying his work there has always been a clear understanding of what is important from the practical point of view. In other words, one never feels, in reading his work that*

*he has got into mathematics simply for the sake of getting to the mathematics. It is there for a purpose because he wants to solve a problem which actually has some practical importance.*

At the Royal Statistical Society Annual General Meeting on 2 July 2008, Jim was awarded the 2008 Royal Statistical Society's Guy Medal in Gold with the citation: *The Guy Medal in Gold is awarded to Professor James Durbin FBA for a life-time 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.*

Jim Durbin met his wife Anne in 1957; they have three children, Joanna, Richard and Andrew. They have lived and worked in Hampstead, London with much pleasure from the early years onwards. They have been regular, if not weekly, visitors to theatres, operas and museums in central London but also to out-door festivals in the summer and to yearly fixtures such as Wimbledon. Furthermore, their visits to their second home in Suffolk have been very special to them. Jim and Anne have been enthusiastic travellers and they have shared many of their memories with me about their visits to so many places in the world, and particularly in the United States, where Jim was invited as a visiting professor. They also shared many good memories about their holidays to France and Italy by car.

In 1950, the main reason for Jim to become an academic was because he thought that the long holidays would give him plenty of time for mountaineering. Since Anne was not so keen on mountaineering they decided to switch to skiing as the sport for their family holidays. At the age of 60 Jim climbed Kilimanjaro (more than 19,000 feet high, the highest mountain in Africa) after three months of preparation that mainly consisted of cycling between his home in Hampstead and his work in central London.

I will remember Jim as a very clever, sharp and proud man with a lot of humour. It has been highly enjoyable to work with him over a time span of twenty years. He was a demanding co-worker but advancing in research requires talent and workmanship. Many fond memories of working with Jim will remain forever.

### References

*The ET Interview: Professor James Durbin.* 1988, by Peter C. B. Phillips and James Durbin, *Econometric Theory*, 4, p 125-157. <http://www.jstor.org/stable/3532030>

*Jim Durbin, how did statisticians evolve ?* 2009, by Julian Champkin, *RSS Significance*, 6, p130-131.

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For this piece I have consulted the ET Interview, the speeches of Andrew Harvey and Alan Stuart at Jim's retirement seminar at the LSE in 1988, the RSS Significance interview by Julian Champkin and my own recollections of our many conversations at lunches and dinners in London while working on our papers and the first and second editions of our book. I would like to thank Andrew Harvey for his comments on an earlier version.