The Economic and Social Review, Vol. 14, No. 3, April 1983, pp. 161-164

ROBERT CHARLES GEARY – AN APPRECIATION

Roy Geary, Ireland's greatest statistician, died in Dublin on 8 February 1983, after a long life devoted to mathematical statistics. He was born on 11 April, 1896 and was educated at University College, Dublin, 1913-1918, obtaining a B.Sc. and an M.Sc., both with first class honours, in 1916 and 1917, respectively. In 1918 he was awarded a Travelling Studentship in Mathematics and attended the Sorbonne in Paris, 1919-1921. He was appointed to a lectureship in Mathematics at University College, Southampton, in 1922 but returned to Dublin in 1923 as a statistician in the Statistics Branch of the Department of Industry and Commerce, and remained there until 1949, apart from a brief period as Senior Research Fellow in the Department of Applied Economics in Cambridge, 1946-1947. He was Director of the Central Statistics Office in Dublin from 1949 to 1957, when he moved to New York for three years to head the National Accounts Branch of the United Nations Statistical Office. He returned to Dublin in 1960 to the Economic Research Institute, where he was to spend the rest of his life, as Director until 1966, as consultant thereafter. Among the many honours awarded him were three honorary doctorates and honorary fellowships of the Royal Statistical Society and American Statistical Association. He was President of the International Statistical Institute and a Council member of the International Association for Research in Income and Wealth. He was elected Fellow of the Econometric Society in 1951 and served as Council member from 1962 to 1964.

Roy's first paper was published in 1925 at the comparatively late age of 29. Fisher was in the early stages of his fundamental work and the celebrated collaboration of Neyman and Pearson had not begun. Roy took no part in the major controversies on fiducial probability and inference which were soon to come but followed the struggles with keen interest. The greatest influence on him was Fisher. He admitted in a letter of 1976: "The luckiest thing that happened to me was that my research lifetime coincided with most of that of Fisher's. Everything is in Fisher. One only had to dig it out a bit." He was obviously greatly attracted to the Neyman and Pearson approach, however, and used it consistently. Other authors who were relatively frequently cited included, in particular, Frisch and Bartlett. He was in contact with many of the greatest statisticians of the day, including his close friends Wishart, Kendall and Frisch.

As a tribute to him on his eightieth birthday, an account of much of his theoretical work was published.[1] It is clear that his most creative and significant years were from 1930 to 1956. Looking over the work of this period as a whole, three distinct but overlapping themes emerge: (a) the sampling theory of ratios (1930b, 1933, 1944b), (b) testing for normality and calculating the robustness of inference formally based on normality (1935b, 1935c, 1936a, 1936b, 1938, 1941b, 1947, 1947a, 1947c, 1956b), (c) the estimation of relationships between variables measured subject to error (1942a, 1942b, 1943a, 1943c, 1948, 1949a, 1953). This choice of problems illustrates his deep desire to direct his keen mathematical skill and imaginative flair towards problems of great practical importance. Most of the contributions he made under these three headings are of lasting importance. On stochastic ratios, 1930 and 1944 are two of the few essential references in the field. His normality test statistic, the mean deviation divided by the standard deviation, remains a classic test, has optimal asymptotic properties against Laplace alternatives and is generally widely recommended.[2] His robustness studies were ahead of their time, both in the generality of the theoretical approach and in their appreciation of the importance of the problem. In this he was not encouraged by Fisher who held the curious view expressed in his enormously influential *Statistical Methods for Research Workers*, first published in 1925, that, while departures from normality, unless strongly marked, could only be detected by large samples, non-normality made "little difference to tests on other questions" (13th edition, 1958, p. 52). This contrasts with results which Geary had established and which are now common knowledge, e.g., parent positive skewness leads to too frequent acceptance of a left hand alternative (1936a, 1947c). Further, as follows from general formulae in Geary (1947c), the approximation to order n^{-1} of var z ($z=\frac{1}{2}\log F$) is $\left(\frac{\beta_2-1}{4}\right)\left(\frac{1}{n_1}+\frac{1}{n_2}\right)$ for two independent samples drawn from the same population, an expression which generalises Fisher's normal approximation for $\beta_2=3$, and suggests that positive kurtosis would lead to too frequent rejection of variance equality on uncritical use

1. J.E. Spencer, "The Scientific Work of Robert Charles Geary", *The Economic and Social Review*, 7, April 1976. This article includes a list of his publications to 1976 and should be consulted for further details of works cited in this Appreciation.

2. See, for example, V.A. Uthoff, "The Most Powerful Scale and Location Invariant Test of the Normal Versus the Double Exponential", *Annals of Statistics* 1, 1973; R.B. D'Agostino and B. Rosman, "The Power of Geary's Test of Normality", *Biometrika*, 61, 1974; and J.L. Gastwirth and M.E.B. Owens, "On Classical Tests of Normality", *Biometrika*, 64, 1977.

of normality assumptions.[3] Regarding his contribution to the estimation of relationships, his early ideas, while theoretically important, have not proved of great practical value but his instrumental variables technique (1949a) is fundamental. The 1953 paper, with certain variables controlled and, accordingly, non-random as measured, remains an interesting curiosity. A striking feature of much of this work and, indeed, of much of all his work, is Roy's reluctance to allow significant intrusion of the a priori, so common in econometrics (see also 1963, 1966b, the latter actually 1967). He wrote privately of actual data misbehaving because in real life our hypotheses are invalid. While he took great delight in mathematics as an art form, he had no use for mathematics in statistics or economics unless clearly relevant to a statistical or economic problem. Certainly, with respect to economics, he thought such cases rare and that the mathematics (or, worse, "pseudo-mathematics") typically dressed boxes, empty of real economic content.

The variety of his interests and the independence of his mind were immense. He contributed the contiguity ratio, a measure of spatial autocorrelation, and some sampling theory to geography (1952b, but actually 1954). His analysis of this problem, which is inherently more complicated than one-dimensional temporal autocorrelation, has been influential. It is reprinted in a book of readings on statistical geography[4] and is quoted by workers in a variety of disciplines besides geography, including sociology and economic history. It is also of interest to historians of statistics as one of the first papers presented to the Association of Incorporated Statisticians Limited (the precursor of the Institute of Statisticians) which "assumed it to be a learned society and which made few concessions to the level of mathematical ability required to understand the paper. It was also one of the first papers to advocate the use of principal component analysis to provide orthogonalising transformations of correlated observations".[5] Roy's delight in mathematical elegance is reflected in his treatment of sampling n_1 from a universe of $n_1 + n_2$, rather than the usual n from N (1927). An idea of the kind of ingenious puzzle

3. On Geary's contributions to robustness studies, see E.S. Pearson and N.W. Please, "Relation between the Shape of Population Distribution and Robustness of Four Simple Test Statistics", *Biometrika,* 62, 1975; K.O. Bowman, J.J. Beauchamp, L.R. Shenton, "The Distribution of the t-statistic under Non-normality", *Int. Stat. Rev.* 45, 1977, who speak of the remarkable accuracy of Geary's approximations to the necessary modifications to standard table probabilities; D.L. Wallace, "Asymptotic Approximations to Distributions", *Annals Math. Stat.* 29, 1958 and the series of articles by Gayen, *Biometrika,* 1949-51.

4. *Spatial Analysis*. "A Reader in Statistical Geography" edited B.J.L. Berry and D.F. Marble. Prentice-Hall, Inc., 1968. See also B.J.L. Berry, "Problems of Data Organisation and Analytical Methods in Geography", *Journal of the American Statistical Association* 66, September 1971.

5. J.N.R. Jeffers, "A Basic Subroutine for Geary's Contiguity Ratio", *The Statistician*, 22, 1973.

that intrigued him can be found in 1944a where he compared Pitman's "closeness" and efficiency and demonstrated an equivalence result under bivariate normality irrespective of correlation. As an application, he found the "closest" estimate of the number of cars (n) in a town, n large, numbered consecutively 1 . . . n, a random selection of m of which were observed (i.e., of b in a uniform [0, b] situation). An example of his exacting requirements for realism is found in his informal paper (1947b), written at a time when he was at the height of his intellectual powers, where he asked if the great depression of the 1930s could have been predicted using modern methods and pre-1930 data. His exuberance is apparent in the same paper, his sometimes whimsical humour appears in his 1941(b) note, and his deep concern for social issues and problems are revealed in the great majority of all his papers, more overtly, perhaps, in the more recent.

His immense zest for work never diminished. Of his some 112 publications, more than half were published after his sixty-fifth birthday. He spent the whole of his adult life deeply and creatively immersed in theoretical and applied statistics, not just because he found immense satisfaction therein but also, as his friend, E.S. Pearson, wrote concerning his great Dublin predecessor "Student", because he knew that it was a job that needed doing and was worth doing well.

JOHN E. SPENCER
New University of Ulster.