# OSKAR ANDERSON, 1887–1960

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Born 2 August 1887 in Minsk, Russia; deceased 12 February 1960 in Munich, Germany. These dates span a web of drama and colour both in personal life and scientific career. The course of outer events in Oskar Anderson's life reflect the turbulence and agonies of a Europe torn by wars and revolutions. His scientific work, always marked by personal involvement, is of sufficient stature to be of lasting interest, in part along with the epochmaking developments in statistics during the first decades of this century, in part independently of these developments. Some of Anderson's endeavours were ahead of his time, along lines that have not yet received adequate attention. Thus his emphasis on causal analysis of nonexperimental data is a reminder that this important sector of applied statistics is far less developed than descriptive statistics and experimental analysis. In an appraisal of Anderson's work, this aspect is highly significant.

Anderson's ethnic origin was Baltic-German. We follow him from his school years in Kazan, where his father was university professor of Finno-Ugric languages. He graduated from secondary school in 1906 with a gold medal, studied mathematics for a year at Kazan university, and entered in 1907 the Economic Faculty of the renowned Polytechnic Institute of St. Petersburgh (now Leningrad), and studied economics for five years. His interests were in the broad area that connects economics and statistics, and in these formative years he developed two main specialities: time series analysis and sampling surveys. As a pupil of A. A. Chuprov he submitted in 1911 a diploma thesis on correlation analysis of time series data. In the summer of 1915 he did field work as sampling surveyor, participating in a scientific expedition to Turkestan for an economic-technical study of the irrigation system of the Ferghana oasis. During the years 1912–17 he was teacher in a commercial secondary school in Petersburgh. During and after the Russian revolution he moved about, first inside Russia and then, leaving his country as a refugee, working as a teacher and scientific specialist. As statistician in a big cooperative center in the Ukraine he edited a number of monographs on the economic conditions in South Russia; in 1918 he qualified for the habilitation degree in mathematical-statistical methods at the Institute of Commerce at Kiev; at the same time he worked at the Demographic Institute of the Ukrainian Academy of Sciences; via Constantinople he came in 1921 to Budapest, where he founded and led a secondary school. From 1923 onwards he was a member of the Supreme Statistical Council in Bulgaria, the country where in 1924 he found stable ground under his feet. During the years 1924–34, at the Institute of Commerce at Varna, he taught statistics and several economic subjects, from 1929 as professor of economics and statistics. Then follows a period

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of intense activity. He goes deeply into econometric research, and in 1932 becomes one of the founders of the Econometric Society. In 1933 he goes to Germany and England on a Rockefeller stipend. In 1935 comes his statistical textbook *Introduction to Mathematical Statistics*, published in German. From 1935 he is director of the Statistical Institute for Economic Research at the State University of Sofia. Under his directorship, the institute publishes some 50 monographs and books on the economic conditions of Bulgaria; in several capacities—one being statistical expert to the League of Nations—he writes many articles and memoranda on statistical methods. In 1940 the Bulgarian government sent him to Germany to study the system of rationing. In 1942 the University of Kiel called upon him to become professor of statistics; moreover, he headed the department for Eastern Studies at the Kiel Institute of World Economy. From 1947 he was professor of statistics at the University of Munich.[1]

Dangers and hardships were Anderson's lot in World Wars I and II. When leaving Russia he lost a daughter, and a son died not long afterwards. A second son died in World War II as a paratrooper. Anderson was shattered but not crushed by the hard blows of fate. It is characteristic of his moral integrity that he did not allow politics to interfere with his scientific work, and his loyalty in personal contacts was beyond praise. Typical instances are on record, from the refugee years around 1920 as well as from the Nazi period in Germany.

Dominant features in Anderson's scientific profile are his intense engagement in his work, and his strong belief in the mission of statistical method in the socio-economic area. In particular, there is first the large volume of Anderson's published work: in all some 150 items if minor articles and book reviews are included. The appended bibliography is a selection, in the main compiled from lists edited by Anderson himself.[2] There is further the high level of aspiration: in theoretical research he made significant contributions towards developing new approaches, and his applied work is marked by a keen desire to make full use of the best possible techniques. Typical in this respect is his systematic use of random sampling in the surveys in Turkestan in 1915 and later in Bulgaria (1929d). Best known among his theoretical contributions is the variate difference method, which was introduced independently by Anderson and "Student"-Gosset in 1914.[3] Briefly stated, when studying the intercorrelations, interregressions etc. of a set of time series the device is to analyse not the series themselves

[1] The present account of Anderson's life borrows material from his pupils, to whose obituary articles [1]-[4] reference is made for documentation and further details. For reading my article in manuscript and for the ensuing helpful comments, especially towards an appraisal of Anderson's work, where my views are more independent, I am indebted to Professors O. Anderson, Jr., Mannheim; E. Fels, Pittsburgh; R. Gunzert, Frankfurt a. M.; H. Kellerer, Munich; S. Sagoroff, Vienna; and H. Strecker, Tübingen.

[2] See [5] and the 3rd edition of his second text-book (1954a).

[3] "Student" [6] was first to present and apply the device, while Anderson (1914) has the priority in making use of mathematical expectations to establish its rationale; see also (1929c), p. 53. The new point was the use of successive differences; first differences had been used earlier in regression analysis. For later developments, see [7].

but their consecutive differences with regard to the time variable; typical assumptions are that a given time series $x_t$ may be written

$$x_t = P(t) + \epsilon_t , \qquad t = 0, \pm 1, \pm 2, \cdots , \tag{1}$$

where $P$ is a polynomial in $t$ of finite order, and the residual component $\epsilon_t$ is a sequence of random variables that are independent and all have the same distribution. Third, there is the polemical pitch in many of his articles. The use and abuse of index numbers is a favourite topic (1937), (1950c), (1952). A consequential contribution of the 1920's is his criticism of the Harvard business barometer (1929b), his main argument being that the underlying time series decomposition was a shallow and too mechanical approach. Fourth, and finally, I refer to Anderson's educational work. His statistical *credo* is voiced in his two textbooks (1935), (1954): the great responsibility of the statistician is to obtain accurate data, and to use sound methods to analyse the data. At Munich, in the last period of his life, educational problems were in the center of his interest (1949d), (1956a). It is largely thanks to Anderson's initiative and efforts that Germany after World War II has been making headway in restoring and developing statistical teaching in the socioeconomic sciences.

The main strength of Anderson's scientific *oeuvre* lies, I think, in the systematic coordination of theory and application. Only to a relatively small extent does his importance derive from specific contributions, such as the variate difference method, or his work in the 1950's on nonparametric methods (1953a), (1955b), (1956b). His most fruitful period was the early and middle 1930. The peak is perhaps marked by his paper on the quantity theory of money (1931a). The paper is pioneering in subjecting the theory to statistical tests on the basis of time series data, and is of considerable historical importance also because his articulate discussion of residuals and their properties sheds light on the gradual evolution of regression methods. Anderson writes the basic relation in two ways,

$$M_i = KP_i + \eta_i ; \qquad P_i = (1/K)M_i - (\eta_i/K) \tag{2a–b}$$

where $M_i$ is the money in circulation in the $i$th time period, $K$ a constant, $P_i$ the price index, and $\eta_i$ an error term that he refers to as a "disturbance" (Störung) and interprets as a random variable. Relation (2b) is statistically estimated by the regression of $P$ on $M$, and in a key passage (pp. 538–541) Anderson postulates that $\eta_i$ has mathematical expectation zero, and says that (2b) "follows immediately" from (2a). This last conclusion shows that Anderson deals with the residuals as measurement errors, as "errors in variables," not as "errors in equations" that would allow the twofold interpretation of being due to neglected causal factors, and of having zero expectation since they constitute the deviation from the conditional expectation of the left-hand variable. More precisely, the residuals cannot be interpreted as "errors in equations" both in (2a) and (2b), for conditional mathematical expectations and theoretical regressions are not reversible in the sense of (2a–b), as has been well known since the beginnings of correlation theory [8]. Thus we see from (2) that model construction had begun to take deviations between theory and observation into explicit account as random variables, but the statistical implications were only partly understood. It is tantalizing that Anderson came very near to an explicit formulation of the question whether it is $M$ that influences $P$ or $P$ that influences $M$, two hypotheses about causal directions that can be formulated as in (2a–b), and equally tantalizing that only a few years later Holbrook Working [9] found a statistical device that can be used for discriminating between such causal hypotheses, a device that was left unnoticed for some 25 years.[4]

It is no easy task to coordinate theory and observation in applied work. Anderson was well aware of the difficulties. In this vein is his constant warning that ever so refined statistical techniques are of no use unless they are applied to reliable observations. In the same vein is his critical attitude towards the modern tendencies of developing statistical theory for theory's own sake. His sneers in this direction had a special sting when referring to some of the lofty developments of econometrics. To comment upon this last point, Anderson's scepticism, valid or not, was partly intuitive. Econometrics in the 1920's and early 1930's was a melting pot for new developments, but the time was not yet ripe for an adequate treatment of some of the ensuing problems. The situation is amply illustrated by Anderson's work on the variate difference method. The residual assumptions in (1) are often too narrow; possibilities for a rigorous treatment of more realistic assumptions (such as autocorrelation in the residuals) did not arrive until 1933 when Kolmogorov [10] strengthened the mathematical basis of probability theory and thereby laid the foundations for the theory of stochastic processes. Another case in point, more important with regard to the general developments in applied statistics, is Anderson's emphasis on correlation and regression methods for purposes of causal analysis. In accordance with the general trend of econometrics he makes a gradual shift from correlation to regression, as is clearly seen from his textbooks of 1935 and 1954. Similarly, his early works (1929c), (1931b) involve half-truths in line with the famous dictum "Correlation is not the same as causation"; later on he realizes that regression analysis is an important tool for the empirical assessment of causal relationships. His treatment of the basic questions is somewhat vague and intuitive, and to some extent it had to be at the time. As illustrated by (2), model builders had begun to take residual errors into explicit account; the transition from exact to disturbed relationships was a radical generalization of the model, and so was the ensuing reinterpretation of exact forecasts as stochastic forecasts in terms of conditional expectations; the generalization had implications at a basic level that could be understood and developed only gradually. There is here a direct connection between the situation in (2a–b) and the basic problems about "simultaneous equations" that later on have been much discussed in econometrics.[5] For example, if we consider a theoretical autoregression, say

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[4] See [16] for a detailed discussion.

[5] Specific reference is made to the dualism between causal chain systems [11] vs. interdependent systems [12]. For a review and development from the present point of view, see [14]-[16].

(3) $y_t = \alpha\eta_{t-1} + \epsilon_t$ with $E(\eta_t \mid \eta_{t-1}) = \alpha\eta_{t-1}$, $t = 0, \pm1, \pm2, \cdots$,

it follows under very general conditions (a) that $\alpha$ can be consistently estimated by the least squares regression of $y_t$ on $y_{t-1}$, and (b) that

(4) $y_t = \alpha^2\eta_{t-2} + \epsilon_t^*$ with $E(\eta_t \mid \eta_{t-2}) = \alpha^2\eta_{t-1}$ and $\epsilon_t^* = \epsilon_t + \alpha\epsilon_{t-1}$.

A rigorous deduction of the substitutive relation (4) requires some general theorems on conditional expectations and stochastic processes first established by Kolmogorov [10].

Oskar Anderson in his most active years was one of the leaders of econometrics, and thereby a pioneer in a broad sector of applied statistics: causal analysis on the basis of nonexperimental data. The same period, say from 1915 to 1940, was one of epochmaking developments in other sectors of statistics, with R. A. Fisher and J. Neyman for leading names, developments that in common parlance constitute "modern statistics" and are too well known to be elaborated here. A point I wish to stress is that the powerful methods of "modern statistics" are primarily designed for three broad sectors of applied statistics: (i)-(ii) description and causal analysis on the basis of experimental data, and (iii) description (by sampling techniques) on the basis of nonexperimental data. Sector (iv), causal analysis of nonexperimental data—an area where the model builder is confronted with more difficult problems in specifying the stochastic structure of the models as well as in their statistical treatment—has long been neglected by the cadre of professional statisticians.[6] This is clearly seen if Anderson's textbooks, with their emphasis on sector (iv), are compared with the textbooks of "modern statistics", with their emphasis on the three other sectors. In the last ten years or so sector (iv) has gradually come forward, but it is still relatively underdeveloped.

We have described Anderson as a pioneer in a difficult and important area of statistics, or perhaps as a forerunner rather than a pioneer, for the area was not yet ripe for systematic development. The handicap only makes his work so much the more significant, and so do other handicaps of a more local nature. One is the antitheoretical attitude of statistical science in Germany in the beginning of this century. After the flourishing period of German statistics in the 19th century with names like Lexis in social statistics and statistics in general, Becker, Knapp and Zeuner in demography, Paasche and Laspeyres in economics, Weber and Ebbinghaus in psychology it is something of a mystery how the development could stagnate so rapidly. And not only this; the socioeconomic sciences in Germany were the arena of an unfruitful struggle between two lines of thought. A typical example is sociology, where the "historical" school had Max Weber as leading name, and the "systematic" school was headed by Georg Simmel. What I am thinking of here is that model building was almost completely nonexistent in the camps that were lined up in the "Methodenstreit", while—on the contemporary international scene—model building had already become the vehicle for steady progress in economics and econometrics. It would seem that

[6] See [13] for an elaboration of the argument.

Anderson's contributions in the direction of model building were hampered by the "Methodenstreit". Yet the germs are there, and, even if the seedlings got mixed with some weeds, in a general statistical setting that allows us to view the principles and methods at issue as applicable not only in econometrics but over the entire area of nonexperimental model building. These germs emerge as Anderson's most valuable and important contribution. I wish to pay personal tribute to the inspiring influence of this aspect of Anderson's work.

Oskar Anderson's scientific status was marked by several distinctions, among those:

Honorary Doctor at the University of Vienna;
Honorary Doctor at the Institute of Economics, Mannheim;
Honorary Member of the Royal Statistical Society;
Honorary Member of the German Statistical Society;
Founder and Fellow of the Econometric Society;
Member of the International Statistical Institute;
Fellow of the American Statistical Association;
Fellow of the Institute of Mathematical Statistics.

Anderson was a man of grandeur, both in his work and his personal appearance. His tall, handsome and somewhat stout figure was seen at several scientific meetings after World War II. Particularly dear to me are the memories from the Scandinavian week at Munich University July 1958, when I had the privilege of visiting him in his own milieu: the institute that he had founded, his graduate seminar, and his large group of students.

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