THE MEETING OF THE ECONOMETRIC SOCIETY IN CINCINNATI, OHIO, DECEMBER, 1932

THE Econometric Society met jointly with the American Statistical Association in Cincinnati, Ohio, December 29–31, 1932. The program was featured by Professor Irving Fisher's presidential address, a paper entitled "Interrelations of Demand" by Professor Henry Schultz of the University of Chicago, and a symposium on statistical forecasting at which four papers were presented. Attendance at the sessions reached a new high mark for Econometric Society gatherings. In his presidential address, entitled "Statistics in the Service of Economics," Professor Fisher said in part:

"A young economist in a western university, who sees eye to eye with me as to methodology, shocked and pained me about twenty years ago when he told me that his own enthusiasm had been so damped that he had practically given up his original life ambition of getting recognition for his contributions toward making economics into a true and useful science. But he was too easily discouraged. For, even at that time, those of us who had still earlier entered economics from the approach of the natural sciences, as contrasted with the approach from philosophy or history, had already noticed a great change. And today, we suddenly wake up to realize that the methods which have made physics a science have at last taken a vigorous hold on the rising generation of economists. To illustrate, I need only mention among many others Frisch, Divisia, Rueff, Schumpeter, Keynes, Bowley, Amoroso, Gini, Haberler, Leontief, Zawadzki, Kondratieff, Hotelling, Moore, Schultz, Roos, Crum, Ezekiel, and Rogers.

"Moreover, the establishment of the international Econometric Society two years ago, the meetings it has since held in Europe and America, and its journal, ECONOMETRICA, to appear next month, signalize this new birth of the scientific spirit in economics.

"As I understand it, this new outburst of the scientific spirit is not a new school but simply an adaptation to economics of methods already nobly tested in the natural sciences. I hope it may mark the beginning of the end of "schools" in the sense of partisan groups or cults. Both the Austrian deductive school and the German historical school have now ceased to command much enthusiasm; for some time the effort has been to find a satisfactory way to join together theoretical and historical studies. This effort has found expression through mathematics, and statistics, and mathematical statistics, the mathematics to express theory and the statistics to express historical facts.

"The Econometric Society, as stated in its constitution, stands for 'the advancement of economic theory in its relation to statistics and mathematics.' No one today needs to apologize for, or even defend, either statistics or mathematics as legitimate and helpful instruments in the service of economics. Both are found abundantly in any modern economic journal.

"It is sometimes said that the ability to predict is the final test of science. Unfortunately, as yet, neither economic laws nor economic data are sufficiently known to enable economists to make safe predictions. In both respects it is still a backward science as compared with many others. What we need in economics, or that branch of economics which we now call economic theory, is more of the old, old method which made astronomy, physics, chemistry, and recently biology, into true sciences. That goal, as I interpret the rising generation of students of economic theory, is where they are tending. Moreover they know where they are going and they are on their way."

The main body of Professor Schultz's paper "Interrelations of Demand"[1] was devoted to a detailed statistical analysis of the interrelations of the demands for the four feed crops, barley, corn, hay, and oats, for the period 1896–1914. The analysis was undertaken with the following objectives in view: (1) to compare the theoretical properties of demand functions for competing and completing goods, (2) to analyze the concrete statistical demands for the foregoing commodities with the view of determining which of them are completing and which are competing, (3) to see whether and to what extent the theoretical relations are reflected in the observations, (4) to call attention to certain new problems in statistical methodology, and (5) to indicate the practical significance of studies in the interrelations of demand, especially their bearing on the problem of taxation.

The theory underlying Professor Schultz's statistical work may be summarized as follows:

Let the total utility function of an individual be

$$\phi = \phi(x_1, \cdots, x_n), \tag{1}$$

where $x_1, x_2, \cdots$, are quantities of commodities $(X_1), (X_2), \cdots$. Then any two commodities (X_i) and (X_j) may be classified as completing, independent, or competing, according as

$$\phi_{x_ix_j} \equiv \frac{\partial^2\phi}{\partial x_i x_j} \gtreqless 0. \tag{2}$$

To translate (2) into conditions on the demand functions, we make use of the well-known relation

[1] To be published in the *Journal of Political Economy.*

$$\phi_{x_i} = \frac{\partial \phi}{\partial x_i} = my_i, \tag{3}$$

where y_i is the price of x_i and m is the final degree of utility of money, which is assumed to be constant.

By virtue of (2), two commodities are defined as completing, independent, or competing, according as

$$\phi_{x_i x_j} = m \frac{\partial y_i}{\partial x_j} \gtreqless 0, \tag{4}$$

where

$$y_i = y_i(x_1, \cdots, x_n) \tag{5}$$

is the demand function for the i-th commodity.

Since the function ϕ is assumed to exist, it follows that $\phi_{x_i x_j} = \phi_{x_j x_i}$. This leads, by (3), to the condition

$$\frac{\partial y_i}{\partial x_j} = \frac{\partial y_j}{\partial x_i}. \tag{6}$$

Professor Schultz stated that the integrability condition (6), which was first obtained by Professor Hotelling by a somewhat different method, is of fundamental importance in the study of the interrelations of demand.

Thus, for example, if the demand functions are linear:

$$y_1 = a + bx_1 + cx_2$$
$$y_2 = a' + b'x_1 + c'x_2,$$

the integrability condition (6) tells us that for both competing and completing commodities, the parameters c and b' must be equal to each other. They are both positive when the commodities are completing, and both negative when the commodities are competing. The parameters b and c' are, of course, negative.

In conclusion he pointed out that his calculations show that for hay and oats the two terms of the integrability condition (6) differ significantly not only in numerical value but also in sign, thus giving rise to several difficult questions.

Professor M. D. Anderson of the University of Florida, who was unable to be present, transmitted to the meeting some comments on Professor Schultz's paper. He questioned the assumption that the marginal utility of money is sensibly constant, and pointed out that there might be cyclical changes in the utility of money which would upset the measurement of related demand in somewhat the same way that a shifting demand confuses the measurement of unrelated demand for a single commodity.

In the discussion of the paper of Professor Schultz it was pointed out by Professor Harold T. Davis of Indiana University that no proof exists that the utility function is a point function rather than a *fonctionelle,* that is to say, that it depends upon the values of the commodities rather than upon the path by means of which the values were attained. The search for a measure of utility in econometrics was compared with the search for the functions in thermodynamics. Thus, in the differential relationship $dE = dQ + dW$, where E is the internal energy, Q is heat, and W is work, the important question was: which is the *fonctionelle* and which the function? The discovery that dQ/T was an exact differential, and hence that entropy was a function, was a supreme achievement. It was equally important to know that W was a *fonctionelle.* The suggestion was made by Professor Davis that the character of the utility concept could probably be explored with profit by means of line integrations in the commodity space, employing the technique of Vito Volterra's functions of lines.

Commenting on Professor Schultz's paper, Professor Wirth F. Ferger of the University of North Carolina said:

"I congratulate Dr. Schultz, as he extends the field of the mathematical-statistical theory of demand study to the inclusion of intercommodity price-quantity relations, on insisting on a continual checking of the mathematical theory by reference to actual data. Not only does he avoid the arbitrary assumptions implicit in mathematical equations involving indefinite functions or functions selected for their operational convenience, but a valuable by-product of the dual method is here shown; the conflicting and contradictory results found in the relations of oats and hay suggest the necessity for additional study of both theory and data. I raise detailed points concerning only two aspects of Dr. Schultz's paper; a clarification of our terminology so that a 'change in demand' will have only one meaning, and that its most significant one, is desirable; and the differentiation of data employed (inclusion or exclusion of 'end stocks') between studies of 'flexibility of price' and 'elasticity of demand,' respectively, is suggested. Dr. Schultz combines in this paper to a remarkable degree mathematical astuteness and economic reality."

The symposium on Statistical Forecasting began with a paper, entitled "Can Stock Market Forecasters Forecast?,"[2] by Alfred Cowles 3rd of the Cowles Commission for Research in Economics. He stated that 16 financial services, in making some 7500 recommendations of individual common stocks for investment during the 4½ years ending June 1932, compiled an average record that was worse than that of the average common stock by 1.43 per cent annually, and that statistical tests of the best individual records indicated that they were probably

[2] To be published in Econometrica

the results of chance. Twenty fire insurance companies, in making a similar selection of securities, achieved an average record 1.20 per cent annually worse than that of the general run of stocks, and their best individual records were not very much more impressive than the records of the most successful of the 16 financial services.

Mr. Cowles reported that William Peter Hamilton, formerly editor of the *Wall Street Journal*, publishing forecasts of the stock market based on the Dow Theory over a period of 26 years from 1904 to 1929 inclusive, achieved a result better than what would ordinarily be regarded as a normal investment return, but poorer than the result of a continuous outright investment in representative common stocks for this period. On 90 occasions Hamilton announced changes in the outlook for the stock market, and half of these predictions were unsuccessful. Mr. Cowles further reported that 24 financial publications engaged in forecasting the stock market during the $4\frac{1}{2}$ years from January 1928 to July 1932, failed as a group by 4 per cent per annum to achieve a result as good as the average of all purely random performances. He concluded that various statistical tests indicated that the most successful records among these 24 forecasters were little, if any, better than what might be expected to result from pure chance, and that there was some evidence to indicate that the least successful records were worse than what could reasonably be attributed to chance.

In discussing the paper of Mr. Cowles, Professor Harold T. Davis of Indiana University explained the technique by means of which it was found possible to measure the probable attainment of the forecasters.

"The first step in this," said Professor Davis, "was to compute the standard deviation, as a function of time, of a group of N stocks from the market average:

$$\sigma(t) = \sigma^{(0)} + \sigma^{(1)}t + \sigma^{(2)}t^2 + \sigma^{(3)}t^3 + \cdots, \quad \frac{d}{dt}\sigma(t) > 0.$$

"By studying the behavior of a list of 60 stocks chosen at random, half of them during the relatively quiet months of 1928, the others during the mercurial period from July 1, 1929 to July 1, 1930, the desired deviation was computed to be: $\sigma(t) = 5.42 + 1.58\, t$, t in units of four weeks.

"If $d(m)$ is the observed deviation of a group of N stocks from the market at the end of 4 m weeks, the sign being chosen positive, and if we write $I(s) = (1/\sqrt{2\pi})\int_{-\infty}^{s} e^{-1/2t^2}dt$, then the probability of attaining by random chance the same or a greater deviation would be, $P(m) = 1 - I[d(m)\sqrt{N}/\sigma(m)]$. Since we are concerned mainly with positive deviations, the probability that the deviation will be both positive and of magnitude $d(m)$ is given by, $p(m) = \frac{1}{2}P(m)$.

"In order to apply this theory to the complete record of a service, its M periods of forecasting are divided into two groups, in A of which the forecast has equalled or exceeded the market, and in B of which it has been below the market. Then the chances to do better or worse than the service are computed as explained above. Averages of each set of probabilities are then made, these averages being justified by considerations which underlie the theory of Lexis and Poisson distributions. Let us call the average for the positive record S, and that for the negative record T.

"Now the probability that a service will be right A times and wrong B times out of $A+B=M$ times, is equal to the first $B+1$ terms of the binomial $(\frac{1}{2}+\frac{1}{2})^M$. Let us call this probability K.

"Finally the probability must be computed which represents the chance that a random service will be on the positive side of the market A times and will achieve a record as good as the service under consideration. This probability is obviously of the form: $P=K(1-Q)$ where Q (the chance to do worse) is to be computed. A reasonable measure of Q, based on considerations of inverse probability, may be chosen to be: $Q=(A/M)S+(B/M)T$."

Victor S. von Szeliski of the Lehman Corporation presented a paper entitled "The Statistical Analysis of Stock Prices."

"The technical action of the stock market," said Dr. von Szeliski, "has so far been studied almost wholly by graphic art which should be supplanted by strict statistical methods. To be acceptable, whatever methods are evolved must be (1) objective, (2) numerical, and (3) permit of indefinite repetition of essentially similar observations.

"Point changes in the price p of stocks at different price levels are not comparable. A change of 1 point in Anaconda has not the same technical significance as an equal point change in International Business Machines. Let q be a function of p such that numerically equal Δq's have similar technical significance for all values of q and p. Clearly, $\Delta q \neq \Delta p = \Delta p/p^0$. The first suggestion was that $\Delta q = \text{const.} \times \Delta \log p = \text{const.} \times \Delta p/p'$. More recently, the square root law has been proposed: $\Delta q = \text{const.} \times \Delta p/p^{1/2}$. Observation of the high-low range of stock prices as a function of price on the first day or two of important moves (when influences are mainly technical) favors the logarithmic law as against the other two. But the best law appears to be a three-quarters power law: technically equivalent price changes are proportional to the $\frac{3}{4}$ power of the price level at which they occur.

$$\Delta q = \text{const.} \times \Delta p/p^{3/4}$$

Integrating:

$$q = C_1 p^{\frac{1}{4}} + C_2.$$

"The volume in a quiet stock like Air Reduction is evidently not comparable with that of an active industrial like United Aircraft, still less with the total shares traded. The obvious first step is to express the volume for a single day, v, as an index, with the average volume for some past period $=100$. In this study, the base volume, V, is the average daily volume during the immediately preceding nine days. $\lambda=\log v/V$ is used, rather than v/V, as it has a more symmetrical frequency distribution, and is unlimited in both directions. A study of the dispersion of λ as dependent on V shows decreasing dispersion with increasing V. The A. D. of λ for $V=10{,}000$ is approximately .2; for $V=1{,}000{,}000$, about .1. (A. D. calculated from O as origin.) Observations on λ for American Can, U. S. Steel, General Electric, Consolidated Gas, General Motors, and the market as a whole, suggest the relationship:

$$A.\ D._{\lambda} = 0.9 \cdots - 0.15192 \log V.$$

If we express each λ in A. D. units, we get quite comparable volume measures for inactive stocks, active trading favorites, and the market as a whole. This measure is the volume index, vi

$$vi = \frac{\log v/V}{AD_{\lambda}(V)} = \frac{\lambda}{\lambda'} \cdot$$

It is based on the assumption that equiprobable volumes are equisignificant, technically.

"What are the statistical characteristics which distinguish the first day or so of a temporary rally from the first day or so of a considerable advance in the market? Measure, for each such rally, (1) its volume in terms of the volume index, (2) its extent in per cent using closing prices of the Standard Statistics Index of Ninety Stocks. (Since the index is not an average price, the three-quarter power price change law cannot be used.) Plot these coordinates as points on a graph, using the X-axis for volumes and the Y-axis for rally. Color the points associated with false rallies red, the points associated with larger rallies blue, and it will be noted that the blues congregate to the right of the chart and down, the reds to the left and up. The probability that a given rally will be followed by still higher prices is the ratio, for that region of the chart, of the number of blue points to total points. The probability is thus a function of vi and $\Delta p/p$. For certain regions the probability is very large or very small; for an intermediate region, about $\frac{1}{2}$. The problem of statistics in stock market research is to decrease the width of this intermediate zone."

"The Use of Mathematics in Business Forecasting" was the subject of a paper given by Warren F. Hickernell, editor in charge of business forecasts published by the Brookmire Economic Service, 1911–1916, and the Alexander Hamilton Institute, 1916–1928.

"The fact that it is impossible to establish periodicity of crises and depressions," said Mr. Hickernell, "limits the use of mathematics in the field of business forecasting. Man-made financial policies or political developments may destroy the value of forecasts based upon the study of sequence and lag as revealed in trade and financial statistics. Thus the only basis of statistical forecasting within our reach is the barometric cross-section method, certain cross-section pictures, or patterns, of statistical barometers being assumed to indicate favorable or unfavorable conditions regardless of previous lag or sequence.

"The ordinates of curves of trade and banking time series, with secular trend and seasonal variation removed, had definite value in business forecasting before the World War. In the United States the rigid reserve requirements of the National Bank Act controlled the trend of bank loans and deposits. In Europe all leading countries were on the gold standard, and the Bank of England controlled the London money market, usually, according to an established rule. The application of mathematical formulae to business cycle statistics was favored by the fact that credit policies were so universally adjusted to the impersonal authority of gold reserves.

"Mathematical barometers have declined in prestige since 1914 because changes in American banking laws have rendered obsolete the pre-war 'normal' in banking series and because gold reserves in the United States since 1919 have been heavily 'adulterated' by inclusion of abnormal amounts of foreign funds. In 1928–29 Europe virtually owned half the gold in the United States, and the statistician could not know whether this foreign gold would remain as a credit base or be withdrawn on short notice. Confident forecasting was impossible.

"Those statisticians who used published statistics of gold reserves in the United States without removing the 'foreign content,' which had steadily increased during the blowing of the Dawes Plan Bubble (1924–29), were entirely unprepared for the gold raid of 1931.

"At present writing, the United States owns practically all of the gold it possesses. But in continental Europe, gold statistics cannot be used as published. A large amount of gold from Austria, Germany, Great Britain, and Japan, has accumulated in Switzerland, Holland, Belgium, and France. The business forecaster must remove the 'foreign content' from continental gold reserves in estimating the trend of economic conditions.

"During the past decade, business forecasting has required diligent analysis of money market abnormalities. At present, allowance must be made for the fact that the velocity of circulation of money and credit is far below average, and for the abnormal withdrawal of gold from effective economic use. When the 'foreign gold' has been removed from continental reserves to Berlin, London, Japan, the United States, and South America, and the velocity of circulation has recovered to 'normal,' the use of mathematical formulae will become increasingly valuable in preparing barometric cross-section patterns."

The closing paper of the symposium was presented by Lewis A. Maverick, Assistant Professor of Economics, University of California at Los Angeles. It was entitled, "Time Series: Their Analysis by Successive Smoothings."[3]

"It has been suggested by Ragnar Frisch," said Professor Maverick, "that a trend or smoothing line may be drawn to pass through the points of inflection in the original curve, and that, if the smoothing line be itself examined, it will in turn show fluctuations which will necessarily be marked by points of inflection. These points may be connected to give a trend or smoothing line of the second order, and it may be submitted to the same process. The first smoothing line is freed from the fluctuation of shortest period, but contains all fluctuations of longer period; the second smoothing line is in turn freed from the lowest order fluctuation remaining in the smoothing line of first order.

"In the present paper the concept is accepted of a succession of smoothing lines which set apart the fluctuations into homogeneous orders. The criterion of points of inflection is accepted as but one of several criteria, aiding in the location of the successive smoothing lines; the shortcoming lies in the indeterminateness of the location of the points of inflection. Added criteria employed are moving averages, minimum radius of curvature, and 'bounds,' which are two curves that touch, respectively, the successive peaks and the successive troughs.

"Each order fluctuation may be studied for period and amplitude and a standard pattern may be determined. In forecasting, the highest order trend may be continued forward, and those of lower orders superimposed in the form of their standard patterns. In correlation, the study may be carried on separately for each order fluctuation. In constructing index numbers, the selection and weighting of the component series may be undertaken separately for each order fluctuation, according to the significance of the series for the fluctuation of the particular order."

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[3] To be published in ECONOMETRICA.