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ROLE OF STATISTICS IN ECONOMIC MOBILIZATION

9 September 1948

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9 September 1948

DR. REICHLEY: During Colonel Reis' recent lecture you may have noticed on the chart he had on the board in front of the audience one element of economic mobilization known as Research and Statistics, the idea being that you had to have the factual background available before you could make a policy decision.

Consequently, this morning we have asked Mr. Clarke Louden to lecture to us on the role of statistics in economic mobilization.

MR. LOUDEN: By way of introducing the subject this morning, let me refer to an article which appeared in the current issue of "Modern Industry" on executive methods. In discussing some of the basic factors of successful executive or administrative action, the author, a partner in the management firm of Rohrer, Hibler and Replogle had this to say, "Decisiveness is a part of intellectual competence. -- But decisiveness should not be confused with obstinacy. It is based on sound judgments, which in turn are based on facts. When the administrator gets lost in detail, he cannot do what it is his function to do. There are managers who like to sell so well that they never stop selling in order to manage, there are works managers who prefer housekeeping to administration, and controllers whose thoughts are so concentrated on working things out to the 4th decimal that million dollar ideas pass them by unnoticed. Today's successful manager uses executive methods that are very different from those of a generation or two ago - - - - and they are very much better."

This statement, it seemed to me, might be used as the framework on which to base our discussion on statistics. For convenience, I have broken down the subject into the following major topics:

1. Growing importance of the statistical approach as a tool of management.

2. Statistics as used in industry today.

3. Statistics as used in World War II.

4. The limitations and abuses of statistics.

5. How to make the best use of the professional statistician?

6. Some comments on statistical procedures applicable to the preparation of reports.

Let us begin with a definition. Statistics deals with the collection, organization, analysis and the interpretation of numerical data. It is not a science--although some enthusiastic statisticians claim it to be such--it is rather a scientific method, and the facts that it deals with must be capable of numerical expression. Sometimes it requires considerable imagination and originality in order to measure motives, emotions, and personal reactions in terms of numerical equivalents, as for example, the desire to purchase an automobile or a shot gun. Yet hardly a phase of human activity exists today which does not make use of statistical methods. Economics, medicine, education, sociology, business, agriculture, etc., all rely upon statistics to measure the significance of results. Even in music, in writing, in acting, and in politics statistical methods are used to measure the nature of popular tastes and the development of changing trends.

One hears frequently, both humorously and critically, the comment that figures can be made to prove anything, that all liars figure, etc. This is due to improper methods of collection, to incomplete data, to data which are not comparable, or to an inadequate analysis of the facts. Figures, as such, cannot prove anything. It is the method of presenting and using them which leads to correct or incorrect conclusions.

In the definition there is implied a relationship within the statistical sample. One fact is related to another, and this relationship furnishes the basic of the statistical approach. Homogeneity of data is the first requirement in the use of statistics as a tool of management.

Statistics, therefore, represent (1) facts expressed numerically and (2) aggregates or masses of data which are sufficiently large to reveal types, standards, or relationships, even though the individual unit shows wide variation. This tendency for large aggregates to conform to definite types or standards, or to show general or underlying tendencies is what is meant by the "law of averages."

Astronomers were probably the first to record data. Sir Isaac Newton, we are told, became interested in explaining the facts that he had recorded and as a result we have his laws relating to the motion of planets. When it was observed that this method was so successful in the physical sciences it began to be adopted in the political, social and economic fields.

The term "statistics" has a rather interesting derivation. It was originally called "the science of the states" and before that, "political arithmetic." In copying the methods of recording data from the physical sciences, pamphlets and reports appeared containing data which would be of interest to the statesman, a sort of world's almanac for statesmen. Hence the connection between the word "states" and the word "statistics."

In the seventeenth century the theory of probability received some attention when a gambler named Cardano published a treatise of rules by which one could protect himself against cheating. Later the mathematicians came along and gave respectability to these laws of chance. It was not until 1890, however, that modern statistical methods came into being. The work of the Census Bureau was greatly expanded at that time, the International Institute of Statistics was founded and in 1893 there occurred the first elaborate investigation of prices by a Senate committee.

Then there occurred in this country the short, swift depression of 1921. Many businessmen were hit unexpectedly. When the economic statisticians began pointing out to these businessmen that the statistical evidence in 1920 was clear and unmistakable, indicating trouble ahead, they promptly started on a "treasure hunt" for some administrative device which could, in a sense, forecast changes in the future. There followed a tremendous increase in the use of statistics as a tool of management.

At one of the early statistical meetings which I attended some twenty years ago, there was circulated a story which may be of interest to this group. It was reported that Bill Knudsen who was in charge of the Chevrolet Division of General Motors in 1920 had sensed in his practical way that orders for cars might suddenly dry up. So while the other division chiefs of General Motors were loading up with steel, he was letting his inventories run down. In fact he sold some of his inventories to the other divisions. When the drop came the other division chiefs were so annoyed at their bad judgment that although Knudsen was right, he told his friends that he had to keep very quiet about it for fear that he might be fired for being right.

Let us consider for a moment some of the uses in industry of statistical procedures as a tool of management. Let us begin with the manufacturer who asks himself, "Why have a statistical department? I have 30 salesmen. If I want to know anything about my market I ask them." There are two obvious answers. Assuming that these salesmen are all honest and efficient, they have, nevertheless, a salesman's viewpoint and a salesman's prejudices. Their observations have value, even great value, but their specialization represents a handicap in getting an impartial view of a situation. They see part of the truth too clearly to get a proper vision of the whole truth.

The second answer is that the function of the statistical division is not only to answer questions, but to discover new factors or influences which have escaped the attention of the responsible manager. A statistical division, or what is generally termed a research and statistical division, is needed to supplement and to broaden the specialized knowledge with pertinent information from allied fields. It is natural and to be expected that specialization should lose perspective in the process of acquiring intensive knowledge of a certain subject, or some part of a

subject or operation. Professor Sholl in his lectures on Industrial Management at M.I.T. continually emphasized the fact that the successful manager is the one who reaches outside of his office to pull in problems. He is then better able to cope with the problem when it appears in his own organization. The problems with which we are familiar receive our attention while those with which we have little contact or about which we have limited knowledge are ignored. It is difficult, therefore, to have at all times a properly balanced viewpoint.

Modern business operations have become too complicated to be appraised by direct observation. This complicated organization is controlled by a series of reports, most of them statistical or partially so in so far as the presentation of facts and their meaning are concerned.

Statistical departments in industry did not develop suddenly. They had to be sold to management, particularly since it represented an increase in overhead costs. Usually the work started with one man, with or without training, who built up his department on a trial-and-error basis. This meant that at every turn he had to convince management of the desirability of further expansion of the department's function and authority. Today, however, the reverse holds true. A research and statistical department is set up and given greater authority and responsibility than it can use at first. It is allowed to develop as quickly as possible into the position ascribed to it on the organization chart. The exact position that the research and statistical division occupies depends, of course, on the assigned functions. Generally the head of the department is represented on various policy-forming committees. The importance assigned to him is due not only to the contributions that his department can make to policy decisions, but also in the opportunity it affords the department to keep abreast of trends in management thinking. This is the arrangement, I understand, that prevails at present at Goodyear and at Eastman Kodak.

What are some of the problems assigned to the research and statistical departments? They include almost every phase of the business from the manufacture of the product to its ultimate distribution to the consumer. The following list was taken at random from a survey made by the National Industrial Conference Board in 1946:

Some Problems with which statistical departments are concerned

Policy	Markets	Product
Price structure	Potential sales	New uses for old produ
Credit	Consumer preferences	Competitive position
Public relations	Sales area analysis	Packaging
Profit margins	Quotas	Distribution channels

Policy	Markets	Product
Salesmen's compensations	Others	New Products
Advertising		Others
Plant location		
Inventory position		
Forecasting		
Others		

It is not intended to convey the impression that statisticians can qualify as experts in the various fields suggested by the foregoing list. Obviously the heads of departments such as sales, finance, advertising, personnel, production, etc., are the experts. The statistician, however, assists in the determination of the facts.

Thus it is obvious that the scope of the work of the statistician is very broad. In the Allis-Chalmers Mfg. Co., for example, it covers economic studies, market research, and sales analysis. In the Coleman Company, the work was expanded in 1945 and the department became the assembly point for all statistical data relating to sales, markets, distribution, economic trends, forecasts, merchandising costs, etc. It is also charged with the responsibility--and this is a little unusual--of establishing a sales-control system and seeing that it works. In the Corning Glass Works, on the contrary, the work is limited largely to market research. The Economy Grocery Stores Corporation, however, has given its statistics and research department wider scope than is customary. It is assigned a large variety of studies dealing with merchandising, marketing, operations, and personnel management.

There is another use of statistical procedures in industry which must be mentioned because of its growing importance and that is in the maintenance of quality control. Broadly speaking, quality control is a method of measuring the quality of a factory's output against the standards that are set up, in other words, inspection. The process, however, involves more than the mere substitution of the "go--no go" testing of factory output by statistical procedures. It involves a predetermination of standards into variations that are permitted because they fall within control limits and those that are not permitted because they fall outside of the control limits.

A very homely analogy is that of a car traveling on the highway, in which the control limits are the center line on one side and the shoulder or edge of the highway on the other side. No car maintains a perfectly straight path. Variability exists because of unevenness in the roadbed, gusts of wind, etc. But it is not worth while to investigate those variations in the path of the car because they are kept within predetermined control limits. It is only when the car swerves outside of these limits

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that an assignable cause can be assumed to exist and an investigation begun. The same principle is applied to the variability that exists in every repetitive operation in the factory.

The second phase of the technique involves sampling. A random sample is used in which every item has an equal chance of being inspected, combined with regularity in which the recurring periods of inspection are consistent rather than at irregular intervals. Tables are usually set up showing the size of the sample to use for the maintenance of predetermined quality goals.

The results of the sampling inspection are then plotted on a chart and it becomes possible to see at a glance the number of pieces that fall outside of the control limits.

In one case, this rather simple rule was then followed: (1) If five successive points on the control chart were outside the permissible limits, be on guard for future developments; (2) if six successive points appeared, start investigating; and (3) if seven successive points appeared, take immediate action.

This procedure has two primary advantages. First, it saves time and money because it is no longer necessary to inspect every piece; and secondly, it actually improves quality because the work of the inspector is more reliable and the introduction of the factor of anticipating trouble gives an opportunity of assigning a cause for it which can be corrected immediately.

Statistical quality-control systems have been worked out even in clerical operations, for example, Alder's Mail Order house in Chicago. Within the Federal Government it is being introduced in the Census Bureau and in the Federal Security Agency.

In many firms there is a realization of the value of the statistical and research departments as training grounds for future executives. An increasing number of companies are placing young men with potential executive ability in these departments for a year or two, not merely for the purpose of becoming acquainted with the major activities of the company, but also to receive training in objective thinking, analysis, and reporting.

In a discussion of the wartime uses of statistics, Novick & Steiner in their report on "Wartime Industrial Statistics" have called attention to the fact that "the more dramatic elements of total war should not deprive statistics of its rightful place in future mobilization planning. Statistics have vast and profound implications in wartime industrial management. They provide the necessary bases for wise management."

I believe it is obvious that intelligent wartime industrial control is impossible without adequate provision for collecting, analyzing, interpreting and using facts. In establishing a policy of control over the productive and distributive system, and in administering these controls, it is necessary for government to make choices continuously among competing demands for resources at all levels of economic activity. Facts are managerial tools without which intelligent choices among alternate courses of action cannot be made.

When the occasion arose for the national Government to direct the industrial machine in World War II, there existed neither the data necessary to support basic policy decisions and administrative action nor the technical statistical procedures by means of which the data could be produced. Although the task of industrial mobilization and the continuous control of the industrial machine during the war was unbelievably complex and difficult, the problem was immeasurably complicated by the absence of an efficient industrial statistical reporting system.

As early as 1941 it became evident to those administering the war production program that neither the necessary facts nor the methods for getting them were available. Naturally the peacetime statistical series were incomplete in coverage, lacked timeliness, were deficient in penetrating detail, and lacked coordination.

The first group charged with responsibility for planning and executing the defense program found itself adrift without map or compass because there was nowhere any information on the size of the economic effort this nation could undertake. The National Resources Planning Board and Brookings Institution had studied the nation's economic capacity to produce, but the wildest dreamer never visualized a gross national product of 200 billion dollars a year. As a result when the "victory program" got under way, there was an explosive effort, a program which outran national resources and which was conflicting. Programs were set beyond capacity and became unbalanced.

From the viewpoint of internal management, centralized control required the accumulation of factual information for the administration of procedures and the implementation of policy decisions. It became a matter of vital importance to know (1) the areas in which major problems of the moment fell, (2) the extent to which policy decisions were being implemented or were dying from inaction, and (3) the work load falling on certain groups of employees. This information was important so that top management could know where the immediate problems were, where the new problems were most likely to occur, the way in which established policy was being implemented, and the development of personnel which would give the greatest operating efficiency.

It may be of interest to know how some of these internal problems were resolved. The procedure consisted of a daily tabulation and classification of all incoming mail. These daily reports showed the volume of the work load, the administrative events on which the work load fell, the subject of current problems, and also the changes in the subject content of the problems.

The reporting system of the War Production Board penetrated every conceivable aspect of industrial production activity, from the accumulation of total production data to cumbersome incidentals. The groping fingers of WPB poked around the front offices, and dark corners of government agencies, touched farmers, housewives, retailers, wholesalers, financial institutions, and foreign governments. Data requirements ranged from questions on operations of giant corporations to the needs of an individual farmer who wanted to buy an alloy steel bolt for his tractor.

Simply stated, the task of WPB and its predecessor agencies was to manage the industrial economy of the United States so as to produce the maximum munitions and essential civilian goods with the minumum dispatch.

This was predominately an administrative job. Looking back, two facts stand out in connection with the use of statistics in World War II. First, those responsible did not have a clear concept of the vital place which fact finding occupied in the emergency management function of government. Secondly, the procedures required for the systematic collection and use of necessary facts were not ready and required development.

Statistical methodology is a tool of management, whether in industry or government, which can be sharpened for use and applied to our emergency administrative problems. This idea bears repetition.

Let us now turn to the use of statistical procedures in the pricing of war contracts. This use developed from the OPA Administrator's interpretation of his statutory responsibilities. Mr. Henderson felt that he was required to watch price developments in the field of military purchases. Conferences were held between Mr. Henderson, Mr. Patterson, and Mr. Forrestal which resulted in signed agreements in September 1942 in which the War and Navy Departments assumed responsibility for the maintenance of fair prices and the prevention of excessive profits within their respective areas of operation. In addition, it was agreed that OPA would be furnished with information on prices and procedures so that the effect of munition contracts on the national economy might be appraised. Accordingly, price indexes were to be established with October 1942 as the base in order to indicate the nature of the changes in the over all price movements.

Although this agreement was made in September 1942, there was considerable delay in carrying it out. Neither the Army nor the Navy was equipped to proceed with the assignment. Finally arrangements were made by which a team of statisticians was loaned by the Bureau of Labor Statistics to perform the necessary collection of the basic data and the computation of the index. The price index finally appeared in October 1943.

What was more significant than the appearance of the price index, however, was the development by the statistical team of "comparative pricing." This procedure consisted of the rather simple device of examining the general price pattern of a specific item. Contract prices for this item were compared with those established in previous contracts for the same item by the same company as well as with those of other contractors producing the same or similar items. Any prices which appeared to be out of line required an explanation to account for the difference. This procedure was first tried out rather effectively with a contract for aircraft landing mats. Then it proved equally effective with reference to contracts for penicillin.

Out of this procedure developed the technique known as the "company pricing program." Two other steps were added to this program: one, an analysis of the components of prices which included an inspection of costs, etc., and the other, a scrutiny of pricing methods on the part of the contractor. Thus, from a simple statistical procedure there developed a rather effective program used by the Purchases Division of ASF and the Office of Procurement and Materials of the Navy. This procedure became to be regarded so highly that it was the subject of a round-table conference on pricing procedures held in connection with the twenty-eighth annual meeting of the National Industrial Conference Board in New York City, 18 May 1944. General Albert J. Browning, Director of the Purchases Division, ASF, the division in which the Price Analysis Unit was located, was the chief speaker. He explained in considerable detail the operation of this procedure. After VJ-day the Ford Motor Company took over the entire Price Analysis Unit. Today most of the former price analysts are carrying on the same type of work in Detroit which they had started in ASF.

The role of statistics in the mobilization of industry during World War II was two-fold: First, to provide the basic knowledge necessary for effective administration and the formulation of policy; and, secondly, to furnish the means by which accountability for specific actions can be established. Mere statement of policy without accountability does not produce munitions.

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What are the tools of the statistician? The numerical data with which he works may be collected by various public or private agencies among which are the Census Bureau and the Survey of Current Business of the Department of Commerce, the Tariff Commission, the Bureau of Mines, and many other Federal, state and municipal agencies. Among the private agencies are the many different trade associations numbering about three thousand, the various state and municipal Chamber of Commerce, the "land-grant" colleges and other large universities having separate research departments, and such private research organizations as the Twentieth Century Fund, the National Bureau of Economic Research, the National Industrial Conference Board, and many others. In case no data are available, one must then resort to the use of the questionnaire.

After having collected the numerical data, the statistician looks for patterns or relationships suggested by the mass rather than by the individual units. From these patterns are established averages, trend lines, lines of regression, and similar relationships. In the short time of one period it is not possible to examine the detail of the methodology involved. Later during the year there is tentatively scheduled a discussion of the use of correlation as a tool in the forecasting of requirements.

As a precautionary suggestion, let me indicate some of the abuses and limitations in the use of statistics. For example, the preparation of the questionaire requires considerable experience to make it as objective as possible. The questions should be so worded that they do not suggest the answers. The individual providing the answers should not be called upon to exercise any comparative judgment because no two persons use the same standards for making an appraisal or expressing a preference. When such questions enter the questionnaire, the person who designed it has lost control over it. Check questions should also be hidden in the questionnaire to indicate the quality or the consistency of the replies. My suggestion, therefore, with reference to the preparation of questionnaires, is that they be edited by someone who has had experience and that, in addition, they be tried out on a small sample before they are released.

With reference to the analysis and interpretation of the data, no amount of procedure can take the place of judgment. Facts not supported by adequate or related data can easily lead to erroneous conclusions. For example, Professor Pigou has pointed out the perfect correlation which existed between the daily number of deaths in South Africa and the daily number of words uttered by the Archbishop of Canterbury. In addition, the statistician all too fequently is expected to provide proof for a predetermined conclusion. He finds himself in the position of a lawyer arguing a case for his client. Members of congressional committees frequently ask not "What are the facts?", but "Whose figures are these?" It appears that the Devil is not limited to the quotation of the scriptures. He can also quote statistics. The great limitation of statistics is that it cannot by itself detect an absolute error in a measurement of numerical data.

Just a word with reference to the professional statistician. In the first place, there are different kinds of statisticians. The Civil Service Commission is discussing the recognition of three different categories of statisticians based largely upon his training and experience. The first and the easiest to define is the "mathematical statistician." He is engaged promarily in the application of mathematical theory to the development of statistical methods and to the determination of whether, or to what extent, various statistical methods are appropriate to the problems at hand.

The second type of statistician is the "survey specialist." He has appeared with the development of large-scale surveys. His specialty includes the planning, organization and supervision of the process of collecting, summarizing and presenting data, including the responsibility for finding ways and means to collect quantitative information that will be useful in the solution of economic, social or administrative problems. The survey statistician must be aware of the types of information available and the forms in which they are maintained. He must recognize what data are feasible for collection within the limits of the available resources.

The third group is defined as the "analytical statisticians" who are concerned with the preparation of statistical analyses and the interpretation of the data, including estimates and forecasts in a particular subject field.

My comments with reference to the use of statistical procedures in the Industrial College are based largely on the reports of previous classes. These comments are divided into three groups, namely, the use of tables, the body in the report, and the use of charts.

The use of tables is covered to some extent in the booklet, "The Preparation of Reports." Reference is made in the booklet to two kinds of tables, the summary table and the reference table. The summary table should be regarded as a method of presentation along with the text material and charts. Too often, in previous reports, long reference tables were included with the copy so that the facts under discussion were not summarized or pointed up to emphasize or supplement the written word. If the reader paid any attention to the table he was obliged to wade through a mass of irrelevant material. Instead of assisting the reader, the table became a hurdle which was either ignored or evaded.

Second, the data submitted and the discussion should be related and consistent. In the past, some reports have been submitted in which only the data which supported the author's conclusions were presented and all other facts were ignored. And in a few reports, the data submitted supported the opposite conclusion from that which was given. In other instances, the data lacked homogeneity. This can readily occur when the

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statistical data represent a consolidation from a number of different sources and sufficient attention has not been given to the conversion factors to assure unity and consistency within the table.

Finally, with reference to charts, your attention is invited to the use of the ratio or semilogarithmic chart.

(Referring to charts)--they were not reproduced.)

In the past, many reports have used the absolute or the arithmetic scale, which is indicated in this chart showing the production of petroleum. The characteristic of the chart, of course, is that the scale is given in absolute terms. In the chart of petroleum production we have an illustration in which the production in the Soviet Union is compared with the world production.

This type of chart (pointing to the one on the right) is useful in indicating changes in absolute quantities.

On the left we have a chart which is based on the ratio scale. This scale, you will notice (indicating), does not begin with zero. It always begins with a quantity greater than zero. The scale which is used is arranged so that the distance from 10 to 20 in this particular chart is exactly the same as the distance from 20 to 40 and from 40 to 80. In other words, the spaces indicated by the scale represent logarithmic quantities rather than the absolute quantities which are indicated on the arithmetic chart.

We have here, I think, a rather striking difference between the two charts. Both charts were plotted from the same data. In this arithmetic scale (pointing to chart on right) we have the relationship between world production and the production in the Soviet Union, in which the production of the Soviet Union looks rather insignificant. The same data are plotted on the chart with the ratio scale. The rate of change was actually greater in the Soviet Union than it was in the world production.

I don't want to belabor the obvious, but merely call attention to the fact that the use of the ratio chart frequently facilitatates comparisons between data, whereas the use of the arithmetic chart merely expresses related quantities in absolute terms.

Summarizing the discussion in reverse order for purposes of emphasis, first, attention should be given to the use of charts and tables as forms of expression to assist the reader in grasping the thought stated in the text. Secondly, statistics as a tool of management has grown tremendously in importance in the past decade. Its value and possible contribution to industrial mobilization in World War II was not fully recognized. Thirdly, it would appear imperative in any future emergency to make full use of statistical procedures in the formulation of policy and the apprais

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and interpretation of results. The use of statistics can assist in providing a focused rather than a blurred view of actual conditions. Its use makes for sounder decisions and more accurate conclusions so that both the individual and government may act more sensibly and confidently.

What I have implied in this discussion, without actually saying so, is that in your future assignments or tours of duty, and particularly in case of a future emergency, do not neglect or ignore the help which you can get from statistics as a tool of management.

DR. REICHLEY: Any questions, gentlemen?

QUESTION: During the war I heard comment quite general to the effect that a suitable number of qualified statisticians were not available. The question then arises as to whether it was the availability of qualified statisticians or whether they were being properly used.

Would you care to comment on that?

MR. LOUDEN: I think it was due to a number of different factors. In other words, you cannot single out one factor and place all the blame on that.

It was true that a sufficient number of qualified statisticians were not available. But the process of training and the searching out of available personnel would have helped a great deal.

And then, of course, there was lack of experience on the part of top management in using statisticians effectively and in training them properly to accomplish their particular objectives.

So I think it was due to a number of different factors and not to a single one.

QUESTION: Mr. Louden, just what is it that your ratio chart attempts to prove?

MR. LOUDEN: It calls attention to the fact that rate of change is one thing and change in absolute quantities is an entirely different matter. So that if you are stressing the rate of change with reference to certain data, use the ratio chart.

QUESTION: In this connection, the rate of change for the Soviet Union is three, I would say, over there (pointing to the chart); it looks as though it is; whereas the world rate of change is about four.

MR. LOUDEN: No. They are the same data. Remember, you have to use that scale on this side (indicating). There are two scales on this chart. The world production starts with approximately 700, using this scale to the right, then goes up to about 290. Here we have 290, or 2.9 billion barrels. You have the same data plotted on both of the charts.

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QUESTION: Maybe it would help if you would explain just what things are plotted on the charts. In other words, on the world production you start in the neighborhood of 700. Over on this one (indicating) you start with 60.

MR. LOUDEN: Remember, you use this scale to the right for world production and the scale on the left for the production of the Soviet Union.

QUESTIONER: For both?

MR. LOUDEN: The scale on the right was used in plotting world production. The scale on the left was used in plotting production in the Soviet Union. Two scales on the same chart is a perfectly good procedure. You can have two scales on the ratio chart.

In absolute quantities there is more danger in having two different scales on a chart. You could have two scales and arrange them somewhat in proportion, but you would still have these absolute quantities of change regardless of whether you attempted to adjust your curves on the arithmetic scale according to the various ratios. In a ratio or semilogarithmic chart you don't have that problem because your ratios are indicated on the chart itself.

Just one other fact that may be of interest. The slope of the line on the ratio chart can be compared with the slope of any other line on the same chart. The slope of the line indicates the degree of change. For example, in this particular case the slope of this line can be compared directly to the slope of this line, indicating that the rate of change with reference to production in the Soviet Union was considerably greater than the rate of change in world production.

DR. HUNTER: How do you determine the different scales to be used? In other words, what is the difference between the right-hand scale and the left-hand scale as applied to the two things?

MR. LOUDEN: That is simply a matter of convenience. In other words, this chart (indicating the ratio chart) could have been shown without the two scales. Had it been shown without the two scales, the slope of this line would not have changed at all. It would have simply been on the next cycle below this base line. You can have another cycle below this base line in which the scale would begin with one instead of ten as shown here. The second cycle would include quantities from ten to a hundred. The third would be from a hundred to a thousand. But the slope of the line would not be changed at all, regardless of the scale you would use. The curve would simply appear in another cycle on the ratio chart. But it is much more convenient to put the curves together for visual comparison.

QUESTION: Wouldn't it facilitate matters if there were a scale showing percent of increase or decrease in terms of distance?

MR. LOUDEN: That is possible; yes. I had fully intended to have additional charts prepared, including some on the raw materials to be studied in Unit II but the draftman's time was at a premium so I had to be satisfied with this single chart. You can do the same thing with rubber, iron and steel production.

QUESTION: Can you explain, perhaps, the reason for some of the mistakes in these surveys? Wasn't it the "Literary Digest" that made such a great mistake in forecasting a Presidential election?

MR. LOUDEN: Yes it was.

In that instance, the collection of data was faulty due to the fact that the sample was a biased sample and the greater the sample the greater the bias. In fact, Mr. Gallup at that particular time forecast, rather to the annoyance of the "Literary Digest," the results of the next "Literary Digest" poll. His sample was, of course, a stratified sample which if properly established is more accurate than a limited random sample.

QUESTION: I understand that a few months ago some of the polls had a discussion among themselves as to which one of them was using the best sampling procedure and Mr. Gallup claimed his was the more simplified method.

MR. LOUDEN: The sampling procedure, of course, is still in its infancy. It is very interesting, indeed, to go to one of these statistical meetings in which sampling is the topic of discussion. You will find there a considerable difference of opinion as to the validity of the various sampling methods and the results which they show.

DR. REICHLEY: Any further discussion? (No response). Thank you very much, Mr. Louden.

MR. LOUDEN: Thank you.

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