along with England and Sweden, which are now in the forefront. The Netherlands is typified by superb organization, and most of the Scandinavian countries are high in quality if not always in quantity of research. France is characterized by brilliant individual contributions but over-all falls far short of her potential for scientific research. Switzerland, a highly industrialized country, is geared primarily for engineering and does not compete as highly on basic research as might otherwise be expected. Italian research is good in certain areas but is plagued by a number of difficulties that retard progress. Nevertheless, there are encouraging efforts being made in Italy to develop some good scientific programs. In the south of Europe the situation is generally discouraging and will continue to be so, except where a few dedicated, brilliant individuals are making good contributions with the meager resources available.

Europe will continue to be a tremendous scientific manpower reserve for the United States, and, despite accusations of proselyting, the fact remains that in many European countries the employment possibilities are not commensurate with the production rate of scientists and engineers. If the universities of Europe would realign the professional structure of their departmental staffs and extend their graduate curricula they would give far more opportunity to young research scientists and make better use of their facilities. America can indeed be grateful to Europe for a great cultural and academic heritage, and one can sincerely hope that close cooperation in science will take place for many years to come.

Note

This article is not an expression of the official views of the Office of Naval Research.

What Is the Economist's Task?

The current recession illustrates his responsibilities as an analyst and as an adviser on public measures.

Gerhard Colm

"The proper attitude in which any economist should review this year's [economic] survey is one of humility towards the failures of his own science" [*Economist* (5 Apr. 1958)].

We have been in a recession for about six months. Although the downward movement has tapered off, signs of a sustained recovery to a satisfactorily high level of activity are not yet in sight. During the last decade most economists have emphasized that the American economy has not become immune to economic fluctuations. They have also emphasized, however, that we now have the legislative and executive machinery established by the Employment Act of 1946 and the know-how to counteract a recession, or at least to prevent a recession from deteriorating into a depression. Are we economists then to blame for the unfavorable economic developments of the last six months? Must we accept the criticism expressed in the quotation from the *Economist*? Or should our defense be that as economists we have a responsibility only for good economic analysis and that the determination of policy is the responsibility of the decision makers, inside and outside the Government? My answer is that the function of the economist extends beyond pure analysis, that the economist can and must contribute to the economic decision-making process. An economist who has been asked to advise a statesman on economic policy cannot confine himself to presenting the findings of pure analysis. For if he does, unintentionally he may give not pure but poor advice.

In this discussion I will examine the relationship of economic research to the current recession problem and to the policy measures which have been or should be taken. In this way we will be better able to judge the responsibility of the economists and politicians for the unsatisfactory economic developments which have been taking place.

In analyzing the multiple role of the economist, I will elaborate a distinction which was suggested by a remark of Edwin Nourse in his book *Economics in the Public Service*.

The economist has to consider a problem such as the recession on four different planes—namely, the planes of (i) economic analysis; (ii) institutional economics or economic engineering; (iii) economic politics; and (iv) economic statesmanship. Let me discuss each of these functions, using the recession problem as an illustration.

Economic Analysis

The economic analysis of the recession, like the analysis of a disease, has three aspects—namely, an analysis of the causes which brought the disease about; a prediction of the likely course of events, assuming that no special cure is administered; and a prediction of the influence which various possible medications could have in promoting recovery.

Causal analysis. An enormous amount of research work has been done, both on an empirical and on a theoretical level, to discover whether or not there is one typical cause of economic fluctuations. If there is a single economic virus which disturbs economic growth and stability, it is elusive indeed and changes its appearance from one economic epidemic to the next. In the present case it was pointed out early last year that the productive capacity of agriculture and industry was growing faster than the aggregate demand for agricultural and industrial products in real terms. This led to growing idle capacity and made it likely that business would reduce future expansion in plant and equipment. In addition to this most fundamental cause of the recession there were a number of contributing factors, such as a curtailment in defense orders, a drop in exports due to world-wide dollar shortages,

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and the effect of a prolonged restrictive credit policy.

Prediction. In giving advice on policy it is essential for the economist to make a prediction of the likely course of events —assuming that no specific antirecession measures will be adopted. Is a recovery of the market forces around the corner, or is a further contraction of business activities or a sidewise movement more likely?

Many techniques for economic prediction have been tried. During the 1920's there flourished the art of devising economic barometers. Attempts were made to discover constellations of economic data which, according to past experience, indicated that an upswing or downswing was in the offing. These barometers failed so utterly in predicting the depression of the 1930's that they were thoroughly discredited and at least temporarily discarded. Yet, using different methods, the National Bureau of Economic Research has identified certain economic symptoms which typically lead, and others which typically follow, fluctuations in economic activities. This approach to economic forecasting has recently been refined by the use of high-speed electronic computers. It is reported that the President's Council of Economic Advisors has been using these refined economic barometers—always in conjunction with other available information.

Another method, at least for short-run prediction, uses an economic *prediction model,* either in a mathematical or in a quasi-mathematical form. This model takes as a point of departure present economic decisions which affect future economic events. Businessmen make at least tentative decisions on programs for expansion of plant and equipment a considerable time before the programs are executed. Governments usually decide on their expenditure and revenue programs long in advance. Consumers deliberate for some time before they buy a new house or a new automobile. Thus, surveys of business and consumer intentions and a study of government budget proposals give some indication of probable future events. On the basis of past experience, relationships are computed between those economic factors for which some present information regarding future action is available and those factors for which no such information is available. A predictive model of the economy is thus constructed, the results of the various intention surveys and the proposed budget being used as building blocks, and the relationships of the past, as binding material.

The advantage of this approach is that a prediction model is constructed solely on the basis of ascertainable current facts and economic relationships of the past. It is limited by the fact that economic relationships are not always constant, so that there exists a considerable margin of error, and also by the fact that present decisions can be changed.

Future economic events are always determined in part by decisions of the past, but these decisions are modified in response to the unfolding economic events. This is what I call the "feedback effect" in economic development. For example, prediction models which were built late last fall for 1958 showed contractions in business investments, residential building, and exports; in part these were offset by rising outlays of state and local governments. On this basis a prediction of a sidewise movement, or of a very slight downward movement, of economic activity was indicated. Anticipation of this not too favorable course of events induced business to curtail production, in several lines drastically, in order to reduce inventories. Also, consumers showed more caution in their buying, particularly of durable goods, than was indicated by surveys taken in the summer of 1957.

We have no quantitative data from past experience for building those feedback effects into an econometric model for the future. Even if we had data for the past we could not assume that the same effects would result in the future. These effects are influenced at least in part by "learning from past experience," which makes it unlikely that the reactions will remain the same. Still, it is possible, at least in a qualitative manner, to take these feedback effects into consideration. Moreover, it appears prudent to assume that these kinds of feedback effects will accentuate either an upward or a downward movement. Even if the prediction model shows no change in the general direction of economic development, the feedback effect cannot be neglected.

Prediction becomes even more uncertain if we take into account what may be called "counterfeedback" effects. Such effects include not only factors which aggravate an economic trend but also factors which mitigate or even possibly reverse it. The classical (but unfortunately largely unrealistic) case is a recession in which prices drop so that consumers will be more inclined to buy, or in which lower interest rates induce business to increase outlays. If the counterfeedback effects could be assumed to be stronger than the feedback effects, one could expect an automatic reversal of the contraction. Actually, the feedback effects aggravating the downswing usually work faster than the automatic counterfeedback effects. That is why antirecession or recovery programs are designed to strengthen the automatic counterfeedback effects. In the present situation the most important counterfeedback factors are the countermeasures which could be adopted by the Government and the Central Bank in response to an unfolding recession. Here we have no precedents to guide the prediction because the response in each case will depend on specific political circumstances and will, in part, be influenced by the experience of the last downswing. Due to the feedback and counterfeedback effects in economics, we may apply Heisenberg's "uncertainty principle" to economics. I can assure you that the behavior of the private and public decision makers in the economy is at least as elusive as the subatomic particle which puzzled Heisenberg.

Fortunately, we do not need to guess what antirecession measures will be taken because our prediction model assumes continuation of present policies. Only thereby can the prediction model help us in determining what, if any, antirecession measures will be needed.

Let us assume that a present prediction model would indicate that we can expect an approximately sidewise movement of economic activity for the rest of the year. At the same time, additions to the labor force and continued improvements in production methods and technology would increase the productive capacity available to the economy under approximately full-employment conditions. The difference between the production potential and the predicted actual production for 1958 measures the gap which a fully successful economic policy would close. A rough estimate indicates that this difference is $25 to $35 billion.

Decision model. The next step, then, is to construct a decision model, which is a tool for finding what kind of policies or what combination of policies could accomplish this job. The decision model would be designed to answer the question: What monetary and credit policies, or what increase in government expenditures, or what reduction in taxes, or what combination of all these and other policies could generate enough additional consumer demand or business

investment, or both, so that the total of additional public and private demand would approximately close the gap? Under present circumstances, one might, for example, reach the conclusion that a relaxation of credit plus an increase in government expenditures of $10 billion, or a tax reduction of $13 billion, or a combination of credit relaxation plus a $5 billion increase in expenditures plus a tax reduction of $7 billion might do the job. Unfortunately, very little is known about the quantitative effect of various policies, particularly of tax reduction, so that, at best, statements can be made only about a general order of magnitude.

The basic approach to the formulation of a program for use both in a prediction model and in a decision model was explicitly provided for in the original Full Employment Bill of 1945. It is still embedded, though in more general language, in the Employment Act of 1946. J. Tinbergen has given the clearest expression to the relationship between the two steps, which must be used in combination. In the prediction model, according to him, we regard policies as given and the economic result as the variable. In the decision model we posit a certain result (economic target or objective) and regard as variables the policies needed to accomplish the objective.

This technique can at best give certain alternative policies for consideration but no definite answer about the best policy. This is about as far as economic analysis can lead us. Many economists will stop here. There is no rule as to what kind of research an economist stakes out for himself. It should be recognized, however, that the economist who limits himself to economic analysis is not yet in a position to give advice on economic policy. Other factors have to be considered before policy conclusions can be drawn.

Institutional Economics and Economic Engineering

Recovery measures must be appraised in terms of their administrative feasibility. An economist who recommends an increase in expenditures must know which expenditure programs have been so prepared that they can be increased within a given period of time without resort to makeshift work. If economists are to blame for the slow progress in getting recovery measures under way, then it is because they have failed to persuade the policy makers to prepare beforehand a work program which could be undertaken at short notice.

The time factor for effectiveness of antirecession measures in relation to the time factor of the prediction is important. It would not be very useful to initiate antirecession measures now if they are likely to become effective only at a time when the economy will be in an upswing again.

Thus, it is necessary to study the time span needed between the initiation of, let us say, a public works program and the actual placement of orders and hiring of workers. This time span is particularly long in some cases, such as when acquisitions of sites or rights of way are implied or when programs require legislative action not only of the Federal Government but also of state and local governments. Where programs have been prepared in advance and have been kept "on the shelf," they can be activated quickly in the event of a recession.

Some economists have recently recommended tax reduction as an antirecession measure in spite of the fact that, on purely analytical grounds, they conclude that a corresponding increase in expenditure programs could have a stronger antirecession effect. They have recognized, however, that taxes could be reduced promptly, while the initiation of programs of beneficial additional public expenditures would take considerable time. Many antirecession proposals have combined such measures of credit policy as can be most readily adopted with some increases in expenditures which are needed anyway and do not require too long a period of preparation, plus some selected tax reductions. Perhaps it would be useful if the economist would point out during periods of favorable economic conditions what preparatory measures should be adopted in order to be ready for prompt action when and if a recession (or for that matter, an inflation) occurs.

The economist who gives advice must take the institutional facts into consideration. Moreover, he must use his knowledge of the institutional facts in making constructive proposals. This constructive approach may well be called economic engineering.

Economic Politics

No proposal of antirecession policies has realistic value unless there is a chance that it may find political support. An economist once proposed that the simplest antirecession measure would be to drop dollar bills from an airplane over populated areas. This method could be defended on analytical grounds, and it is certainly technically feasible; it would, however, be political insanity. A program must be so formulated that it has a chance of finding political support. This does not mean that only those measures should be proposed which have greatest political appeal. A responsible economist often will have to recommend measures which are not popular. In these cases he has to examine the reasons for the lack of popularity and to propose a presentation of the measures which would be likely to reduce the resistance.

For example, a recovery program may encounter the argument that it creates a budget deficit. This argument may be met by demonstrating that a deficit would also result from letting the recession deteriorate into a depression. Estimates may, for example, be presented which compare the deficits resulting from a prolonged recession with those resulting from a successful antirecession program over a number of years. It may be further pointed out that a deficit which *results* from a recession or depression yields no assets on the other side of the ledger, whereas a deficit arising from the adoption of an antirecession program creates tangible assets (such as roads and hospitals) and intangible ones (reduction of unemployment and of its attendant hardships and frustrations).

The economist's function in the process of winning political support for an economic program should not be confused with the role of a politician who uses economic arguments to support a politically advantageous situation. I am talking about the economist who must take political considerations into account in constructing and presenting an antirecession program which would have a chance of winning the needed political support.

Economic Statesmanship

The Employment Act of 1946 wisely prescribed that the Government should use all "practical means . . . to promote maximum employment, production, and purchasing power" consistent with its "needs and obligations and other essential considerations of national policy." The economist who gives advice on economic policy must see the objective—in this case, that of restoring a high and

rising level of economic activity—in the perspective of other objectives of national policy. Assume, for example, that the international situation should necessitate a drastic increase in defense expenditures, such as has been recommended in a number of experts' reports. If, within a short time, the Government were to be embarking on very large additional defense programs for purposes of national security, the responsible adviser would not now recommend special antirecession measures, either public works expenditures or tax reduction. For this reason I hesitated to recommend tax reduction at an earlier time until it became clear what action, if any, the Government would take with respect to national security programs along the lines of the so-called Gaither and Rockefeller reports. Such an appraisal of policies for recovery in the perspective of policies for other national objectives is a function of statesmanship, and the economist, as an adviser, has to make it clear to what extent policies for various national objectives may either support one another or conflict with one another.

Another decisively important aspect of economic statesmanship results from the fact that policies must be decided under conditions of uncertainty. We all know by sad experience that our economic predictions are, to say the least, imperfect.

Using again the current antirecession policy debate as an example, we find two main attitudes. One of these advocates a continued policy of "wait and see," expecting an early upturn of market forces which would make additional government policies unnecessary. The other view is based on the expectation that the market forces will not bring about an early and adequate recovery and therefore recommends additional recovery measures.

The economist advising the statesman will recognize that, whatever view he personally espouses, he may be wrong. Therefore, he must evaluate the harm done in either case if the policy proves to have been based on an erroneous prediction. Assume that the Government does adopt additional recovery measures but that it turns out that the forces of the market bring about recovery independently. Then the total demand—government plus business plus consumer demand—may become excessive, and demand inflation conditions may develop. This would necessitate the adoption of anti-inflation measures at a later time. In the light of all experience we may anticipate that such anti-inflation measures will not be fully effective, and some price rise may result.

Let us now assume that the Government, advised of the probability of an early upturn in market forces, takes no further action but that, contrary to expectations, the upturn does not materialize. As the labor force grows and capacity to produce rises, unemployment and idle capacity increase.

Both types of error are certainly possible. Therefore, it must be evaluated which error will do the greater harm in the light of all aspects of economic, social, and political (in particular, foreign policy) objectives. This is, in my opinion, the crucial consideration in giving advice on final policy formulation.

A renewed rise in prices at a later time would certainly be undesirable, both from an economic and a social point of view. However, it is my opinion that the failure to counteract effectively the recession would be much more harmful and undesirable. We must consider not only the frustration of the unemployed and the irreparable loss of potential production but also the disruptive effect of the recession on the raw-material-producing foreign countries. The latter effect, in turn, might have serious consequences on foreign policy.

For a decade we have stated with pride that we have established the necessary legislative and administrative machinery and that we have the knowledge for dealing with severe economic fluctuations. Failure to use that machinery and that knowledge to prevent a serious or prolonged recession does great harm to the prestige of our political and economic system in the world and supplies ready-made arguments to the critics of that system. The economic adviser has to consider and present the risks involved in either action or inaction. But, in the last analysis, it is the statesman's responsibility to weigh the respective risks and to make the decision.

Specificity of Peptides

New aspects of the specificity of peptides with vitamin and hormone action are described.

D. W. Woolley and R. B. Merrifield

The marked structural specificity required in vitamins and other biologically active substances is a concept so widely held that evidence against such a view excites attention. The purpose of this article (*1*) is to summarize recent work which suggests that several kinds of peptides with recognizable functions in many living things do not conform to the classical picture of rigorous specificity. Rather large changes in chemical structure often do not seriously alter their biological activities. That such a situation should appear among peptides is interesting because the proteins have long been regarded as the prime examples of exquisite structural specificity. This view, too, is undergoing some modification in the light of recent discoveries with certain enzymes and antibodies (*2*).

In the past, the structural specificity exhibited by essential compounds such as the water-soluble vitamins has been striking. Minor variations in chemical constitution, such as the replacement of a $-CH_3$ by $-H$ or $-CH_2 \cdot CH_3$, have led to compounds of much reduced or no potency. Frequently such minor alterations have yielded antimetabolites which antagonize rather than exhibit the biological action. When evidence has been found of lack of specificity, as, for example, in the biotin activity of oleic acid (*3*) or the vitamin B_{12} activity of thy-

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