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Research Required for the Application of Interindustry Economics

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THE TWENTIETH CENTURY FUND

My title is written in shorthand. For the purposes of this paper, by "interindustry economics" I mean the development of economic theory and practice that begins with the introduction of Leontief input-output matrices.[1] The term specifically includes such adaptations of Air Force machine programing techniques as may be appropriate to the detailed analysis of the economy as a whole. By "application" I mean primarily the use of these techniques to develop detailed projections of the entire economy. Whether you call such applications conditional forecasts, models of the future, or analyses of the implications of certain policy and structural assumptions is a matter of semantic choice; I prefer to call them by the shorter (and I hope equally neutral) term *projections*. In my usage, this term does not necessarily denote a *prediction*, which as I understand it is something expected to be realized in fact. By "required" I refer to work that will improve the quality of these projections. I do not wish to imply anything that may be interpreted as a necessary precondition to useful application now. Finally, by "research" I mean the collection, compilation, and testing of statistical data. I am not concerned here with the mathematics of model formulation and computation, or similar related problems.

A. Introduction: The Strategy of Interindustry Research

The required research can be explained and defended in relation to problems of policy formulation and top-level decision making in both government and business. However, it may prove more informative to attempt to derive these requirements from an examination of the characteristics and logical structure of the interindustry approach itself.

I intend to paint with a very broad brush. I will not pause to formulate my proposals with the terminological precision expected of project statements. I will also try to disclose my biases, insofar

[1] As the views expressed are my own and do not represent those of any government agency or other research institution, I shall use the first person singular.

as I am aware of them. I do not believe that the economy can be adequately represented by a closed system. At present, I see no satisfactory general relationships or propensities that can be introduced from politics, psychology, or sociology to close the gap in our analysis. Nor am I sanguine about the immediate prospects of specifying the sort of quantitative objective functions necessary for optimization models. I believe that it will be necessary for a long time to come to stipulate over the entire span of our projections a large proportion of all the variables included in our analytical systems. In short, I am extremely skeptical of "pure" econometric models. To recall V Lewis Bassie's discussion of this matter at the Conference in Ann Arbor in 1951, I believe that we must continue indefinitely to use a combination of judgment and analytical techniques.[2]

My general approach to the problem of making effective projections may differ from Bassie's in one important respect. I look forward to the early adoption of the practice of making multiple projections based upon alternative policy preferences and sets of expectations. This procedure is customary with respect to population and labor force projections. The advent of interindustry techniques makes it practical and expedient to extend the practice to economic projections. Indeed, one of the contributions of interindustry analysis, in contrast with the more aggregative systems of gross national product analysis, is that such alternative projections may now be given sufficient detail to be interesting. But something else may be involved. Interindustry analysis necessitates the manipulation of very complex structures. If it is to play as versatile and effective a role as GNP analysis in day-to-day decision making, much work will have to be anticipated and kept in readiness. The preparation of multiple projections is one way of further "precooking" the material to hasten its application to more specific problems as they arise.

You are also entitled to know what I consider to be a "good" projection. Since I question the efficacy of single-valued projections (or predictions), I cannot give the easy answer that a good projection is one that turns out to be true. If one among a set of multiple projections contains a stipulation of final demand that subsequently turns out to approximate actual deliveries, and this projection

[2] V Lewis Bassie, "Recent Developments in Short-Term Forecasting," *Short-Term Economic Forecasting*, Studies in Income and Wealth, Volume Seventeen, Princeton University Press for National Bureau of Economic Research, 1955.

also anticipates approximately the achieved levels of industrial activity, then it is a good projection. As a practical matter, it may be better to rephrase this question retrospectively and in terms of projections systems rather than single projections. A good projections system is one that can estimate actual activity levels and input schedules from actual deliveries with something approaching the same degree of approximation that the basic data used have to the reality they are intended to represent.

James B. Conant, by an extension of concepts that comes naturally to any one of us whose life has been dominated by World War II, suggests that we consider the *strategy* of scientific development.[8] In interindustry economics, the process is quite apparent. Starting with the concept of gross national product, and proceeding by logical and practically justifiable subdivision, we arrive by easy stages first at the familiar product and income breakdown of GNP, then at a rudimentary interindustry chart encompassing only GNP components, next conventional interindustry charts in assorted sizes, then all sorts of special expansions, particularly in the final demand quadrant, until finally we reach very large structures, such as those contemplated in section E3. Neither alternative formulations of mathematical models nor alternative computing procedures modify the essential situation. Adequate data will always be the critical problem.

The process is like the old childhood puzzle of the box cover that showed an identical box that showed an identical box, and so forth. Where do we stop our probing into ever-greater detail? Eventually, the benefits of additional detail must become imperceptible. Some skeptics, like Rutledge Vining, appear to believe that diminishing returns set in with the first stage of interindustry application. As an avowed promoter of the technique, I probably represent the other extreme. Nevertheless, I would be the first to insist that the interindustry technique prove itself every step of the way. All I ask is that it be given this chance by being put into routine service at the comparatively modest level of performance possible today.

Three aspects of the data problem must be kept in mind: degree of detail, coverage, and systematic comparability. The third aspect will be touched upon briefly in section F. The developmental strategy

[8] James B. Conant, *On Understanding Science*, Yale University Press, 1947, Chap. 4.

I wish to illustrate is the following: The same logic that has driven the Bureau of Labor Statistics to construct a 450-industry table, an expansion that has occurred almost wholly within the input quadrant, will call for a similar expansion in the final demand quadrant and, later, in the charges-to-final-demand quadrant as more elaborate applications of the technique are attempted. In particular, I wish to counteract the naïve impression that, because the Bureau's 1947 chart is both conceptually complete and very detailed, it affords a ready-forged tool for making economic projections. Only a part of the prerequisite data has yet been made available. The marginal research dollar will probably have a greater immediate pay-off in the final demand quadrant than elsewhere.

B. The Quadrants of the Interindustry Table

If the detailed 1947 interindustry chart had not been prepared, no question of the immediate practical application of the technique would arise. While I do not wholly concur either in Harold J. Barnett's methods or findings, his study does suggest that the condensed classifications and the high proportion of unallocated inputs and outputs included in the 1939 chart may result in a structure too crude to serve as a useful instrument for projections.[4] Consequently, it seems important to inquire: What precisely does the new BLS study contribute from the standpoint of projections, as distinct from its contribution of a 1947 cross-section pattern to economic history.

Herman I. Liebling reminds us again of the close interconnection of gross national product and interindustry analysis.[5] In his paper he shows how the principal GNP accounts may be retabulated in the form of a simple two-way table to provide a rudimentary five-by-five input-output chart. Indeed, the interindustry chart in the form conventionalized by BLS may be derived from this conceptually by the repeated division of the business row and column.

Now look at this process from the point of view of a complete outsider without knowledge of the history of interindustry analysis. What would you see? First, GNP analysis is firmly embedded in the interindustry structure. In this respect, the differences in classifica-

[4] Harold J. Barnett, "Specific Industry Output Projections," *Long-Range Economic Projection*, Studies in Income and Wealth, Volume Sixteen, Princeton University Press for National Bureau of Economic Research, 1954, and Ronald W. Shephard, *A Survey of Input-Output Research*, Rand Corporation, 1952.

[5] See also W. Duane Evans and Marvin Hoffenberg's paper in this volume, "The Nature and Uses of Interindustry-Relations Data and Methods."

tion employed by the Office of Business Economics and the Bureau of Labor Statistics are irrelevant. Second, at first glance the expansion into the detail of the interindustry matrix may appear to be just another instance of the familiar process of scholarly elaboration. But what, in fact, motivates this elaboration? Could it be that there are serious limitations felt to be implicit in the high degree of aggregation that characterizes the GNP approach? Third, fragmentation may also be subject to limitations and implicit risks. However, the expanded matrix appears to have one inherent advantage: It allows for the explicit consideration of the respective roles of aggregative and detailed relationships in structural analysis and provides for the incorporation of either or both as may be found warranted.

1. GROSS NATIONAL PRODUCT

For purposes of exposition, I find it convenient to divide the interindustry chart into quadrants. By custom, the GNP categories are placed in the lower right quadrant, the distribution of final demand in the upper right quadrant, the distribution of charges against final demand in the lower left quadrant, and the distribution of inputs in the upper left quadrant. In interindustry economics it is the practice to give the rows and columns identical classifications and to maintain a square array. The interrelations among the four quadrants perhaps may be better understood if this condition is relaxed, while preserving the proper aggregative relations among the quadrants. This facilitates the expansion of detail within any quadrant on a basis comparable with any other type of analysis.

If the summation of the business sector is assumed to be included in the GNP quadrant, all the familiar aggregates of GNP analysis are together. Apart from the accounting identities, what stable relationships are exhibited here? If viable relationships cannot be established from regression and other analyses of time series, is it reasonable to expect such relationships to be derived from the cross section for a single year? In this case I think not. All those who argue, like Bassie, for the exercise of judgment in GNP projections would, I presume, support this view.[6] Actually, this quadrant contains the more important cross totals for the entire economy. The

[6] Bassie, *op. cit.* Also, Michael Sapir, "Review of Economic Forecasts for the Transition Period," *Studies in Income and Wealth, Volume Eleven*, National Bureau of Economic Research, 1949, pp. 275-370.

relationships within it should be expected to be stable only if the relationships within the other quadrants are also relatively stable.

2. INPUTS

The input quadrant is a different matter. The usual expression of these relationships is in the form of straight proportionalities: input to output. Wages, salaries, interest, rents, royalties, taxes, profits, and other charges that may be expected to have a more complicated relation to output have been deliberately segregated in another quadrant. At first these proportionalities seem highly plausible. However, there are four jokers concealed in the deck that must be examined and evaluated before these proportionalities can be accepted, even provisionally, as viable approximations.

First, the output of the several industry groups is not homogeneous but consists of a variable product mix. Even so seemingly homogeneous a product as electric power may be a composite of many different types of load. Incremental requirements originating in the atomic energy program or in the electrolytic chemical industry may call for different inputs than would an equivalent increase in demand originating in households. No problem arises, of course, no matter how heterogeneous the output, if the composition of demand is itself stable. The attempt to escape the difficulties created by the variation of product mix has been the principal cause of the expansion of detail in this quadrant. Increasingly narrow definitions of groups may lead to a breakdown of the industry scheme of classification. Considerable experimentation has yet to be done to test and improve the classification schemes available within the range of from 100 to 400 industry groups.

Second, no industry groups are outside the process of technological change. Input patterns do change with time. But how fast are they changing? Here there is no substitute for observation. However, I may remind you that even if we are dealing with as many as 400 industry groups we are still concerned with large aggregates. The process of technological substitution within an industry is necessarily a gradual one. The changes in aggregate inputs may turn out to be small enough to be neglected during the period in the immediate future for which projections are to be made. If large changes are observed, or are anticipated, explicit modifications may be introduced. This is really one aspect of the problem of keeping the interindustry matrix up to date, a matter to be considered more specifically below.

Third, input patterns are subject to price substitution. This is more than a matter of keeping up with what has occurred or of anticipating, on the basis of external evidence, changes that may occur. Changes in price relationships may be implicit in the stipulated changes in final demand themselves. Moreover, there may be a technological trend toward increasing flexibility in productive processes. For example, new steam electric-generating stations are being built with the capability of switching back and forth between coal and oil as the supply situation and market advantage may dictate.

Fourth, the required input of materials, even for a fixed product mix with stable technology and no price substitution, may not actually be proportional to output. To be sure, a businessman used to a bill-of-materials approach in his own planning operations would probably contend that this is a viable first approximation. An economist brought up on marginal analysis, however, might counter with the argument that it is precisely in the range of full employment and capacity utilization of plant that this strict proportionality assumption becomes most doubtful. He might expect, for example, that the less skilled labor then available for employment would result in higher rejection rates and thus in higher input rates. A production planner, possibly, might adduce compensating advantages in larger batch sizes and other material-saving factors. But obviously this matter cannot be settled a priori. Nevertheless, mathematical techniques are available that are sufficiently flexible to incorporate more complicated relationships into the analysis, if such should prove necessary and can be implemented statistically.

I doubt that the information is presently at hand for making an objective evaluation of the importance of these difficulties. The 1947 study serves less to settle these questions than to raise them anew more specifically and more urgently. Here, the first step is to determine an acceptable degree of approximation. This does not look to me like something for which a general answer can be found. It depends, rather, on the type of projection and the use to which it is put. To date, our experience with application of the technique is too limited to afford much insight into these problems. Some light can be thrown on the relative sensitivity of the economy to different types of change by comparative analysis of (1) different final demand stipulations and (2) the same stipulation with different classifications and different structural relationships. Experimental work of this sort should be given a high priority. But in many respects

what we need is better and more detailed data. Here we are up against serious limitations in the detail that can be made available across the board.

As serious as these four difficulties may be, it is obvious that the relationships within the input quadrant are much more stable than those in the other three quadrants. Indeed, the promise of the interindustry approach lies in this very difference.

3. FINAL DEMAND

An inquiry as to the stability of relationships within the final demand quadrant may seem redundant. This is, after all, the quadrant of the independent variables in the usual, straightforward applications of the interindustry technique. We do not expect the 1947 pattern of the distribution of final demand to persist. The size and composition of consumer, government, investment, and export outlays are expected to change. In fact, we stipulate those changes and seek to examine their industrial implications. But the interindustry system of analysis requires us to stipulate in 50, 100, 200, or possibly even 400 industry orders of detail. Only a minor portion of the total expenditure is likely to be specifically programed in advance in a form that can be made available to us. So we are confronted with a very formidable task.

What can be salvaged out of the 1947 expenditure patterns as a guide in making detailed stipulations? Again we are driven to progressive subdivision of a quadrant. We divide government into federal, state, and local; then, in turn, divide federal into defense and nondefense expenditures. We separate consumer durable goods from other consumer outlays, etc. In some cases, we may actually use the 1947 distribution in default of anything better. But throughout, this quadrant lacks a general principle, similar to the bill-of-materials concept which justifies the use of proportionalities in the input quadrant, to support the repetition of a given historical pattern. Working in this detail does not encourage the belief that we are dealing here with the ultimate independent variables, but neither does it support the view that a suitable basis for stipulation can be found wholly within the quadrant, or even the table as a whole. Determinants of the structure of final demand must be sought for elsewhere.

4. CHARGES TO FINAL DEMAND

There are many possible applications of the interindustry technique that do not require the use of the charges-to-final-demand

quadrant at all. But whenever we are concerned with conversion of the output levels of specific industry groups into required man-hours, or productivity, or the consistency of assumptions, stipulations, and projected activity levels with respect to the economy as a whole, then we must immediately work with this quadrant. We have deliberately dumped most of the nonlinear structural elements into it. I think it is correct to say that the 1947 study furnishes only historical information for this quadrant. The auxiliary research, conducted as a part of the interindustry-research program as a whole, has as its objective the provision of basic data for making crude estimates of the productivity, and of the man-hour and employment requirements associated with given levels of activity. This research, as presently formulated, contributes little to our understanding of the nonlinear structural elements. What this work amounts to so far is a series of estimates of time trend, not the isolation and analysis of variations with respect to changes in levels of output. The linkage from man-hours to employment to real income has not been explored. Profits, the most troublesome element, have not been considered at all.

What conclusions do I draw from this superficial review of the four quadrants? One is that we must guard against falling into a fallacy. Because we have set up a convenient device for arranging so much data, we cannot infer any persistence in the relations among the numbers with which we fill our empty boxes. The only necessary relations involved are accounting identities, and these are insufficient guides for most purposes. Part of the trouble arises from the ambiguous use of the term "structure." Sometimes it applies to the classification scheme, sometimes to the set of relationships. Preferred usage should, I think, apply it to the combination of both classification scheme and numerical relationship.

A second conclusion is that the interindustry table lends itself to the uniform postulation of simplified types of relationship across the board. The only place where such relationships give much promise of working is in the input quadrant. A cross section for a single year, like the 1947 chart, does not contribute much toward the establishment of usable relationships for the other quadrants.

A third conclusion is that there are important variables explicitly required in the application of the technique, particularly those relevant to the stipulation of final demand, which are either outside the interindustry table altogether or buried as components of one aggregate or another.

In summary, I must conclude that analysis of economic structure may well start with an interindustry table, but it only starts there. The 1947 study does not, by any means, provide a complete kit ready for instant application.

C. Several Modes of Application

The application of interindustry economics entails an interplay between the relatively persistent input proportionalities and the more transient relationships of the other three quadrants. Before considering the research implications of the foregoing conclusions, it will be well to examine several of the ways of applying the technique.

1. BASIC GNP PROJECTIONS

The elementary way of playing the interindustry-projections game is to start with a complete GNP projection. In this method, the first step is to confine the projection problem to the GNP quadrant (assuming for this purpose that the summation of the business sector is included within the quadrant). The projection of GNP and its components is then arrived at in the usual way, either by the exercise of judgment or by the use of some econometric model. Such a projection stands by itself. It is subject to all the limitations and inherent weaknesses that Bassie and others have discussed.[7] But it provides a starting point for the interindustry analyst and, incidentally, relieves him of responsibility for the major outlines of the projection.

The second step is to convert the aggregates of the GNP quadrant into the corresponding distribution of final demand by industry group. This has actually been done for the so-called emergency model on an 190-industry classification. It amounted to the most detailed projection of the product side of the GNP accounts ever undertaken. In the absence of firm relationships between the GNP categories and final demand by industry, this process of secondary stipulation cannot be carried out to a unique solution. Such stipulations may be made according to historical patterns, actual or pro-

[7] Bassie, *op.cit.* See also, Gerhard Colm, "The Nation's Economic Budget—A Tool of Full Employment Policy," and Everett E. Hagen, "Forecasting Gross National Product and Employment During the Transition Period," *Studies in Income and Wealth, Volume Ten,* National Bureau of Economic Research, 1947; also, Carl F. Christ's paper in this volume, "A Review of Input-Output Analysis"; and Arthur Smithies, "Business Cycle Analysis and Public Policy," *Conference on Business Cycles,* National Bureau of Economic Research, 1951, pp. 137-182 and pp. 405-421, respectively.

posed programs, or any other available scheme. The third step is to generate the corresponding levels of industrial activity by suitable application of the matrix of input coefficients. The fourth step is the translation of these activity levels into the corresponding schedules of inputs.

Altogether, considerable useful information that is not immediately apparent in the projection of the GNP quadrant itself is thus developed. It should make possible, for example, a test of the consistency of the original assumptions by permitting an examination, industry by industry, of the implications of the GNP projection. That is, it should assure the rejection of infeasible or unbalanced assumptions by requiring the projection to pass through a more finely meshed screen. However, a serious reservation needs to be made here. As yet we do not know very much about the sensitivity of these projections to differences in detailed stipulations within the same GNP category amount. Presumably, this question will be cleared up by experiments to be conducted as a part of the government research program.

2. FINAL DEMAND BY INDEPENDENT SECTORS

Another way of playing the interindustry-projections game is the converse of the one just described. In this case, final demand schedules are worked out in sector detail without reference to the GNP quadrant. The problem that the projection is intended to answer then becomes one of determining whether the postulated final demand is feasible within the known limits of industrial capacity and resource availability, and what levels of productivity and manhours may be required to support it. This approach is essentially complementary to the GNP type of projection. Indeed, an aggregate GNP projection, independently based upon reasonable limits of productivity, working hours, and participation in the labor force, may be used as a preliminary screen for testing the reasonableness of the summation of sector final demands.

3. MULTIPLE PROJECTIONS

Still another mode of play is to develop multiple projections for the same time periods. This may be done by working out alternative schedules for each sector of final demand. Such alternatives may express representative levels within the range of possibilities in each sector. Instead of consolidating these alternatives into combined final demand sectors, it may be more informative to compute the industrial impact of each alternative sector schedule separately.

This will permit much more varied combinations bracketing the range of possibilities for the economy as a whole. This procedure will make it possible for us to engage in an anticipatory form of comparative statistics. To date there is little systematic knowledge about the differential impact of various levels and distributions of final demand. It may be hoped that time to be made available on the Univac will provide for extensive experimentation of this type. At the outset, much more elaborate variations in the stipulation of final demand may be desirable than may ultimately prove expedient in routine applications.

4. CIRCULAR SUCCESSIVE APPROXIMATIONS

In making GNP projections there has always been a good bit of playing around the circle. This is the essence of the judgment technique. A provisional assumption as to one variable is used to estimate the value of other variables, which in turn are used to re-evaluate the first, and so on. Despite the much greater complexity of the analytical apparatus involved, this procedure of circular successive approximations may now be followed in preparing interindustry projections. It may prove particularly useful in routine applications prepared quarterly (or at other short intervals) in which the levels of important stipulations do not change drastically. The appropriateness of a stipulated investment program may depend on the levels of activity associated with the corresponding aggregate final demand. The computation of these industry levels will make possible a revision of the stipulated investment program, which may then be introduced into the next round. Thus, a progressive improvement in the quality of projections may be expected from the one computation cycle to the next.

D. Approaches to the Stipulation Problem

The quality of interindustry projections depends as much on the care put into the stipulation of final demand as on the degree of approximation achieved in the representation of the structure of production by the input quadrant. Sidney S. Netreba's account[8] of some of the technical problems involved in the projection of final demand in 200-industry-group detail hardly does justice to its full complexity. There is little precedent and very little structural analysis available as background for such an effort. Apart from

[8] Sydney S. Netreba, "The Bill of Goods for Interindustry Analysis," in "Input-Output Analysis: Technical Supplement," National Bureau of Economic Research, Multilithed, 1954.

military requirements and some pioneer work on the structure of capital expansion, the interindustry-research program does not as yet provide for adequate work in this area. To be sure, the distribution patterns developed in the 1947 study may be used, but only in default of better information. Outside of the interindustry program, little has been done at the level of detail required.

Let us consider four different approaches to the projection of final demand, insofar as possible in relation to its four principal sectors: consumption, investment, government, and export (and, negatively, imports = stipulated external availabilities).

1. PROGRAMING

The interindustry analyst, of course, would prefer not to be burdened with the projection of final demand at all. He would like to get ready-made schedules and confine himself to determining their implications in terms of industry levels and required inputs. In practice such ready-made schedules are rarely available in adequate detail and coverage.

Even the military services, which regularly schedule the procurement of thousands of major items (and actually buy millions of distinct items), cannot readily furnish complete delivery schedules in the detailed interindustry classifications. To do this would necessitate the establishment of a group of interindustry specialists in each department to supplement and systematize the work of the military planners. As yet there is little flexibility in this procedure, so that detailed schedules corresponding to different levels of defense expenditure are neither easily nor promptly obtainable.

Outside the military, there is a great reluctance to assume any responsibility for the detailed projection of expenditure programs. Presumably, in time, the Bureau of the Budget can be educated up to it. Certainly the determination of the industrial impact of proposed federal expenditure programs should be of great interest. With respect to state and local expenditures, of course, there is no vestige of centralized decision making, and no procedures exist for consolidating and summarizing proposed expenditures, except perhaps at the most aggregate level. Where such a focus is lacking there is no prospect for success in a programing approach.

2. INTENTIONS SURVEYS

Where programing is of no avail, the technique of market analysis may be invoked. In the popular form of intentions surveys these

have been extensively employed in the investment and consumer durable fields.[9] Without question such surveys are important and useful. Supplemented by the interindustry technique, they may be made even more helpful in the formulation of government and business plans and policies. The industrial impact of a set of investment intentions is important information. The consistency of such intentions with an associated aggregate final demand schedule may be considerably more significant. Routine determinations of this sort should be included among the regular applications of the interindustry technique.

As a part of a projections system, however, intentions surveys suffer from certain shortcomings. For one thing, they are extremely short range. They taper off into the future with a rather unsystematic understatement as the period in question becomes more remote. For this reason, they are extremely tricky estimates to blow up properly. Although it would shorten the time span involved, it would be helpful to segregate investment decisions for which some form of commitment has been made from intentions concerning which a firm decision is yet to be made.

I doubt if much stock can be taken in surveys of such "pure" intentions. The solid part of forecasts based upon intentions is accounted for by the longish lag between an investment decision and its execution. The more volatile character of intentions to buy equipment, in contrast with intentions to undertake construction, supports this contention. A survey of intentions mixes up two components: a concealed opinion poll as to the prospects for the period in which the intention is to be carried out, and estimates of individually appropriate investment action in the corresponding circumstances. The upshot is a prediction. It can provide no base for projections built upon an assumption applied uniformly across the board. Indeed, you cannot distill out of such a survey with any exactness even an "average" assumption. Hence, the results of the survey can have no specified place in a multiple-projections system.

I also doubt that usable results can be obtained now by introducing hypothetical questions into the surveys. To do this successfully,

[9] Irwin Friend and Jean Bronfenbrenner, "Anticipated Capital Expenditures in Relation to Forecasting"; O. J. Firestone, "Investment Forecasting in Canada"; John B. Lansing and Stephen B. Withey, "Analysis of Consumer Demand from Repeated Interviews and Reinterviews"; Irving Schweiger, "Contribution of Consumer Anticipations in Forecasting Consumer Demand"; all in *Short-Term Economic Forecasting*, Studies in Income and Wealth, Volume Seventeen, Princeton University Press for National Bureau of Economic Research, 1955.

three conditions would have to be fulfilled: First, it would be necessary to state the assumed prospective situation in terms that would be meaningful and specific to the individual respondent; second, the respondents would have to have on hand information on investment opportunities equivalent in content to a set of well-costed plans; and third, the minimum conditions for triggering those plans would have to be known in advance. In short, we would have to count on finding respondents having the benefit of a flexible capital budgeting system.[10] At present, that would not be a representative group. But if and when such practices become more common, surveys containing such speculative questions may make a real contribution.

3. REGRESSION ANALYSIS

Another extensively used approach, particularly in the field of consumption, is that of regression analysis. It is an obvious means of bringing information about the past to bear upon the future. As commonly practiced, it involves the assemblage of historical data for a number of variables deemed relevant to the determination of the demand for a particular item. The combination of variables that provides the best fit to past data is then selected as the basis for estimating future demand.[11] This is a partial approach. Each item is estimated separately. It is true that the selection of variables may allow some weight to be given to the size of the budget fund from which the expenditure is to be made, but the method does not provide adequately for the interrelation and substitutability of items within budgets.

It is questionable whether an expenditure schedule built up item by item in this way will turn out to be a consistent whole. It would be interesting to discover whether an expenditure pattern developed in this way for the two-thousand-odd items in the Consumer Price Index would be compatible with an assumed aggregate consumer outlay. In practice, of course, it has been impossible to make separate estimates for the whole list of items, so that a sizable proportion of expenditure has had to be handled in various catchall categories. Regression analysis gives us no indication whether these residuals are being squeezed or stretched in this estimation process.

As Bassie has commented in a slightly different context, the closer

[10] See Joel Dean, *Capital Budgeting*, Columbia University Press, 1951; also, his *Managerial Economics*, Prentice-Hall, 1951.

[11] Jack Alterman and Beatrice Vaccara, "Estimates of Consumer Expenditure for the Emergency Model," Bureau of Labor Statistics, Division of Interindustry Economics, Mimeographed, Jan. 21, 1952.

the fit to the past, the less likely the prospect of making a good estimate for the future.[12] In the type of economy for which we project, there is always some element, perhaps a large element, of autonomy. More often than not, we shall be called upon to project for situations that involve an acknowledged break with the past, such as a partial mobilization, a "post defense build-up period," a war, or simply striking innovations in consumption. Regression analysis is a device that will frequently have to be used in default of a better. But it must not be mistaken as an adequate answer to the stipulation problem, even in fields like consumption, where it seems most readily applicable.

4. STRUCTURAL ANALYSIS

I do not believe that there are any shortcut solutions to the problem of providing basic data for the stipulation of final demand. In my judgment, this task can be accomplished satisfactorily in the long run only by extending and deepening structural analysis within this quadrant. For the purpose of computing industrial activity levels and input schedules, of course, it is sufficient to stipulate merely a single consolidated vector—final demand by industry producing. Such an aggregate stipulation may easily be put together by "guesstimate." But unless such a vector is built up of clearly identified parts, no one can say what the computation based upon it would mean. It could only serve the very limited purpose of elucidating the differential impact of various levels and compositions of aggregate final demand.

Although final demand as here defined is equivalent to the product side of the GNP account, and is taken as the independent, autonomous, or exogenous side of an interindustry computation, we must give up the notion that it represents the ultimate level of stipulation. It does not. We know, for example, that the Air Force subsector of final demand, introduced into interindustry computations as a vector defined in 200 industry groups, may be based on the identification and interrelationship of as many as 25,000 separate activities. Yet this structure, vastly more detailed than the present interindustry structure itself, is driven by a comparatively few activities, each of which can be stipulated in advance for programing purposes.[13] The problem is to find for the rest of the final demand quadrant a

[12] *Op. cit.*

[13] Marshall K. Wood, "Research Program of Project SCOOP," *Symposium on Linear Inequalities and Programming*, Project SCOOP Publication 10, Headquarters, U.S. Air Force, Planning Research Division, Apr. 1, 1952, p. 7.

set of stipulatable activities and an associated structure that can bring us as close to the real determinants involved.

If a structural approach is adopted, it will be found, I believe, that the type of expansion of detail required will vary for the business (investment), household, government, and rest-of-the-world sectors of final demand. The basic Leontief matrix pattern, even if indefinitely subdivided, will prove inadequate except for business investment demand. This simple double array of establishments by industry group, a *from whom–to whom* alignment, will have to give way to a more complicated setup that explicitly provides for *who* (establishments), *what* (products), *from which* (industries of origin), *from where* (initial inventories or capacities), *why* (operations, maintenance, replacement, capital additions), and *when* (time periods). Different classifications, or bases for aggregation, will be needed in each sector.

First, consider households. A breakout between old and new, by age of head, by income class, by size or membership composition, and possibly by location, may be needed. To reduce the multiplicity of subclasses, various standardization and weighting devices should be employed. On the produot side, the Standard Commodity Code may be used for the identification of individual items, but the aggregation of items should be by use, and for this the National Income Consumer Expenditure categories may be helpful.[14] In collecting data for this purpose, nothing like the complete enumeration of establishments that characterizes the *Census of Manufactures*, on which the input quadrant is based, may be expected. Sample budget studies will have to suffice.

The sensitivity of expenditure for various items and categories of consumption to changes in real disposable income by class of household will require study. This conventional study of income elasticities should probably be supplemented by examination of sensitivity to changes in the total outlay allotted to various sections of the household budget. These are ways of getting at the *why* of household expenditure. Another important means will be to compile available budget data into a fivefold set of matrices for (a) holdings of consumer durables, (b) expenditures for household operation, (c) household maintenance, (d) replacement of durables, and (e) additions to household stocks of durables. By such a combination of subdivision and layering, it should be possible to identify

[14] Table 30, *National Income Supplement, 1951, Survey of Current Business*, Dept. of Commerce.

and define an inclusive set of activities appropriate to the household sector. Suitable measures of performance or work-load will have to be developed for each of these activities.[15] Demand for specific items or categories of items may often be found to be uniquely related to such a measure and thus provide a convenient basis for aggregation. Before such activities are put to work for purposes of projection, they must be tested retrospectively. It should be possible to determine for a past period a set of activity levels that will account, to a desired degree of approximation, for the actual expenditure of the period.

The structure resulting from this approach will have only a remote resemblance to the original Leontief matrix. The fivefold set of matrices proposed above will serve only an heuristic purpose. For projection work, they will be replaced by a set of activities, each of which will contain relationships derived from two or more of these matrices. Since we are dealing here with final demand, which by definition involves no feedback, these activities will be arranged in a triangular rather than a square array.[16] This triangular arrangement will give expression to the fact that for many types of household activity a distinction, say, between old and new households is irrelevant.

A similar development is required for the structural analysis of government expenditures. Establishments here should be classified by level (federal, state, local), by type (hospitals, police protection, agricultural research, etc.), and by service or function (passenger automobiles, printing and duplicating, etc.). The same basic commodity classification may be used, though there are several rival systems in the field, but appropriate special-use categories are yet to be developed. The same fivefold set of matrices listed above will have to be employed in this development, and something analogous to income elasticity studies may prove useful in identifying activities in this sector.

To define final demand to include business investment as we do may appear arbitrary. It has the advantage and plausibility of conceptual conformity with the product side of the GNP accounts.

[15] In the Air Force system of machine programing, these measures are called "program elements." See *A Flexible Procedure for Computing Material and Manhour Costs of USAF Consumption Type Items*, Project SCOOP Publication 2, Headquarters, U.S. Air Force, Planning Research Division, May 2, 1949.

[16] Marshall K. Wood and H. Burke Horton, "An Experimental Dynamic Model of the U.S. Economy," Headquarters, U.S. Air Force, Planning Research Division, Hectographed, 1951.

However, a strong case can be made for considering gross business investment as a derived demand. The logic of this case is obvious in a situation like a war mobilization, in which aggregate demand suddenly far outruns existing capacity. Yet even under conditions of such an extreme change, it may be expedient to stipulate business investment.

Here are some of the considerations that lead me to believe that it will continue indefinitely to be desirable to stipulate business investment. First, investment cannot be omitted entirely from an interindustry computation without grossly distorting the derived patterns of industrial activity. We then have a choice of stipulating either investment or existing capacity. Of the two, investment may be the more convenient to handle. Second, business investment cannot be tied directly to the immediate requirement for the expansion of industrial capacity, because in some degree all investment decisions involve anticipations in the expansion of demand beyond the period in question. Third, in a period of highly dynamic technological change, investment may be as much a function of the substitution of improved techniques as of increases in aggregate demand. Under these circumstances, the share of GNP that can be made available for investment may be decisive. Fourth, investment is the field for entrepreneurial antonomy par excellence.

These considerations make me doubt whether the investment process can ever be reduced to a neat set of formulas. By stipulation, we may proceed cautiously in this intricate field. We can make alternative stipulations, based upon the isolation of various of the forces at work, and make comparative examinations of their implications. As in any case in which we arbitrarily cut across a circular economic process for analytical purposes, we shall have the problem of seeing whether the several ends match up. Thus, one of the major inquiries to be answered by interindustry computations will be the consistency of the stipulated investment program with the investment required by the level of industrial activity implicit in the stipulated aggregate final demand.

The fundamental break in investment expenditure is between replacement and expansion. Although clear in concept, this differentiation becomes very hazy in practice. In our dynamic technology, there is very little replacement of like for like. Even such seemingly standardized items as telephone poles and railroad rails, for example, may involve significant changes in quality. Current methods of treating poles have greatly extended their expected service life,

while advances in metallurgy have markedly decreased the liability of rail to fissure, thus giving rail of the same unit weight greater load capacity. The ordinary process of replacement may drastically alter the pattern of existing capital with respect to its average expectancy of service life, and to the capacity relationships of the separate items combined in a single industrial process. The decision to replace a particular capital item, however, may have little to do with its remaining useful life. The current replacement of steam locomotives by Diesel electrics, for example, has not been much affected by the age distribution of the steam locomotives in service. The relative profitability of an item as opposed to its technological substitutes is what counts. Current high rates of obsolescence must be given explicit recognition in the stipulation of investment demand.

The expansion of capacity may be required to match increases in population or higher levels of per capita expenditure or to provide for innovations in the form of new processes, new materials, or new products. Such expansions may take the form either of complete new plants or of additions to existing plants. Generally speaking, an existing plant does not consist of a perfectly balanced collection of equipment and structures. Expansion of output in an existing plant will encounter a series of bottlenecks at various levels of operation. Often, these can be eliminated by the addition or substitution of other units of equipment and structures. But the typically unbalanced character of these additions will create, in turn, new bottlenecks at higher levels of output. Similar bottleneck problems are created by conversion of capacity from one product to another when this is feasible.

Such stubborn facts as these must be provided for in the structural analysis of investment. This approach requires that the data be marshaled in such a way that separate structures are developed for meeting investment demands for replacement, unbalanced additions, new plant, and obsolescence or innovation. The combination used in a particular industry or for the business sector as a whole is to be taken as a matter of choice for the stipulator.

The basic classification scheme required for a structural approach here is establishment by industry group, as in the input quadrant. However, it is already obvious from the work on capital structure so far undertaken that differentiation of processes within groups of establishments (and even within establishments), and of products within industries of origin, will be required. A standard classifica-

tion scheme for industrial processes is now urgently needed. Almost the same may be said for industrial structures and equipment.[17]

Measures of capacity are essential tools in the important applications of the interindustry technique. No questions of feasibility can be answered without measurements of capacity, nor can the stipulation of investment be carried out effectively without such baseline information. Yet capacity is a treacherously ambiguous subject. To get ahead I think we must abandon both the rigidity of the engineers and the relativity of the economists. Like accounting, this is a field in which we must frankly adopt conventions. If we can get a set of measures into common use, we can then act rationally with respect to their limitations. Without them we shall have no guide lines at all. A high priority should be given to the exploration of the economic implications of proposed conventions with respect to the measurement of capacity. Whatever conventions are eventually adopted, we shall need frequent surveys to determine the capacity of establishments, by industry group and probably by process within industry. To parallel these studies of capacity, inventories of industrial equipment and structures on hand will be needed.

The stipulation of two-way trade with the rest of the world involves such special problems that it will be well to pass over them here.

Let me summarize briefly my tentative conclusions about the structural analysis of final demand. It will prove necessary to provide more adequately detailed classification schemes for each sector of final demand. On this base there will be erected sets of related and consistently designed matrices in which all routine and special-purpose collections of relevant data can be compiled. These matrices will furnish a ready reference from which numerical relationships can be drawn for the construction of appropriate final demand activities.

A limited number of these activities will be the ultimate level of stipulation in this system of analysis. There will be a larger number of intermediate activities that, in turn, will be collapsed into a smaller number to provide the linkage with the interindustry struc-

[17] An extremely detailed classification of industrial equipment and machine tools already exists in the Standard Commodity Classification. Here, the problem is essentially one of developing an acceptable scheme of aggregation and of conversion to the Standard Industrial Classification. The problem of secondary inputs is also of concern; see the discussion below.

ture proper. What I have called the "ultimate level of stipulation" represents an attempt to give formal recognition to forces much closer to the real determinants of final demand than the abstract composites of the final demand quadrant of the interindustry structure. Out of this approach there should eventually develop a check list of the types of assumptions that must be made in order to initiate any economy-wide projection. It may then be possible to estimate the practical ranges that such assumptions might take. Such constructs would give us very valuable insight into the forces and potentialities at work in our economy.

Because the amount of data that could conceivably be brought to bear on the structure of final demand is so immense, it will be necessary to conserve our effort. All establishments and all products are not equally important, yet it is highly desirable to maintain the principle of complete coverage. In this situation the use of systematically stratified samples, both in the establishment and in the product dimensions, should be pushed. Analytical work should be apportioned according to the dollar volumes involved.

E. New Fields of Research

1. STIPULATION OF SECOND-ORDER IMPACTS

The problem of product mix deserves further examination in relation to the stipulation of final demand. For example, let us stipulate an expenditure of $100 million on aircraft. What does this mean? With reference to the 1947 chart, it implies the purchase of a package of output having the same composition as the output of the base year. It happens that 1947 was a very unrepresentative year for the aircraft industry. At that time the output of the industry was not so much aircraft as aircraft research. But even if that had not been the case, we should need to take into account the significant change in the character of the aircraft produced between then and now. To get around this change, the Air Force has adopted the device of stipulating the demand for aircraft not in terms of the output of the aircraft industry but of the inputs for specific models and series of aircraft, that is, in terms of the second-order impact of the initial demand.[18]

[18] There is some confusion as to the numerical ordering of successive economic impacts. I have adopted the convention that direct expenditure by the ultimate consumer represents the first-order impact, while purchases made by the manufacturers of these items constitute the second-order impact, and so on. As in interindustry usage generally, trade, transportation, and similar charges are not considered separate impacts but are taken as auxiliary to each principal phase of production.

The implications of this characteristic feature of the interindustry formulation are revealed by an examination of how it works out with respect to household final demand. Let us suppose that our stipulations include a certain dollar outlay on vacuum cleaners. These are products of the electric appliance industry. This stipulation does not imply the straightforward purchase of a corresponding number of vacuum cleaners, but rather the dollar equivalent of the 1947 composite of domestic laundry equipment, sewing machines, vacuum cleaners, service and household machines, and other appliances. Serious distortions may occur if, during the period for which the stipulation is made, vacuum cleaners and other products of the industry are not taken in the same proportions as in the base year. Such distortions would be avoided only in the surprising event that the input pattern of the industry turned out to be approximately invariant to changes in the composition of output. As in the Air Force procedure, this difficulty may be escaped by stipulating in terms of the second-order impact.

In the Air Force this practice is described as the creation of "synthetic industries." It is an interesting question whether such synthetic industries belong to the structure of final demand or to the input quadrant. The formulation of a synthetic "B-52 aircraft industry" may not at first appear to be very different conceptually from the creation of another activity within the Air Force structure itself (that is, within this subsector of final demand). Yet this so-called synthetic industry is not just a statistical construct. It implies a real counterpart. It absorbs the capacity and manpower of some actual industry. These "services"[19] must be stipulated for, yet we are permitted to stipulate only in terms of the composite base-year output of the actual industry. By this route we come back to our original difficulty. An alternative is to split the actual industry into two parts. When it can be conveniently carried out, this is, of course, an acceptable solution costing only a comparatively small enlargement of the original interindustry table. However, the availability of data and other conditions will often not permit it. The requisite for a true industry split is the ability to make the same product differentiation in all other sectors of final demand and in the input structure of all other industries.

The remedy for this situation, it seems to me, is to recognize this anomalous piece of structure for what it is, and to make corresponding structural adjustments elsewhere. It is far too useful a device

[19] Accounted for in the charges-to-final-demand quadrant.

to chuck out altogether, as some structural purist might advise, but its uncompensated use may lead to serious distortions of its own. The Air Force use of the device has escaped doing much harm, I suspect, because it has been largely confined to items entering exclusively into final demand and originating in an industry nearly dormant in the base year.

The required adjustments involve a split of the appropriate column, but not the corresponding row, of the base-year interindustry "transactions" table. Really, a threefold split is needed. First, the base-year purchases of the "special" product by the final demand sector in question, and their corresponding inputs, must be segregated; next, other products of the industry purchased by that sector, and their inputs; finally, all other purchases from the industry by other final demand sectors, and by other industries indirectly, together with the corresponding residual inputs. The coefficients based upon the two new columns are then incorporated into the final demand structure of the sector concerned. The third new column serves in the place of the original in all other interindustry computations.

Now that the device has been put in a more acceptable form, what are the prospects of more general application? In the so-called emergency model it has already been extensively applied in major military procurement, special investment areas, and producers' durable equipment. These uses seem likely to continue, and may easily be extended to include other government expenditures, construction, and such concentrated areas of final demand as consumer durables. The device may be adopted wherever the structure of final demand is specified in greater detail than is the interindustry structure with which it is to be linked. In short, I should expect to see the practice spread wherever the opportunity exists for stipulating final demand in product detail, and where the corresponding direct inputs can be fairly readily estimated. It seems likely to spread to industries in which the output is concentrated in a few, but dissimilar, product types, or where there is a similar concentration in a few dissimilar input patterns. There should be an early exploration of the possibility of extending the practice to all industries in which changes in product mix create serious problems. If use of base-year composite outputs can be confined to indirect impacts, this will greatly reduce the distortions involved.

This development can only be bought at the sacrifice of considerable conceptual neatness in the interindustry analytical system. The

upshot is a triangular system of the Air Force type in which the final demand structure is carried a phase further than before, and the indirect impacts are handled in a large area of local iteration near the bottom of the triangle.

2. SEASONALITY

So far we have dealt with the stipulation problem as if all we propose to do is to project an "equilibrium" flow of goods and services for some distinct future period or periods. Projections for discrete periods are no doubt useful, but for many purposes continuous projections over a sequence of periods will be required. The path of the economy, projected over a span of time, will be determined by the stipulation of final demand in conjunction with an appropriate set of lead times. In this technique an important objective is the correct timing of inputs, for these determine the actual levels of industrial activity. I will not discuss the general subject of lead times here. Some research on it has already been done and more is to come. I am here concerned with the seasonal pattern of inputs.

The 1947 interindustry table is an annual table. Stipulations so far have been made in terms of annual rates. The effect of this practice is to introduce serious distortions into the projections over a sequence of periods phased in intervals of less than a year. The use of annual rates implies an averaging out that may significantly understate peak requirements, particularly important with respect to capacity and manpower. If capacity and manpower alone were affected, compensatory estimating procedures and suitable offsets might be devised. But seasonal variations may have ramifications throughout the economy. Because of the practice of holding inventories, these ramifications are less conspicuous than they otherwise would be. This merely cites another aspect of the problem.

In the interindustry system it is intended that inputs reflect only "technological" requirements for a given volume of output. That is, no inputs are provided to cover seasonal carry-over or other inventory change. It is true that the interindustry technique will generate changes in inventories based upon changes in stipulated final demand. But these inventories are in "pipeline" form, or goods in process. This convention should be preserved. Inputs should in this sense be kept "technologically clean."

There are two cases to consider: production-oriented seasonality, of which agriculture, construction, and shipping are conspicuous examples; and demand-oriented seasonality, of which holiday and

vacation businesses make good examples. The simplest device for handling the first case is to introduce a variable pipeline—that is, to allow the lead time to vary during the year. A demand for wheat in January would have a different lead time from a demand for wheat in July.

The demand-oriented cases, however, are more difficult. Here, to begin with, we need to stipulate a seasonal pattern of final demand. Studies already available, isolating the seasonal component in relevant sales data, may suffice as background for this task, but there will probably be gaps in coverage at the desired level of detail.

The timing of inputs of perishable products will create no problem. Storage is impossible and the regular input lead time may be used. But storable outputs raise several possibilities. An item may be produced uniformly throughout the year and held to meet demand. Or it may be produced for storage in a counterseasonal pattern. The storage may occur at any or all stages of fabrication, and by either buyers or sellers at each stage. Beyond the first impact stage, the identification of the storage of an industry's output with a particular seasonal demand may be lost. (The interindustry technique may be invoked to trace other indirect effects, but not storage.) In some cases it may prove possible to meet the demand seasonality problem by stipulating in terms of secondary impacts. In others it may be necessary to introduce an explicit storage activity. In this event it will be necessary to accompany the stipulation of a seasonal demand with a corresponding pattern of inventory accumulation and decumulation.

The background data presently available are inadequate. As a first step it will be desirable to rank industry groups with respect to their seasonal variation and volume of output. The seasonality of industries low on the combined rank list may well be ignored. An appropriate cutoff could probably not be decided a priori. Pronounced seasonality may be sufficient reason for splitting an industry wherever a nonseasonal industry can be separated out easily. On the other hand, less seasonality should be expected for industry groups than for specific products. Seasonality will become a more pressing problem as the analytical system expands in detail.

It seems likely that screening will indicate the need for new studies of seasonality in selected industries. These will have to be tied closely to interindustry classifications. Heretofore, most studies of seasonal variation have considered sales, inventories, and pro-

duction independently. For this purpose it will be necessary to adopt an integrated approach.

3. THE STRUCTURE OF COMMITMENTS

The complete stipulation of final demand for a future period does not conform with the way in which decisions are actually made. It does conform with budget practice. Economists, accountants, management engineers, military planners—rationalists all—often think and act as if once a day, once a month, once a year, or on D-day, the slate would be wiped clean and every element on it could then be freshly determined. Actually, many commitments made in the past extend into the future. Periodically to redetermine everything would be an intolerable burden. In practice we make decisions piecemeal about a portion of our affairs at a time. We tend to face up only to the exceptional, and so confine our decisions to the more emergent, and therefore more urgent, aspects of existence.

It is true, of course, that the whole drive of rational action is to enlarge the area of deliberate choice, to bring a situation under review so that the interrelation of its parts may be explicitly recognized, in order that the whole may be brought under control. But a budget slice, a cross section of an economic situation at an interval of time, is not the best framework for this purpose. It does have the merit of being familiar and handy. It is undoubtedly a carry-over from accounting, where a summary of transactions for a past calendar period has meaning. Yet the artificiality of it, together with the burdensomeness of filling out all the detail covering decisions that are already over the dam, may go far to explain the resistance that budgeting encounters at every level of application. The fact that we use accounting data and are accustomed to think in discrete accounting periods, makes it difficult to set up a proper alternative. Let me try to put the decision maker's task in a more adequate perspective.

The past is distinguished from the present and future because it is entirely and irrevocably committed. Some past commitments project into, and limit, the present and future; of these, some are irrevocable but others may be modified at a cost. Today's events are almost completely predetermined by choices made yesterday and before; nevertheless, a small area of free choice remains. As of any day, the opportunity for the exercise of free choice increases as we include more and more of the future within the compass of our decision making.

So far, I have considered the future as it unfolds before all participants collectively. From the standpoint of any individual decision maker, some elements are at his disposition while others are subject to the control of the other participants. The future thus divides into three parts: that which is already committed either by the decision maker or by others; that which comprises the area of free choice of the decision maker; and that which comprises the free choice of the other participants. Future events are determined by the interaction of the three parts.

Note that according to this conception the area of decision making is not the complete set of elements falling into a single calendar period but a wedge, narrow in the present but broadening out in the number of elements it encompasses as it extends into the future. For short, I call this wedge the "uncommitted complement." Past commitments may not be known very explicitly, still less their implications. Thus, the borders of the uncommitted complement may not be readily apparent. One of the important contributions that the interindustry technique may make is to compute forward projections of past commitments, thereby making possible a more exact knowledge of the possible area of free choice.

In economic projections, past commitments play a role analogous to that of persons already born in a population projection. In that process, attention is focused not on total population but on the uncommitted complement—expected mortality and future births. In stipulating for purposes of economic projection, we should adopt a rule of economy of effort. We should direct our attention to the uncommitted complement. We should stipulate only expectations and proposed decisions, and devise a procedure to build new commitments into the computations as incremental layers as they occur.

The commitments approach may perhaps be better understood by giving brief consideration to an alternative projections method. The immediate future could be projected by the repetition of the immediate past except for specifically introduced changes. In this method, stipulation is confined to anticipated or proposed changes. It works best in internal planning systems, where such changes are under direct control. As a general procedure it offers no obvious framework for identifying the areas in which change needs to be stipulated. If we attempt to elaborate this method systematically, we are driven back to an equivalent of the commitments approach.

Pursuit of the commitments approach will require the reorientation of the research on the structure of final demand as previously

suggested. In all sectors it will involve separating out types of expenditure that flow from prior commitments, as, for example, telephone subscriptions. In all sectors it will be desirable to develop reporting systems, in the appropriate interindustry detail, designed to measure the extent of such commitments. In the investment sector particularly, there will be a call for comprehensive, periodic information on work in progress, new orders, and intentions. In this context it might become more desirable to project the charges-to-final-demand quadrant. This would provide a form of sources-and-application-of-funds analysis that could be used to set limits on various categories of expenditure. Altogether, adoption of this approach would make it possible to bring more of the available and potentially available information to bear on projections.

F. Postscript: The Tactics of Interindustry Research

Ten years ago the data requirements sketched out above might have appeared fantastic. After the double experience of WPB and NPA, we cannot say so today. The volume of data suggested for the fanciest elaboration of the interindustry technique is probably not much greater than that used by these emergency agencies. The difference would consist in the organization and consistency of the data. It is no exaggeration to say that the statistical systems of these emergency periods have been improvised patchwork. The later period is perhaps distinguished by its ability to improvise streamlined patches faster. In neither period were the data so classified and fitted together that they could be brought to bear as a whole on the problems of industrial mobilization. As a matter of fact, until now it has been possible to content ourselves with special-purpose data, because it has not been practical to manipulate any considerable mass of data to serve a general purpose.

The whole context has changed. Herman Hollerith invented punch-card accounting to facilitate the compilation of data solicited from firms that kept their records in longhand. Today, the Census has acquired a Univac to facilitate the compilation of data collected from corporations that keep their records on punch cards. The day is in sight when private business organizations will marshal their facts for internal planning and control, and incidentally for reporting to the government, with the aid of Univac.

The availability of the requisite data is the basic limitation on the application of the interindustry technique in the preparation of multiple, detailed, economic projections. Not everyone may be as

patient as I am prepared to be. I can foresee in some future emergency an administrator who will come in to find projection techniques available, mathematical models available, computing procedures available, even machine time available, and only the data lacking. I can see him order in the data.

Now it would seem to me to be a reasonable research assignment to try to anticipate what such an administrator's data requirements would be and how they could best be met. Big claims are made for interindustry economics, not because of what it is or has accomplished today, but because it is the precursor of a major technological development. We are going to learn to use information in the mass to increase our individual and collective freedom of choice and to control events in larger blocks. Let us pick the *Census of Manufactures: 1963* as a target. How is the federal statistical system to be redesigned to match the information potential of that year? It seems to me that at the present time this is an appropriate assignment for a private research institution under private financing.

I would like to answer two possible objections to this suggestion.

First, it may be asserted that the project is premature. With reference to a possible war emergency, it may more truly be said that it is overdue. Neither the Munitions Board, the National Security Resources Board, nor the ODM-DPA complex of agencies has come up with a design for an emergency statistical system geared to the requirements of mobilization planning and control. It must now be recognized that the Controlled Materials Plan is not a plan, but an administrative device. It even fails to generate within itself sufficient information to plan materials production and allocation effectively. Yet it is the only comprehensive instrumentality in the field.

With respect to civilian peacetime requirements, there would appear to be no such urgency. But look at the time schedule. The *Census of Manufactures: 1953* at the time of writing was too far advanced for any but minor changes. Five years is rather too short a time for developing, testing, and introducing a major new classification system. A process-within-industry classification scheme might well be found to be necessary. Yet no system changes in classification can be expected to be introduced into the 1958 census. That leaves 1963 as the first peacetime occasion for a possible across-the-board overhaul of the federal statistical system.

Second, it certainly will be argued that a government statistical system cannot be created *de novo*. It is created rather by slow elaboration, by steady negotiation, and by the patient dovetailing of

innumerable parts. Granted. A federal statistical system cannot be imposed by executive order. The slow, patient, steady work must and will go on. What is needed, and needed urgently if the potentialities of the emergent technology are to be achieved in a reasonable time, is a reference design. This will greatly facilitate the work of the Bureau of the Budget in its day-to-day responsibility for reshaping the system. Is it really too early to begin work on a guide for those who work on the actual puzzle?