THE ROLE OF INTERINDUSTRY STUDIES IN ECONOMIC INTELLIGENCE

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Interindustry economics, or, as it has sometimes been called, input-output analysis, is an organizational framework and tool of analysis for studying an economic system quantitatively, rigorously, and systematically. The techniques permit analysis of an economy as a whole and of individual products and industries simultaneously. Interindustry research must necessarily be regarded as long-run cumulative research. The requirements for data are large. In many cases intelligence sources cannot provide much of the information needed. Only a slow and painstaking process of continuous research can fill the gaps. In the short run, interindustry studies contribute mainly a system or framework in which many types of quantitative economic information can be related to one another. In the long run, as the data improve and accumulate, it will be possible to undertake the solution of complicated problems, as, for example, to estimate the economic consequences of given sets of wartime demands on an economy.

The beginning of analysis with interindustry techniques is a detailed description of the economic system for an annual period. The goods and services produced in the economy are aggregated into sectors. The description indicates the transactions (purchases and sales) among these sectors. Any given sector is described both in terms of its purchases from each of the other sectors — the input, or cost, structure — and its sales to each of the other sectors — the use, or consumption, pattern. For the whole economy, all the transactions which took place in the given year are shown in a double-entry accounting tabulation organized so that along the rows the use patterns of the sectors are arrayed and in the columns the input structures of the sectors are listed. The interindustry tabulation is the basic information with which analysis is performed.

Analysis can be conducted either by regarding the economy as a closed circular system in which the output of all sectors is consumed by other sectors or by distinguishing between two types of sectors in order to determine the impact of changes in one group of sectors on the other sectors and on total output. The open interindustry system has been the most useful both because the assumptions it is necessary to make more nearly approach the facts than is the case with the closed system and because open interindustry system analysis offers the possibility of examining a wide range of problems concerning changes in demand and technical structure.

The open interindustry system distinguishes between interindustry sectors and final demand sectors. The interindustry sectors are engaged primarily in buying from other sectors and selling to other sectors. The food-processing, chemicals, and transportation sectors are examples. These sectors buy raw materials, electric power, fuel, and other inputs and in turn sell their output to many other industries and to households. The final demand sectors consume the output of other sectors but do not produce a processed output which is sold to any other sector. Sectors usually considered to be final demand sectors are household consumption, foreign trade, government (including military) expenditures, and capital formation.

The amount of research effort, the quality and quantity of data, the objective of research, and the technological and decision-making processes of the sectors condition the decision to place a sector in final demand. For the interindustry sectors, rigorous analysis assumes fixed technical interrelationships between inputs and outputs. The fact that such assumptions are not made for final demand sectors, in which constancy of technical interrelationships is seldom characteristic, implies that an open interindustry system is most suitable for analytical purposes.

The breakdown of transactions within the economy and the nature of the interrelationships may be of varying degrees of complexity. The three major transactions categories are (1) current account, (2) capital account, and (3) interregional transactions. Technical interrelationships are frequently as-

sumed to be constant. If data are available, however, linear, discontinuous, or curvilinear functions can be used.

Any given transaction between one sector and another may be divided into its components and tabulated along with the total. A purchase designed to meet the current operating needs of the buyer is usually the largest proportion of the total purchase by a sector. In much of interindustry analysis this transaction is the only one taken into account as a part of the interindustry system. Another segment of a purchase by a sector is that which is on capital account — purchases designed to add to capacity or to increase inventory. When analysis is performed using the relatively simple current transaction interindustry system, capital transactions for all sectors are aggregated into separate capital formation and inventory sectors, which are usually placed in final demand. When capital transactions are identified for each purchaser from each seller, then a double interindustry system results. The double system is called the dynamic interindustry system.

Another breakdown of transactions is to specify the region originating and the region receiving for every purchase and sale. Such an interregional interindustry system amounts to splitting the national interindustry tabulations into regional components and indicating not only the interindustry transactions but also the interspatial transactions.

The more complicated the interindustry systems become, the more rigorous become the assumptions which it is necessary to make to perform analysis. In the simple current transactions system it is usually assumed only that the relationships between inputs and outputs for all interindustry sectors are known technical functions. With a dynamic system it is assumed, in addition, that the relationships between capital inputs and outputs at capacity are known technical functions. An interregional system involves the assumption that there is a known technical relationship between inputs and outputs region by region.

The technical interrelationships are usually assumed to be fixed and constant. It is not analytically or computationally necessary that technical coefficients be constant. The func-

tions may be linear, discontinuous, or curvilinear. The use of such functions, however, implies that data exist to support the described relationship. It is seldom that such data are available. Most analysis, therefore, has been driven back upon the constant coefficient asumption.

Despite the possibility of undertaking quite intricate analysis with dynamic and interregional systems and notwithstanding the analytical feasibility of flexible assumptions about technical interrelationships, the work which has been done in interindustry analysis has in fact been largely confined to the more simple current transactions system, in which the final demand sectors correspond roughly to gross national product, which includes household consumption, government expenditures, and capital formation.

The type of analysis which can be performed with an open interindustry system is called the analysis of parametric change. Parameter is a mathematical term denoting in this case a set of values derived from a hypothetical situation. It is the purpose of analysis with an open interindustry system to trace through the economy the consequences corresponding to a given set of values. The parameters in interindustry analysis are (1) sales to final demand and (2) interrelationships among interindustry sectors embodied in the description of the structure of the economy. Changes in these elements have economic impact far beyond the immediate change.

The interdependence of modern economies, as depicted in interindustry tabulations, is such that any change in the structure or in final demand initiates a complicated round of indirect effects. Interindustry technique is oriented toward determining quantitatively the magnitude of indirect effects on the output of all sectors.

An increase of $1 million in final demand for aluminum products, for instance, results in an increased demand for all inputs feeding into that sector. Aside from labor and taxes, which are charges against final demand, these inputs are bauxite, alumina, electric power, chemicals, metals, and transportation. Since demand for aluminum is up, the supply sectors must expand operations and hence demand more in-

puts from their suppliers, and so on. These reciprocal and indirect effects are frequently small after the first round, but the cumulation of the second, third, and fourth rounds, and so on, amounts to a significant proportion of the total indirect effects. From an initial increase in final demand of $1 million worth of aluminum products there results an industrial expansion of $2.5 million, or indirect effects of $1.5 million. The total expansion is divided as follows:

The Impact of $1 Million Worth of Aluminum Product Deliveries to Final Demand

	In Thousands of Dollars
Steel Works and Rolling Mills	10
Primary Metals	16
Copper Rolling and Drawing	20
Nonferrous Metal Rolling	22
Primary Copper	25
Metal Mining	27
Coal and Coke	30
Wholesale Trade	37
Railroads	39
Primary Lead and Zinc	43
Petroleum Products and Crude Petroleum	47
Electric Light and Power	64
Industrial Chemicals	111
Secondary Nonferrous Metals	252
Primary Aluminum	479
Aluminum Rolling and Drawing	1,097
Other	181

Like changes in final demand, changes in technical relationships start a round of indirect effects, resulting in a different level of output for all sectors. A comparison of sector output under the two situations indicates what effect the structural change has had.

It also is possible to interpose side conditions and determine the consequences of the economy's operations under these conditions. Assume that the outputs of all sectors have been computed under given conditions. Then it may be postulated that a given sector's output is a specific amount. With the new schedule of outputs, the same as before except for the one sec-

tor, a new final demand may be determined. In addition, different magnitudes and mixes for final demand may be postulated, all consistent with a specific output for the given sector but with other sector outputs free to change.

Within the framework of analysis of parametric change (and side conditions), it is possible to deal not only with the structure on current account but also on capital account and to take into consideration other more complicated phenomena. To do so multiplies the data requirements, requires new assumptions, and introduces time explicitly into the analysis. While more complex in data, analysis, and interpretation, the results are in finer detail and are more precise and reveal aspects not discernible in simpler analysis.

Underlying all the analysis, indeed all analysis, is a logical system. In interindustry analysis the logical system can be framed in mathematical terms. The mechanism of analysis follows this mathematical structure closely. The precise form of analytical process is not uniform, and there is no "grand solution" which solves all problems. It is true that when the assumptions are decided upon, when all the data are in, and when no changes are foreseen, the data can be manipulated mathematically and the solution to the system (or systems) of equations implied by the interindustry structure can be obtained. This is a particularly costly procedure, and it freezes the data, classification system, and assumptions, so that even a small change involves a repetition of the expensive solution. The usual process makes possible more flexibility in data changes (including estimates of temporal and scale changes in structure) and in the application of limiting assumptions, and it allows for detailed examination of specific groups of sectors without much attention to other sectors. The process is called iteration, but the procedure cannot be spelled out in detail, since it changes from problem to problem. In general, iteration involves tracing a given impact through the economy by hand rather than mechanically, starting with the initial change in a sector's output, determining its impact on the sector's suppliers, then the impact on the sectors supplying

these suppliers and the sectors supplying the second-round suppliers until the indirect effects are negligible.

It must be remembered that the technique is not in itself a predictive device. The predictive element enters through the parametric changes or side conditions which are imposed on the economy. The analysis performs the function of taking these predictions and converting them into predictions of a different type. It is a vehicle for completing conditional statements of the form: "If X, then Y." The "X" is a prediction about a change in final demand, a structural change, on a side condition. "Then" is the analytical framework by which it is possible to derive conclusion "Y," which is also a prediction. "Y" is a schedule of sector outputs, to be compared with previous outputs determined before "X" was specified. The technique simply carries the prediction along and reveals implications that are not clearly obvious. Since the analysis embodies information about the economy, it influences the derived prediction "Y." In any event, however, if "X" is an inaccurate forecast, then "Y" will inevitably be wrong.

Grist for the interindustry analysis mill is information as to (1) the magnitude of transactions (purchases or sales) among the sectors of the economy and (2) the technical interrelationships (input coefficients) among the sectors of the economy. Transactions data can be viewed as coming from two sets of books. One set of books records all of the purchases of each sector from each of the other sectors. The other set of books indicates all of the sales of each sector to each other sector. The two sets duplicate each other. A complete record of sales is also a complete record of purchases. The technical data, showing intersector relationships, consist of scattered information derived from engineering analysis. In practice, however, sectors of the economy do not keep books, data are scarce, and the information needed for interindustry analysis is limited and difficult to obtain.

Generally, there are three sources which form the empirical basis for interindustry analysis: (1) statistical records, (2) engineering and technical data, and (3) information derived from samples.

Statistical record information is the most important. In the US and many other countries, such data are based ultimately upon records kept by individual firms. The data are compiled and made available through census and survey re-reports (*Census of Manufactures, Mineral Yearbook,* and others in the US), publications of trade and industrial associations, and directly from the production and accounting statements of the firm.

Engineering and technical data are available in many published engineering analyses to be found in textbooks, manuals, and specialized periodicals. It is possible in many cases to undertake research investigations making use of engineering methods to develop information on industrial interrelationships.

Techniques of sampling make it possible, by interviews and questionnaires, to obtain information about the whole from limited data about its parts. Samples of recorded information, where the whole body of data is large, have also proved useful.

The three principal empirical sources provide the underlying data required to piece together a complete quantitative description of the structure of the economy. The sources of data are not independent, and none by itself is adequate. They combine to form the description of economic structure on which subsequent analysis is based.

The data required for interindustry studies are more detailed than the data needed for most economic analysis. The minute detail of data for interindustry purposes gives rise to a greater chance for error. Much economic analysis makes use of more highly aggregated data, in which small errors are canceled out, whereas in interindustry analysis every error is fully reflected in the results. In other economic analysis, greater reliability also can be achieved because more attention can be given to each part of aggregated data.

The data used in interindustry work have not been notably accurate. Census information, sampling, and some engineering coefficients have gone into the construction of existing interindustry tabulations. Despite the fact that a great

amount of data has been accumulated and that competent analysts have been working with the data over a period of years, there is still much to be desired. Weaknesses in data and lack of data have been the major stumbling blocks to successful analysis.

One of the most important analytical uses of interindustry studies is as a study of the implications of changes in external demands on the economy. These changes are based ultimately on peace or war strategy and tactics, technological innovations, weapons systems and defense measures, and decisions of investors and consumers. These considerations must be reduced to quantitative economic terms which are consistent with the description of economic and industrial structure. The data involved in hypothetical changes are no less important than the data on economic structure, although the former are frequently neglected. Estimates and, often, guesses substitute for a careful derivation of the economic quantities implied in a change in strategy. If the data specifying the change are not accurate, the conclusions will be amiss.

The uses of interindustry analysis have already been implied in the types of analysis which can be undertaken. The great single analytical use is the determination of indirect effects of a change in final demand, sector output, or the structure of the economy, or in some combination of these. A knowledge of these facts is useful not only in itself but also as an aid in the analysis of the operation of the economy.

Several broad classes of uses may be enumerated: (1) national security, (2) national welfare, (3) technological innovation, (4) market and sales research, and (5) economic intelligence. In all of the uses, variations and combinations of types of analysis can be used.

In addition to the analytical uses mentioned above, interindustry studies provide a valuable consistency check and confirmation for estimates derived from national accounts (such as industrial production indexes and gross national product) and are a starting point for analysis along other lines or of separate sectors. These auxiliary analytical uses are in some cases as valuable as the analysis of parametric change. For

instance, analysis of the relationship between the construction industry and other industries in the US has revealed serious errors in data on construction activity.

The organizational system implied in interindustry analysis is one of its most significant contributions. The use of a detailed coded classification system in which each sector is rigorously defined makes it possible to organize the data, documentation, and methods of estimation in an orderly manner and provides a means both for continual accretion to data and for checking their consistency on a continuing basis.

The limitations of any technique of analysis result from (1) failure of assumptions to approximate actual conditions, (2) inadequate or improper formulation of the hypothesis, (3) weakness in and lack of data, (4) errors in inference, and (5) inaccurate and inadequate interpretation of the results.

Economic analysis has advanced to the point where logical flaws in inference are rare. The basic formulation of the hypothesis in interindustry analysis is sound. Granting its assumptions, interindustry analysis has been demonstrated to be logically accurate. Even so, however, it can be misused, and care must be exercised to see that the formulation is correct and the inferences are carefully drawn.

The other limitations, those arising from assumptions, data, and interpretation, impose a heavy obligation on those undertaking the analysis. The limitations are such that no precise statement can be made as to the magnitude of error introduced by any of them separately or by the three combined. Generalization as to direction and magnitude of error cannot be made. If a datum is wrong, it is reflected in the results. If an assumption is inaccurate, the conclusions will be biased. If an interpretation is not appropriate, the purpose of the analysis is defeated. Precisely the same conditions obtain for any other form of analysis. If there is a difference between interindustry and any other kind of analysis in this respect, it results from the facts (1) that the assumptions are more specific and comprehensive, (2) that more detailed data are involved, and (3) that interpretation is more complex. Each of these may allow error to intrude.

Two particular considerations are especially troublesome. One is the frequent assumption that the input per unit output is fixed for all ranges of output. The other is the possibility that the errors in data are so large that they are as large as, or larger than, the indirect effects which are the major reason for undertaking the analysis in the first place. These limitations cannot be dismissed and must be constantly kept in mind. Extreme care must be maintained to see that the limiting assumptions, especially those involving fixed coefficients, are handled so that conclusions are not impaired. The process of iteration mitigates in some degree the fixed coefficient assumptions, since by means of this process the coefficients may be changed to reflect temporal, scalar, and structural changes. Even so, analysis necessarily proceeds on the basis of assumed technological rigidities which are frequently at odds with actual events, and the limitation must always be considered. Data weaknesses are often so great that one has no confidence that a particular indirect effect may be twice as much or only half that resulting from analysis. The errors may be greater than the indirect effects. The hazard is increased by the fact that it is not possible to determine where weaknesses in data have vitiated the results. The data are intermingled to such an extent that it is almost impossible to untangle them and find where a poor datum has influenced the results adversely. Nothing can substitute for data. Where data are weak or are lacking, the results of any analysis based upon them are correspondingly weakened. There are no "tricks" to get around this limitation. Only data improvement through arduous and assiduous research can raise the level of analysis.

It is still too early to offer a definitive evaluation of interindustry techniques. No one questions that interindustry analysis has some capabilities not possessed by other forms of analysis; that it is a flexible and powerful tool of economic analysis, and that, used judiciously, it is a valuable analytic framework for many quantitative economic problems. So far, however, interindustry analysis cannot be said to have been tested and proved as an accurate predictive device in the comprehensive detail which it implies.

In a literal sense, interindustry analysis cannot be "tested." It can be compared, and its consistency can be checked internally. Prediction resulting from analysis can be compared with realized results, but this operation tests the techniques only in part, since the real predictive element is apart — that is, independent of the analytical technique.

The basis for judgment of analytical results is the correspondence of the data with the facts and the correspondence of the assumptions with the operational procedures. When these conditions hold, analytical results can be counted upon as reliable. "Good" and "bad" are misnomers when applied to internally consistent theoretical frameworks. Such frameworks may be useful or not useful for purposes of solving particular research problems. A tentative favorable evaluation can be given interindustry analysis.

Economic intelligence data having a bearing on the operations of the economy of foreign powers are of three general kinds: direct intelligence, derived intelligence, and analogous data.

Direct economic intelligence data are relatively scarce. Two kinds of direct intelligence are available. The first consists of official statements, and the second is classified information obtained from observation, documents, and other sources. Both of these kinds of data are spotty and inadequate. In addition, the data are of uneven quality and reliability.

Derived intelligence is that information which can be inferred from what is known directly. The basis of the derivation may be the complementarity of industrial products, technology, or many other situations in which an unknown quantity may be deduced from known quantities.

Analogous information is that body of data known and available for some country other than the foreign power under study which can be used to fill gaps in direct and derived intelligence. Information concerning the US economy, because of its abundance and ease of acquisition, has become the standard analogy.

Any research effort, including interindustry research, must necessarily make use of all three kinds of data and data from

all sources. The combination cannot be known in advance. Ideally, direct intelligence should be the empirical backbone of any research, with derived intelligence providing the primary support data. Analogous information, if used at all, should be used sparingly and only to fill gaps which must necessarily be filled.

In interindustry research, because of the detail required, the weighting of various kinds of data is often quite the opposite of the ideal. In order to complete a systematic study of the economic structure of the USSR, it is necessary to borrow extensively from US information on technological interrelationships. Direct intelligence and derived intelligence are important in establishing the control totals and for some of the estimates of inputs and allocations.

At the very best the data used in interindustry research are of questionable reliability. In some cases it is possible to assign error limits for individual figures, such as the production of a single product. But when this estimate is aggregated with other such figures having differing reliability and with some data on US industry, it becomes difficult to assess the reliability of the final figure.

Weaknesses in data and lack of data are the most serious problems in interindustry analysis of foreign powers. Accurate data are mixed with the less accurate, and the final tabulation, because of aggregation and forcing to fit the control totals, has a mixed quality without any way to identify the more from the less reliable.

Since the technique is oriented to revealing indirect effects, the data weaknesses may result in a situation in which the error limits are as much as, or greater than, the indicated effect. In this case the actual indirect effect may be half or twice as much as that indicated. There is no way out of the dilemma. The deleterious effects of inadequate data can be mitigated in some measure. The only satisfactory remedy is to raise the level of confidence in the data by continuous research.

Interindustry research serves several important uses in economic intelligence. Not the least among these uses is the

direct use of the data in industry and product description. The cost structure and use pattern of an individual product are an integral part of interindustry analysis, and they are also of considerable intelligence value in and of themselves. Alone or in combination with other data, interindustry tabulations can form the frame of reference for analysis of products, product groups, and large sectors of the economy.

Nearly all sector and product studies have as a part of their research effort the estimate of output, of some critical inputs, of major end uses of the item, and of possible substitutes. These data are substantially the same as those needed in interindustry analysis. Hence a double purpose is served in working up these data: direct use in sector studies and use as a part of interindustry studies.

The most significant area of analysis is that of determining the implications of changes in the economy which affect the sector outputs. A parameter is an element in the economy which is fixed for any postulated situation but which may change as the postulated situation changes. The parameters are (a) allocation of sector outputs to final demand, (b) the input-output coefficient for particular sectors, and, in special cases, (c) the output of specific sectors. These three elements are fixed for any given time period under a given set of conditions. Analysis proceeds on the basis of postulating changes in any one of them and working out the implication of these postulated changes.

There are innumerable examples of changes in final demand. From the point of view of economic intelligence, the most important examples are analyses of mobilization and war demands to determine the capability of a foreign power to support the demands of such action. Interindustry techniques are particularly valuable for such an evaluation, since this type of analysis is explicitly designed to bring out the indirect requirements of a military program and economic mobilization for war. For instance, a direct requirement for aluminum products by the military services might be easily within the economy's capabilities. But in order to attain the higher level of demand, 150 percent more aluminum products are required

and other vital sectors have a heavy expansion burden placed upon them. Levy of a complete schedule of mobilization and war requirements resulting from the expansion of supporting sectors of the economy may make the difference between the ability of the economy to meet the new demands or the necessity of cutting back important sectors.

The analysis of mobilization and war demands inserts a new element of uncertainty. The data on direct requirements, which become a part of final demand, and data on cutbacks and shifts in consumption and investment are hypothetical. But these data must reflect accurately the postulated conditions, or the analysis becomes a simple exercise in logic. The demands of the war machine must be quantified and tabulated in terms of the sectors of the economy analyzed. This involves a conversion from specific end products, such as tanks and aircraft, into steel and aluminum products. The consumption sector must be analyzed to determine the extent of cutbacks which it can endure. The composition of the investment sector will shift, and it may be reduced. The demands of these sectors must be quantified. When all of the relevant data are assembled, they may be analyzed with interindustry techniques.

The implication of the new final demands may be traced through by the iteration process, singly and/or collectively. As a result of the new demands, new direct plus new indirect requirements must be met sector by sector. These new required outputs must then be matched with independent intelligence estimates of maximum output and capacity of each sector. These estimates inject another element of error which can vitiate the results of the analysis.

A single estimate for mobilization and war demands is not sufficient. Several sets of hypothetical final demands can be analyzed and their implications traced. Each set is presumed to represent different circumstances. In this way an array of estimates of capabilities can be made.

The elements of strength in interindustry analysis of mobilization and war programs lie in its ability to determine indirect requirements for each sector of the economy, thus showing the

total impact of demand. The weakness of interindustry analysis lies primarily in its requirements for data. The data which form the basic structure of the economy may well be subject to considerable error. Military, investment, and consumer demand cannot be determined accurately in many cases. In the verification procedure, independent estimates of capacity may be in error. Errors introduced by the data may be so great as to undo the benefits to be derived from the calculation of indirect effects. No precise assessment of reliability is possible; only a gradual improvement of the data can be counted upon to improve reliability and reduce uncertainty.

Within the framework of interindustry analysis it is possible, given the data, to become much more sophisticated than is indicated above. For instance, a flow interindustry system can be coupled to a consumption-investment-military final demand. Using this basic framework, the new final demand allocations can be fed in by quarters and direct and indirect requirements can be calculated by quarters. Proper accounting can be made for lead times by this process. Furthermore, by expanding the simple flow system into a flow and capital-capacity system it is possible to bring the capital requirements explicitly into consideration. Interregional transactions can also be considered. Both require additional data and additional assumptions. At the present time, refinement of the flow (or current transaction) interindustry system for intelligence purposes is not practicable.

A second area of analysis is the problem of interdiction. The foreign trade transactions of the economy are generally considered a part of final demand. Elimination of imports and exports in whole or in part constitutes interdiction; but, since they are in final demand, the implications for the rest of the economy may be traced out as indicated above. Another use, perhaps more important for the intelligence community, is that of determining the effects of air damage on the economy. An air strike would reduce capacity and hence output in many sectors. By fixing the output of those sectors which have been damaged at a specific level and treating the other sector outputs as fixed at the same level as before the air strike,

the deliveries to final demand can be determined. This set of deliveries to final demand can then be matched with a set of deliveries to final demand required under postulated conditions. Several final demands can be determined. The output of sectors not damaged in the strike would readjust to the new conditions. The interdiction problem gives rise to innumerable solutions, and no single solution has any more merit than another, since there are many possible ways to adjust to a reduction in output for one or more sectors.

Because of the lack of a unique solution, the interpretation of results of an analysis of interdiction is especially difficult. The limitations of data are another serious obstacle to this type of analysis. Even so, the interdependence of the economy makes it important that interdiction problems be analyzed by techniques in which this characteristic is explicit. For instance, suppose damage to the aluminum products sector reduced output by 50 percent. If the interindustrial requirements are 50 percent or more, there will be no deliveries to final demand unless sector outputs are reshuffled so that aluminum-demanding interindustry sectors reduce their output and hence their consumption of aluminum products. Only with a general interdependence schema is it possible to determine the full impact of interdiction.

The third area of analysis is the consideration of structural change. Although this problem is conceptually separate, it is in fact usually coupled with changes in final demand and interdiction. The basic descriptive data — the input per unit output for all sectors — are usually assumed to be fixed for analytical purposes. The coefficients are presumed to reflect technological necessity, and it is on this assumption that most analysis, including that discussed above, is based. Using the iterative process, however, it is not necessary to adhere slavishly to this assumption. The coefficients may be changed to reflect the changed conditions.

The analysis of structural change, whether as a problem in itself or as a part of the analysis of war or mobilization or interdiction, implies that there are data concerning such structural changes. In reality this is seldom the case, for most

of the structural changes are hypothetical with an empirical base limited to analogous information about the US economic structure. Despite this, structural change, however it arises, is of sufficient magnitude that it must be taken into account.

The three types of analysis collectively would represent the ideal analysis of capabilities. For instance, in a hypothetical war situation the economy must bear the demands of mobilization and combat and at the same time sustain foreign trade interdiction, substantial air damage, and loss (or gain) of territory. While adjusting to these severe conditions, the economy would undergo a series of structural changes. Realistic postulates for all three circumstances and a reliable structure of the economy would make possible more detailed estimates of capabilities than heretofore possible.

A number of ancillary analytical purposes can also be served by interindustry studies. Analysis by means of national aggregates also suffers from weak and insufficient data, and interindustry studies offer an independent method of building up these national aggregates. The relationship between particular production estimates and aggregates has been incompletely explored, and interindustry analysis offers some hope for the integration of indicators with aggregative analysis.

Interindustry analysis, expressed in a numeraire, is an opportunity for a systematic study of prices and the relationship of prices to real costs. Such cost analysis is valuable not only in that it points to the drain of a given sector on the allocation of materials to alternative uses but also as a weighting system for the construction of index numbers for the economy as a whole and for various components.

No precise outline can be made of all the ancillary analytical uses of interindustry studies. Many such uses are confirmatory in nature, and they tend to buttress analysis of different kinds by providing both a confirmation of results and data from a new source. Other analytical uses, such as examination of prices and costs, break new ground. It is quite possible that the ancillary analytical uses will prove, at least in the

short run, much more valuable than the direct analytical application for which interindustry studies are specifically designed.

While the ultimate aim of interindustry studies is analysis, there are within the process many benefits to be derived by looking at the economy as a double entry accounting system and organizing the data in such a manner that economic interdependence is revealed.

One of the most significant of these organizational uses is its educational value. In a research effort organized largely along functional lines it is all too easy to concentrate upon particular products and industries to the relative neglect of the over-all economy. The interindustry approach, by putting the economy and all its components into perspective, enables one to grasp details simultaneously with the over-all situation. At a glance the complicated industrial interrelationships are revealed, while at the same time the over-all functioning of the economy can be comprehended.

Since interindustry analysis depends upon a cross referencing of costs and shipments of each sector and its components, the approach naturally leads to a filing system in which all of the information about the economy can be conveniently and logically placed. The interindustry tabulation itself is, in fact, a filing system. Behind the tabulation lies a more complicated set of files which encompasses all relevant data, such as prices, production (in heterogeneous units), technical interrelationships, cost and shipment data, and other such information.

The interindustry file is not static; it is a constantly growing, changing compilation of data. It is arranged in such a manner that there are continual accretions to the base fund of knowledge of the structure of the economy. New data can be added so that they have an immediate impact on the final tabulation; better data replace the old, and more or less comprehensive information fits into the filing system in such a way that the improvement in results is immediate. This implies that no interindustry tabulation is final. For a specific purpose, a tabulation can be drawn out of the files, assembled,

reconciled, and used. At another time, for another purpose, another tabulation can be developed in the same manner. Thus the interindustry file, a continuing and gradually improving body of data, stands ready on short notice to support a capabilities estimate with the latest data available.

The filing system implied in the interindustry approach makes possible another important organizational use. This is in the testing of the reliability of data and checking their consistency. When the data have been assembled, it is possible to evaluate their reliability by comparing them with other data. Every sale of a product is also a cost to some sector, and every input is a part of a sector's output. Hence the data can be checked and cross-checked. Data which are inconsistent can be weeded out, and the general level of reliability can be raised. New information can be compared with existing data, and the relative merits of each can be assessed.

Finally, the interindustry approach provides a guide to further research not only along interindustry lines but also in other methods. Gaps in the data can be spotted readily, and steps can be taken to remedy them. If price information for a particular group of products, or production data for some sector, or any other information is needed, the technique, backed by its organizational system, makes it possible to detect the missing elements. It may become clear, because of weakness of data, that some types of analysis cannot be undertaken but that other kinds of analysis can be profitably expanded or that other techniques should be exploited.

These applications of interindustry studies — direct use of data, analysis, and improved organization — must be regarded as a whole and none slighted. They complement one another. The tendency might be to get on with the analytical uses and neglect the other uses. This would be dangerous. The technique is one which improves with age; the analytical stage, particularly the analysis of parametric change, may well be several years in the future. This is not only because the pilot stages of research are expensive and inefficient but also because data exploitation and preparation, both for the interindustry and final demand sectors, are difficult and time-consum-

ing activities. To ignore the direct use of data by all researchers and to neglect other analytical uses and the benefits to be derived from improved organization would be to fail to use the framework of interindustry techniques to its fullest extent.