Why Economics Needs Input-Output Analysis

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Q. Last November, you received a high honor from the Japanese government for your lifelong work on input-output analysis. Their citation claims that you not only ''greatly contributed to the formation of effective economic policies for the Government of Japan,'' but directly aided Japan's economic growth and ''proved the practical value of (your) industrial matrix analysis.'' What was the nature of your work in Japan?
A. I have often visited Japan to give lectures and participate in seminars. Over the years I have trained a large number of Japanese students of economics at both Harvard and New York Universities; they have worked with me in U.S.-Japan joint research projects, and many have returned to Japan to become leading scholars and civil servants. I have kept in close touch with Japanese leaders in every economic sector.

The Japanese are unusually interested in input-output analysis, both in the theory and in its application across a wide range of economic and social problems, because their economy has gone through tremendous structural change and technological transformation since the Second World War. They have found the input-output approach to economics invaluable in studying those problems and forming policies that aid economic development and growth. The Japanese government has committed considerable resources to building input-output tables. They update the necessary information and statistics after every census, yielding a revised table every five years or so. They have become experts in these techniques, and now apply input-output analysis regularly to many different kinds of problems.

Q. But our country also produces input-output tables, doesn't it?
A. Yes, but it takes our government some seven years to produce an input-output table. The Japanese do it in maybe three years. The U.S. table is very good, but it is constructed by a small working group in a subdivision of a division of the Department of Commerce. As an indication of Japanese interest and commitment to this kind of work, thirteen of their ministries are engaged together to produce an input-output table under the direction of a cabinet committee. I remember several years ago, when our ambassador to Japan asked me to receive a visit from the associate director of the

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Japanese government planning agency. He came to me not to exchange views on general economic policies, but to discuss a technical question in using input-output analysis. In that case it was something about the structure of international trade and inventories. The very top officials involved in economic policy are interested and are capable of handling substantive technical questions concerning input-output analysis. It is a very flexible method that can be used for many different purposes. What will happen if demand changes? If taxes are increased? If technology changes?

Q. In looking over your enormous list of publications, I noted your first article on input-output analysis [''Quantitative Input-Output Relations in the Economic System of the United States''] came out in 1936, just after Keynes' *General Theory*. What struck me in that is the fact that while most economists in the 1920s and '30s were still mastering Marshallian analysis—as Arthur Burns impressed on me in the January/February *Challenge* interview—and then turning to understand what Keynes was all about, your thinking was focused on an entirely unrelated, innovative approach to economics. What were those early conceptions which have captured your intellect and energies for so many decades?

A. My first input-output table described transactions among forty-four U.S. economic sectors for 1919 and 1929. The table listed those forty-four sectors down the left-hand side; each row recorded sales from the sector indicated at the left to each of the forty-four sectors arrayed across the top of the table, at the head of the columns. Looking down the columns, each entry recorded inputs purchased by a sector at the top from a sector on the left side. The sum of each column indicated a sector's total gross outlays. The sum of each row indicated a sector's total gross output. From this basic transactions matrix of input-output relations, we can derive a second table of technical coefficients. From this basic technical information, the analyst can ask, for example, how much output must come from each sector on the left-hand side of the table in order to produce $1 of output from the sector indicated at the top of the column. This is a very simple example, but you can get the basic idea.

Q. What did you want to show with that first table?

A. In fact, that very first input-output table I compiled was specifically intended to explain the effects of technology change on the American economy. Since then I have continued to be interested in the effects of technology change on the economy and the society.

Q. I happened to share a taxi not long ago with Professor Raymond Goldsmith, and in the course of our conversation I mentioned my interview with you. I was surprised to hear how he had met you in Berlin back in 1925 when both of you attended the same seminar. He, too, was struck by the fact that you have continued to develop one basic idea virtually from your graduate-student days right down to the present time. [Leontief received his doctorate in economics from the University of Berlin in 1928.]

A. Yes, Ray Goldsmith and I were both students at the University of Berlin. I, incidentally, was seminar assistant of the then-famous Professor Werner Sombart. One of the students I admitted to the seminar was Thomas Balogh, now Lord Thomas Balogh. Since Sombart could not understand my mathematical formulations, it was Professor Ladislaus von Bortkiewicz, the mathematical statistician who formulated the ''law of small numbers,'' who had to supervise my Ph.D. thesis.

The preliminary work on my first input-output table was done in 1931, when I held the position of research associate at the National Bureau of Economic Research. That same year, Harvard invited me to join the faculty. I outlined my research proposal to the Harvard Committee on Research, but didn't get great encouragement. The committee had come to the conclusion that my project was absolutely unworkable. They didn't think it made any sense, but nevertheless extended their invitation to join the Harvard faculty with the research support I had requested. There was one proviso: when the funds were spent, I would report to the committee my research failure so they could close the book on it. So I got the money anyway, I hired an assistant—a Mr. Haines—and together we constructed the first input-output table of the United States, supplementing the figures contained in the U.S. Census by using the telephone to secure additional first-hand information. We simply called up people—not economists, but businessmen, wholesalers, and other people actually engaged in economic transactions—to find out about the flow of particular goods and commodities.

Q. You called to ask about their output and what inputs they had to purchase to produce it?

A. No, when you construct an input-output table you must ask: Who are the principal users of a product? What industry uses it? In other words, you can construct an input-output table either by rows, which means analyzing the market, or by columns, that is, listing inputs. You call commercial people to learn about sales in various markets; that provides information along the rows. You can also ask engineers and mass-production managers, company by company, to find out about all the different inputs used in their production processes. Very often they say, "Oh, I don't know, I cannot tell you." What you do then is to take out your little book and say, "According to my reckoning from a variety of sources, you use so much of this, so much of that." The engineer replies, "That's absolutely wrong, what you have there." So I say, "Can you give me the right figures?" The most important result of this exercise is the basic empirical information we collect, which is of crucial importance for really understanding how an economic system works. We're not just theorizing. This requires a constant interplay between actual observations of economic transactions and theoretical modelling. It is an iterative process.

Q. What originally motivated you to come up with the idea? If you look at the history of economic ideas, economists seemed involved in trying to define and solve problems in the real world. How did it begin with you?
A. That was exactly the way I started out. First let me say that the eighteenth- and early nineteenth-century economists really laid the foundation for everything that followed. Adam Smith, Ricardo, Malthus, and John Stuart Mill formulated the idea of interdependence between different types of economic activities, which is quite fundamental, I think, in understanding how the economy works. They also conceived of a national economy as a self-regulating system.

Q. I noted your quotation from Quesnay in the epigraph of your 1941 book, *The Structure of American Economy, 1919–1939*. That eighteenth-century economist gave birth to an input-output idea in his *Tableau Economique*.
A. Exactly; I really had some magnificent ideas from those early economists to develop my approach. But other economists who inherited those ideas continued to theorize instead of collecting more facts. When they ran out of facts, they began to make assumptions. This is where modern academic economics began to go wrong. In the 1930s, I wrote some critical articles on the English Cambridge school in which I suggested that the way to build a quantitative theory is to observe reality, and to define certain concepts. [See "Implicit Theorizing: A Methodological Criticism of the Neo-Cambridge School," *Quarterly Journal of Economics*, February 1937.] Your concepts first need some empirical meaning and content. Then you can theorize and construct a formula in which the relationship between the parameters and variables explains the phenomenon you observe. Academic economists in our day have generally not been subject to the harsh discipline of systematic fact-finding. Our colleagues in the natural sciences have always had to find data, to generate data from observations. Since economists can't run controlled experiments, they developed an irresistible predilection for deductive reasoning. In fact, many of our economists entered the discipline after specializing in pure or applied mathematics. The habits were well established among the early Cambridge economists in England, and this affected Keynesians in our own country. Typically, such economists first developed a theory, then wrote it as a formula, and then proceeded with defining its terms in such a way as to make it true.

Q. Can you give me a concrete example?
A. Take the so-called equation of exchange, the fundamental formula of the monetarist theory: the quantities of commodities, multiplied by their prices, must be equal to the quantity of money multiplied by its velocity of circulation. The economist accepted it as being absolutely correct and then asked the statistician to figure out how to define the quantity of money, how to define prices and the quantity of commodities, so as to make the formula hold. Economists first wrote the formula and then let somebody else describe its factual meaning so as to make it right. I called that implicit theorizing, and much of it is still going on. Keynes really was a great artist in that. From a purely logical point of view, why not?

Q. But don't the mathematical physicists like, say, Einstein, start out with a formula first and then try to demonstrate it or prove it in the universe?
A. But Einstein knew what the concepts meant; they were not given. In fact, two years ago I asked one of my students to make a count of articles appearing in the *American Economic Review*. We found that 50 percent of all articles appearing during a large part of the 1970s represented mathematical models without any

empirical data. Twenty-two percent of the articles contained empirical information, but it was essentially not information based on direct observations. They contained parameters which were derived by very complicated processes of indirect statistical inference. In short, most of the data were cooked up. Of the four or five articles based on direct observations made by the authors, one dealt with pigeons and the other with mice. In their search for data, economists have turned to government statistics, normally compiled for administrative and business purposes, not for scientific purposes. These data fall short of what we need for a more concrete and detailed understanding of a modern economic system. Today's economists don't build models capable of preserving the identity of hundreds of variables needed for the concrete description and analysis of a modern economy. Instead, they depend on the aggregation of detailed data to build "bundles" that correspond to the concepts built into models of the aggregate economy. To begin with, the data come from secondary and tertiary sources, not from direct observations, and are fitted as time series or cross-sections into standardized statistical computer programs. Meanwhile, the government has allowed the quality and coverage of official statistics to deteriorate without much protest from economists who need them. At the same time, masses of concrete, detailed information from technical journals, engineering firms, and marketing organizations are neglected. No other science uses as sophisticated and complicated methods of mathematical statistics as economics does. And when I ask my natural-science friends why they don't use such methods, the answer usually is: if we had to go to that length to manipulate the data, we would stop all our research and go out to find better information.

Q. So then you think a lot of our empirical work has gone way beyond the quality and extent of our data base?
A. Exactly, economics is getting too far removed from observation. Observation must be the origin of the idea. Then there must be an interplay between observation and theory. In my capacity as a trustee of the North Carolina School of Science and Mathematics, I was once asked by Governor Hunt of North Carolina how I would teach science to exceptionally gifted boys and girls. My answer was that you can't simply teach science; you have to train young people, not simply in logic, but first in how to observe things. Observation by itself is the beginning of any science. At the outset you can only point out the object of your curiosity with your finger, because once you use words to describe it you are already beginning to theorize. Then you translate it into theoretical terms. But the theory leads you back to fact. You translate the theoretical results into factual statements, and you move forward by shuttling back and forth. That process is what propels you forward in developing a science.

Q. Tell me more about your work in Japan.
A. The Japanese see input-output analysis as nothing more than a systems approach that can be applied to many different economic and social problems. Several years ago, I was invited to Japan to speak on how to use the input-output approach in analyzing the delivery and allocation of health services. Here we have to deal with complex issues of health, economics, demography, and environment. These fields are very closely connected: in order to say anything significant about health care, you have to have a comprehensive analytical approach that pulls together these various fields. We need facts from each. We need to know about behavior. We need to know about the state of technology. We also have to remember that the final output of the medical system is not simply medical services, but their impact on the state of human health. Often, when I talk to medical people, they avoid discussing how medical services affect health. Medical professionals like to describe what they do, but it is difficult to say how medical services affect human health in the long run. We must try to collect the information and organize the data to answer that question.

It was Shigeto Tsuru, the renowned Japanese economist who served as my research assistant at Harvard before the last world war, who gave me the opportunity to present, at a symposium he organized in Tokyo, an application of the input-output approach to the analysis of environmental pollution and its abatement. An input-output table can set out the problem very clearly. The steel industry, for example, produces steel and uses certain inputs. But steel production also produces dirty air. The output of steel and dirty air in each case depends upon the state of technology in the industry. All of these relationships in production processes, the use of inputs to produce certain outputs, define a state of technology. You change the technology and you change the input-output relationships; you change the efficiency, and you change the amount of pollution and the impact on the environment. So in this example, we can see not only the relation between producing an output and its impact on the environment, but we can see how changing the technology of the production process has an impact on inputs and outputs.

Q. It seems to me that agriculture offers another example.
A. It's a good example. Agriculture produces grain and meat, for instance. But everybody knows that it also produces dirty water—that industry is one of the greater polluters of water in the United States. The paper industry is another. Coal-burning is an example of an air polluter. In each case, the input-output table gives a technological description of the fact that for every ton of steel, every ton of meat or grain, you also produce a quantity of smoke, dust, or water pollutants. The technological relationships are indicated by the input-output coefficients which appear in the table.

Even population growth and demographic change can be made an integral part of this analysis. More people mean more steel, more energy, and more food, and as I said, this output also means more air and water pollution. You can look at several different assumptions about population growth and use the input-output table to help estimate how much pollution this growth will produce. In a similar way, the changing composition of the population is essential for any analysis of a health care system. So changing demography, along with changing technology, must be an integral part of any analysis of health care.

Q. What on the surface appears to be a very complicated technique really boils down to something rather simple—I suspect deceptively so.
A. Your perception is accurate. One reason why input-output analysis has had some success in many different countries is because it can be easily explained to a layman, to a nonspecialist. The input-output table has concrete numbers that people can understand—tons of steel, hours of work, units of electricity, gallons of gasoline. People can visualize what these numbers mean, whereas the economists' numbers are often aggregated and measured in dollars, which may be harder to visualize. Besides, econometric models often use complicated mathematical and econometric equations, which the layman cannot understand. Things can, however, be overdone. A few weeks ago I received a copy of an Italian large-circulation weekly which contained, to my consternation, a translation of one of my recent technical articles—matrix equations, linear programming formulations, complicated graphs, and all. An editorial note explained that the subject—technological change—is so important that the reader should do his best to understand!

The input-output table is also helpful because it lets policymakers look at a variety of possibilities for outputs and the inputs they require. They are left to make the choices. A friend invites me out for a meal: "Wassily, I would like to invite you and your wife tomorrow to go out to a very good restaurant; will you be free?" I usually find the time for this. But imagine if my friend were to say, "Wassily, to simplify the procedure, tell me about your taste in food, so that by the time you come I will have ordered the right sequence of dishes." My answer would be, "No, my dear, I cannot describe my tastes, but show me the menu and I will choose." And that's how the input-output analysis helps policymakers make economic choices. Whether it's a policy for growth, health, education, or defense problems, it gives you the menu of many alternative choices. Since input-output analysis requires very concrete information, the economist can't speak in generalities or in terms of aggregated numbers. There are input-output charts which measure the amount of dirty air produced by each industry. Another example would be the amount of garbage produced by each household. But the quantities we use here are pounds, gallons, units of energy, tons of steel, rather than simply dollar values. So the input-output approach forces you to collect a lot of detailed information. Certainly, we now have computers which can handle it; the computer which I am using can perform 800 million multiplications in one second. So calculations and data storage are no longer a problem. But collecting data is a problem. You have to organize data in a way that makes it useful.

I like to use the example of a telephone book. You have many numbers, but they are useful only if you organize them according to names of people and their addresses. Just try to get a telephone connection by dialing the average of several pages of numbers! We need a systematic and disciplined collection of information in the United States. We have made great progress, but now our efforts must be improved.

Q. Input-output exposes all the consequences of changing economic structures . . . .
A. Oh, far more than that. It resolves a basic methodological dilemma confronting economists in their

thinking and research. A major problem in economics is to be able to describe an entire forest in terms of individual trees and their interrelationships—to perceive the totality, while preserving all the minutiae in clear detail. The macroeconomist deals with broad concepts and aggregated data, far removed from real behavior. The microeconomist may work with fine detail but lose sight of the larger world. Now, of course, modern mathematics and modern techniques of data processing have broken down the barriers in research. We now have the means to preserve the tiny details while seeing at the same time the total picture. For me, the study of the interdependence between different sectors and the relation of the parts to the whole picture is really the most interesting part of economics. Input-output analysis gives you a method to describe that forest in terms of individual trees. The information revolution gives us huge computer systems to achieve our need for detail while still preserving the total picture. We can break down the economy into many different sectors, taking information from people who are operating in the microeconomic units throughout our economy.

Q. But in compiling the modern input-output table, where do you get these empirical data? Don't they come from the national income accounts?
A. No, you see input-output tables use parts of the national income accounts. In many countries they constitute the core of national income accounts, not the other way around. The major source of empirical information is not the national accounts—just the reverse. In fact, sometimes we discover discrepancies between the input-output data and the national income accounting, and usually you have to correct the income accounts so that they don't contradict the input-output table. That is mainly so because input-output tables are much more detailed. There is another very important element, too. You see, when I first constructed the input-output tables, I used them simply as a source of observations to determine the input-output coefficients which then define the technologies. I really wanted to study technology and the effects of technological change. But now in some instances it becomes possible to determine the state of technology directly, without having to derive it by computing the coefficients from the input-output table.

Q. How do you get the technologies?
A. I look at technical, engineering literature, discuss it with engineers, and I get descriptions of enterprises. Most input-output tables are still done in dollar terms, in value terms, but not all. In a modern input-output table for electric energy production, as a good example, the table uses kilowatt-hours for output; the labor force is described not only in wage bills but in man-hours. More and more we are introducing straight physical units of information, and this is where straight engineering data become so helpful. Slowly, the center of gravity is shifting toward the use of physical information. Even in elementary textbooks, you read about production functions described in physical terms. Once you know production functions and tastes, you can compute the prices. And more and more we do that in input-output research. I visualize the modern competitive economic system as a huge automatic computing machine. Computers solve numerical problems through a process of successive approximations. So does the competitive economic system—through iterative interplay between demand and supply.

Q. Apart from Japan, you have been involved in input-output projects in other countries, haven't you?
A. I am now envisasging an exciting new project in Italy, still under negotiation with the Italian Ministry of Transportation. The Italian government asked me to take charge of developing the input-output methodology for a comprehensive, fully integrated transportation plan for Italy. It will cover railroads, airlines, highways, maritime ports, and even municipal transportation systems. It's an awesome project, really challenging, but, noblesse oblige, I said all right.

Q. Are other countries so involved in input-output analysis?
A. I have already mentioned Japan. Norway is another example, and France does it, too, in principle at least.

Q. You seem to hesitate there. What's the difference between the two?
A. Well, the French statistics are not quite up to it. You have to have first-class statistics, and Norway is collecting good statistics for this purpose.

Q. Does the United States use input-output analysis for solving practical, or policy, problems?
A. In this country the biggest user is probably the Pentagon. The office of the chief economist in the

Pentagon uses input-output tables to figure out how to produce the armaments required in the military budget. In order to produce so many submarines, planes, rockets, and so on, input-output can tell you the levels of output needed in different industries. Very often they discover that certain industries don't have the capacity to produce the needed output, so you must first make investments to expand the capacity of those industries.

Q. If President Reagan increases his military budget by, say, 9 percent, the Pentagon then turns to input-output methods?
A. Simply increasing the budget by 9 percent doesn't tell us anything. We must know exactly what has to be delivered by whom to whom and when; which weapons, what commodities. Dr. Faye Duchin and I analyzed the effect of military expenditures on the economy and employment [W. Leontief and F. Duchin, *Military Spending: Facts and Figures, Worldwide Implications, and Future Outlook*. New York: Oxford University Press, 1983]. But we must have very great detail about what the Pentagon is actually planning. Input-output analysis is the only methodology for doing this; you cannot do it by time-series econometrics.

Q. If we update our input-output tables so infrequently in the United States, and the economy is changing dynamically very rapidly, how can we keep these technical coefficients current?
A. First of all, the *structure* of the economy doesn't change as rapidly as people often think. Comparing the input-output coefficients over time, we can certainly see the matrix change. But it does not change dramatically. As a matter of fact, if I show you the input-output matrix of today's American economy with one of forty years ago, and obliterate all the names of industries, you could still identify them. We can learn something interesting about observation here. We seem only to notice those things that change. If you stand on the side of a valley, and in a field on the other side there is a farmer who does not move, you will not observe him. The moment he moves you observe him. But the landscape remains unchanged. The same thing is true when you observe the economy and when you analyze the input-output table. You have to relate the size of a change—say, an input-output coefficient—that signals a technological change to the whole structure of the economy. For example, a one-half percent change in an input-output coefficient of a very large industry, like agriculture, can have a much greater effect on the American economy than a 200 percent change in an input-output coefficient of a very small industry. We hear so much about revolutionary change in electronics and in computers, but when you analyze what has happened, you will see that along with the change there is very great continuity. Most of the economy's structure remains unchanged.

Q. Well, then you would be one of those who say that despite great technological changes, the economy is not changing all that much.
A. Not changing so rapidly. I believe, for example, that introducing modern technology will ultimately reduce very markedly the role of labor as an input in all production processes, just as tractors reduced the role of horses in agriculture. This causes all kinds of problems—income distribution for one, because if you don't need horses in production you just eliminate them. It will not be so easy to eliminate humans.

Q. Yes, but I think that in the United States today the population of horses is larger than it was in 1900. Maybe I read that in one of your articles?
A. I think the number is greater, but they are out to pasture. If horses could vote, they would find a way to get the government to introduce some kind of income-maintenance program. An easy way to do it would be to declare the maintenance of, say, a 20-million-horse reserve to be absolutely indispensable for national defense. Mr. Weinberger would very readily put $50 billion into the budget to maintain horses. The Congress naturally would vote it; the Republicans would possibly reduce it to $35 billion. All the horses would be very nicely maintained, and I assure you, we would have enough output to feed them. I argue that in a not so remote future, we will have quite enough output to feed the entire American population even if we work only thirty hours a week. The process of technological change will have only a gradual impact on employment in the American economy. My study took a very short time horizon—only sixteen years, to the year 2000. But we won't have pronounced general technological unemployment. There will be a very great shift between different types of work. There is also a powerful factor working so that technological change won't produce serious unemployment. That is demography. The number of people in the age group of new job entrants will grow much more slowly in the next sixteen years

than in the past decade or so. I am sure the U.S. president at that time will claim he reduced unemployment, but actually he should thank the people who introduced birth control.

Q. Well, we were very successful in creating jobs from 1970 to at least 1980.
A. Naturally, we had a growing economy.

Q. And it was a very rapidly growing population. Didn't technology change contribute to the kinds of jobs that were created, mostly in the services, while the number of jobs in manufacturing declined?
A. Right, and what I say is this: technology will affect services, too. The growth in services was due to two things. First of all, as you get richer, you cannot eat much more, you can wear only so many clothes, you can have a little more space, but you use many more services. That is one reason. The second reason is that in the past, many so-called business services were carried out within the corporations that needed them. Large enterprises, for example, had engineering staffs to design new products, new processes. They had their own trucks to transport their goods. But now the division of labor has increased specialization across the economy, so that you hire engineering firms to provide design services. You contract out to trucking firms. You can see the same phenomenon in other areas. In the past, the housewife cooked the family's meals at home; now, with the change in the role of women, you eat your meals in a restaurant. The amount of cooking in the United States didn't change so much, it only shifted statistically out of the household into a separate industry—restaurants and fast-food outlets. So much of the growth in the service industries reflects that division of labor and the externalization of services. Modern technology also affects the efficiency of service industries very much: the labor input per unit of services rendered is decreasing very fast. Yet anybody who has an office and introduces word processors knows the demand for typists is going up. There is a competition between two trends—growth in the total amount of services to be produced as demand expands, and the ability to produce more services with less and less labor. I think soon the second tendency will begin to catch up with the first, so that the present trend in the service industries will not continue *ad infinitum*. But it is silly to theorize about these things. We need to get the figures on these changes and study them. Collecting the data and analyzing them will cost us millions of dollars, but it's worthwhile if it can contribute to more reliable answers to these questions.

Q. What kind of data do you want the government to collect?
A. Follow the Japanese example. Organize much more detailed research on data collection. You have to recognize that a big statistical operation must begin by deciding how to use the data. If you intend to use it for input-output analysis as the Japanese did, then you must organize your statistical operation with that specific end in mind. I remember when Norway began to organize for this task. A minister went to Parliament to defend his departmental budget for collecting information and compiling data specifically for input-output analysis. He felt members of Parliament should understand input-output analysis just as we now understand national income analysis.

Q. Suppose President Reagan were to announce to you, "I am going to give you an agency to collect the data for your work." What kind of numbers would you collect from American industry, farms, and businesses?
A. First of all, President Reagan didn't come to me, but the Japanese, the Norwegian, and the Italian government people did. In Italy we have a pretty good national input-output table which describes the Italian economy in terms of some eighty sectors. In the United States we can do much more. We already have 600 sectors. I would begin with regional input-output tables that are linked together. My study of Italian transportation is just a part of the larger matrix, with subsectors and corresponding input-output data on railroads, highways and automobile traffic, trucking, shipping, municipal transportation. In addition, we need data to develop capital coefficients for each activity. Simple input-output tables only show how much current ingredients you need for the "cooking recipes." But you also need pots and pans, that is, physical capital. The capital coefficients will tell us how large the stocks of capital must be in order to produce the equipment that will supply the final transportation services. The capital-stock requirements involve the construction and capital-goods industries, and here I expect the engineers and construction companies will provide the information.

Q. In other words, major private companies will give you the component of a production function for their industry?

A. Exactly, and in some instances not only for one industry. In my Italian study, for example, Fiat should provide information not only on auto production, but also on highway construction, because it is obviously interested in highway-building, too. Now in the United States, we also have important corporate sources of input-output data. Take, for example, Bechtel—the construction company, Secretary of State Shultz used to run it. That company has a gigantic input-output library. I could really use that data, and someone did offer to sell it to me. A private firm isn't about to give it away. But I, of course, have no money.

Q. Bechtel would sell it to you?
A. Yes, and there are many other firms that have such information—Arthur D. Little, for example. Batelle Institute has 1,300 engineers and also an input-output division. The U.S. Bureau of Standards has an incredible amount of engineering information. But I would need $5 million to $10 million to get data from these sources. Meanwhile, the U.S. government is cutting back on budget allocations for statistical operations, so that the information now collected is already becoming smaller in quantity and inferior in quality compared with the statistics produced some years ago. The government argues, why shouldn't private enterprise do it instead of us? So private enterprise is doing it. The problem is that private firms don't publish data collected by them at great expense or make it available to researchers. The information becomes a corporate secret. Now secrecy in military matters may be necessary, but if basic data in our economy become the secret property of many different firms, researchers cannot use it; for all practical purposes, this information doesn't exist.

Q. But why should the chief executive officer of Bechtel or any other company release this information to the public, even if you paid for it? That would reveal the secrets of the firm's efficiency, or maybe the reasons for its inefficiency.
A. From this point of view, it's remarkable how much more open American companies are than their European counterparts. American businessmen are eager to compete for information. Of course, if they spend a lot of money to get the data, they want naturally to charge you for it. All right, I say, let's buy it from them. In these instances the data should be made public. Yet there are serious problems in getting such data from private firms. They are not collected systematically for research purposes.

Q. You have already described how the Pentagon uses input-output analysis. In what other policy areas could the United States government fruitfully use input-output analysis?
A. As I mentioned, in following the impact of technological change on national employment. Where can we expect new jobs, where are jobs being extinguished? Input-output analysis could help in understanding and dealing with important problems of income distribution. Tax reform and tax simplification are hot topics in Washington now. I think there is much we can do to reform taxes, and input-output analysis can be a useful tool. When the income tax was introduced early in this century, it was made progressive because the American government felt the tax system should produce a more equitable distribution of national income. Now we find an arrangement of taxes and spending that differs greatly from those early days. On the spending side we have social services, medical services, educational aids, and entitlement programs that affect the lifestyle and standard of living of the American people. In effect, I think, the spending side of the budget is more effective than the tax side at producing a more equitable distribution of income. So why not switch tax policies now, especially since it is getting more difficult to collect income taxes, with all the exemptions and exlusions? Why not simplify the tax system by using just a sales tax? You can differentiate a sales tax, levying much higher rates on luxury goods than on necessities. Obviously this will affect income distribution; only rich people buy luxury goods, and they will pay the higher tax rates. Besides, I don't believe we should tax savings that are channeled into productive investment. If most of a person's income is reinvested, don't touch that income.

Q. But what does this have to do with input-output analysis?
A. That is simple. To estimate receipts from a sales tax you have to use an input-output matrix. I don't know for sure, but I'll bet that the U.S. Treasury made the computations for estimating sales tax receipts by using an input-output table.

So while the U.S. government uses input-output analysis, it doesn't do it as well as others. We should collect data as the Japanese do, and carry out the analysis systematically—but I am not at all optimistic that it can be done. Our government is organized differently and has quite different motivations and objectives. Toqueville made some of the most pertinent observations on that subject a hundred and fifty years ago.