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PROGRAMS AND METHODS FOR INPUT-OUTPUT ANALYSIS—A PREVIEW

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Two of the following articles describe programming packages especially designed for the calculations required by the kind of interindustry economic analysis usually called "input-output." The third paper offers a guide to the literature on matrix factorization, an alternative to matrix inversion which can cut computing costs by a factor of three or more. The fourth article illustrates the kind of computations which can be done with the first package, and at the same time, sets forth a program of research which will almost certainly require computations beyond those offered by the package.

The first and more versatile of the packages, IOPE—Input/Output Program for Economists, provides almost a language, a Fortran of matrix operations. For example, to obtain the matrix A as the sum of matrices B and C, one need only write

$$\text{ADD } A = B + C \text{ "title"}$$

where "title" is to be filled in with the desired title for matrix A. IOPE has some thirty commands of this sort. They provide not only the usual basic matrix algebra provided by other matrix handlers of this sort—such as addition, subtraction, inversion, and multiplication of matrices—but also some convenient commands for labeling the rows and columns on the printed page, for keeping a record of the steps which have been gone through in calculating a matrix, and for performing the RAS balancing of an input–output flow matrix to given row and column totals.

The great advantage of IOPE from the user's point of view—its easy and natural way of expressing matrix calculations—is also its great limitation in hands other than those of its creator. There are a number of calculations related to input–output which it will not presently do. It is easy to write Fortran subroutines to perform these operations, but to include them into the IOPE command library seems to require assembly language programming. Anyone wishing to use a package such as this to avoid having to write Fortran will be even more reluctant to get embroiled with assembly language. Some of the calculations not presently included are aggregation of input–output tables, finding a good triangular order for the sectors, and solution of the input–output equations $x = Ax + f$ by the Seidel method using this triangular order. This last calculation is the most valuable of all for input–output work. The impression seems to persist that the above equation should be solved by finding $(I - A)^{-1}$ and then multiplying it by f. The Seidel method, which takes advantage of the zeroes in A, can often find the solution of the original equation in less time than it take s to multiply $(I - A)^{-1}$ by f *after* $(I - A)^{-1}$ has been calculated! Consequently inverses of input–output matrices become virtually useless computationally. I have had no occasion to calculate one in years.

To use the large matrices now being produced for the U.S. economy, one needs programs which store only the non-zero elements of the matrix. IOPE does not presently offer such a facility. The calculating portions of IOPE are, I believe, written in Fortran. A version of the package consisting of these sub-routines, callable by an ordinary Fortran CALL statement, would make it easy for the user to expand the program library to fit his needs.

The second paper concerns a program, RIMLOC, for regional input–output analysis. It will scale the rows of a matrix and calculate impacts of various changes in final demands on industry outputs or various resources. It is all in Fortran and can be readily altered or expanded. On the other hand, it offers little flexibility.

The third paper, the one on matrix factorization, is a good guide to the literature, much of it quite recent, on alternatives to matrix inversion. Matrix factorization requires only one-third as many multiplications as does inversion, and the factorization is as useful for solving equations as is the inverse. The author notes, however, that where the Seidel method works, as it does with input–output matrices, it is likely to be the best alternative. Unfortunately, IOPE does not yet contain a factorization algorithm.

The fourth paper describes IDIOM—an Income Determination Input–Output Model. Note that it is a model, not just a program. It incorporates a view about the econonomy and how it works. The application of IDIOM is to an old problem for input–output, that of calculating the effects of reduced military expenditures. It differs from most other such calculations in considering consumer income endogenous in the fashion of the original Leontief closed system. It also includes some environmental impacts.

IDIOM is a young and growing model. Its author has the vision of a comprehensive model of the economy that can spell out at the industry level the influence of nearly all the factors that economists generally consider to be important. Tax rates, demographic variables, and environmental policy are all to enter. There are to be equations for investment, export and import, and wages and prices. If I may be allowed a personal word, which may be out of place, I would only express my delight that someone else has set out independently upon the work that I have pursued for a dozen years. The interindustry forecasting model of the University of Maryland—INFORUM, since models like pet names—presently does, in some fashion, the kinds of things which IDIOM is eventually to do. Descriptions of the parts of this model are available, and I am in the throes of trying to bring the whole thing together in a book. Meanwhile, we welcome inquiries about the construction and use of the model.

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