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COMMUNICATION IN ECONOMICS: THE MEDIA AND TECHNOLOGY*

BY RICHARD AND NANCY RUGGLES

After examining the growth of the economics literature, this article describes the role of bibliographies, indexes, directories, conferences, and workshops in aiding research. The authors conclude that a continuous census of the profession - in the form of a central register - would be of substantial benefit to the scientific and policy-making community. Several case studies are then presented to show the problems posed by computerization, the feasibility of a register, and the probable costs of its operation.

In every field of specialization, the communication media and technology are central to the development of cumulative knowledge. Thus, the contribution of the invention of printing to the subsequent acceleration in the growth of knowledge has long been recognized. In recent years Xerox, telephones, jet travel, television, and computers have all had major effects on the communication process. It is in this context of changing media and technology that the substantial increases in the supply and demand for information in the field of economics have been taking place. The current communications processes in economics are not optimal, but hopefully an examination of the present situation will suggest steps which can be taken to improve efficiency and productivity.

THE PRESENT STATE OF COMMUNICATION IN ECONOMICS

According to estimates made by the Behavioral and Social Sciences Survey, there are now approximately 40,000 professional economists in the United States.¹ Approximately half of these are members of the American Economic Association. Since 1940, membership in the AEA has risen from about 3,000 to 20,000, and more than half of this increase has taken place since 1960.² Furthermore, in the last 10 years, the number of Ph.D.'s granted in economics has risen from about 350 per year to about 800 per year. The BASS report projects an increase to 1700 Ph.D.'s per year by 1977.³

The growth in economic literature. This rapid growth in the economics profession has been matched by a similar growth in the volume of economic literature. Before World War II, the main outlets for academic economists were half a dozen well known journals and a modest quantity of books. The growing supply of economists has greatly increased the supply of articles submitted to the major journals. As a consequence, journal acceptance rates have fallen drastically.

* Prepared for the NBER Workshop on Communication in Economic and Social Research, June 4, 1971. Revised July 1971. A summary of that workshop appeared in the January 1972 issue of the *Annals*.

¹ *Economics*, The Behavioral and Social Sciences Survey, Nancy D. Ruggles, ed., Prentice Hall, Englewood Cliffs, N.J., 1970, p. 13.

² "1969 Handbook of the American Economic Association," *The American Economic Review*, Volume LIX, Number 6, p. 593.

³ Ruggles, *op. cit.*

and the time lag between the acceptance of an article and its appearance in published form has lengthened. Major journals have responded by significant expansion: the *American Economic Review* now accepts 120 manuscripts a year, in contrast to 40 or 50 a year in the 1950's.⁴ *Econometrica* is now publishing 1200 pages a year, in contrast with 400 or 500 in the early 1950's. But despite this expansion, acceptance rates have fallen to 15 to 20 per cent of the manuscripts received. In response to this situation, many new journals have been created. Berg⁵ indicates that the number of economic journals in the United States increased from 14 in 1940 to 85 at the present time: 50 new journals have been introduced since 1950.

In addition to journals, other forms of publication for articles have become important. The *Index of Economic Articles* which was published for 1967 lists 2850 articles from professional journals, but there were an additional 3300 articles appearing in collective volumes.⁶ There has also been a substantial growth in unpublished literature which circulates in mimeographed form. Almost every research organization has its own working paper series, and formal exchanges of these series between research centers have begun to develop.

At the same time that the supply of economic literature has been increasing, the demand for access to the literature has also increased. The professional journals have all experienced substantial increases in circulation. However, these increases have not been commensurate with the growth in the population of economists, for several reasons. First, as the number and size of the journals has increased, the cost to the individual of subscribing to the major sources of economic literature has also grown. This cost is reflected not only in the subscription prices, but also in the space needed to accommodate the stock of journals. Furthermore, because of the increasing specialization within economics, the individual economist finds that a smaller percentage of the articles in any given journal is of interest to him—often only one or two articles in any issue. Therefore, subscribing to a journal means receiving a great deal of unwanted material along with the small percentage that is useful.

As a consequence, fewer and fewer individuals subscribe to a substantial number of journals; most have left the task of acquiring the journals to their institutional libraries. This solution has been facilitated by the existence of the Xerox machine, which lets the individual obtain copies of those articles he wants at little or no cost to himself. Some libraries even circulate Xerox copies of the tables of contents of various journals, so that the individual can check the items he is interested in and get Xerox copies automatically.

Such behavior means, of course, that the professional journals themselves do not reap the financial benefits of wider readership, and as a result may have serious difficulties in covering their costs. As a consequence the financial position of the journals remains relatively weak. As costs go up, journal prices must be raised.

⁴ "Report of the Managing Editor for the Year Ending December 1970," *The American Economic Review*, May 1971, Vol. LXI, No. 2, p. 498.

⁵ Sanford V. Berg, "Increasing Efficiency in the Scientific Journal Market," *Journal of Economic Literature*, September 1971.

⁶ "Report on Economic Index Project," Richard Ruggles, *The American Economic Review*, May 1971, Vol. LXI, No. 2, p. 514.

cutting further into future growth. Thus, despite the increase in the demand for economic literature, the financial problems of the publishing outlets have not been solved.

Bibliographies and indexes. The increase in the sheer quantity of economic literature has led to the appearance of various kinds of bibliographical aids. In the mid 1950s, UNESCO published the first systematic bibliography of economics. This bibliography was intended to cover economic literature of all sorts in all the different countries of the world. The method of collection was similar to that employed for the *Bibliography of Income and Wealth*, which had been published by the International Association for Research in Income and Wealth. Correspondents were appointed for each country, with the responsibility for sending in relevant items of bibliography classified by subject. The individual submissions were then put together into a combined bibliography. Such a system makes the quality of the bibliographical reporting highly dependent upon the conscientiousness, knowledge, and ability of the individual correspondents. These, inevitably, differed considerably from country to country and from period to period. Nevertheless, the UNESCO volumes represent a major accomplishment.

In the early 1960s, the *Index of Economic Journals* was undertaken for the American Economic Association by John P. Miller at Yale, under a grant from the Ford Foundation. This effort differed from the UNESCO bibliography in that a staff was employed to classify articles published in the major economic journals. The *Index* has now been carried up through the year 1968 by Truus Koopmans at Yale.⁷ It became increasingly apparent that the restriction of the AEA *Index* to journal articles excluded a large body of economic literature that was appearing in collective volumes. In 1967, the AEA decided to expand the coverage of the index to include such articles, resulting in a doubling of the literature covered in recent periods.

A second effort undertaken by the American Economic Association was the publication of abstracts of current literature. Again with the help of a Ford Foundation grant, the *Journal of Economic Abstracts* was initiated under Arthur Smithies at Harvard in 1963. The establishment of this journal represented a marked institutional change in the economics profession. The journal was a cooperative enterprise, initially involving 24 journals. By 1968, however, the cooperative aspect had largely disappeared, and the entire enterprise had become an activity of the AEA. The journals contributing abstracts had expanded to 60, and the listing of articles appearing in current periodicals formerly carried in the *AER* was merged with the abstracts. In 1969 the *Journal of Economic Literature* was created under the editorship of Mark Perlman at the University of Pittsburgh. The new journal contained (1) articles and communications, (2) book reviews, (3) an annotated listing of new books, (4) contents of current periodicals, (5) a subject indexing of articles, and (6) selected abstracts. Furthermore, provision was made

⁷ A comparison of the coverage of the UNESCO bibliography and the AEA *Index* is instructive. Of the journal articles published in English listed in the UNESCO volume, approximately 30 percent were also found in the AEA *Index*. Conversely, about 25 percent of the articles contained in the AEA *Index* were included in the UNESCO bibliography. In point of fact, since the UNESCO coverage was so very much broader, including foreign language titles, books, and articles in collective volumes, the literature covered in common amounted to only 10 percent of the total UNESCO collection.

at that time for the bibliographical material relating to articles which was contained in the *JEL* to be published in cumulative index form annually, replacing the *Index of Economic Articles*. The *JEL* now classifies and indexes articles from more than 250 journals. In response to this more comprehensive effort, the *Economic Journal*, which had provided listings of recent periodicals and new books, is discontinuing this service.

Another new service is an early announcement service in the field of agricultural economics, which is being sponsored by the American Agricultural Economics Association.⁸ The first issue appeared in June 1971, and it will be published every two months. It is anticipated that about 3000 items per year will be assigned subject descriptors by 10 subject specialists. The bibliographical information is keypunched and put on computer tape so that a cumulative master file can be created. As the number of items contained in this cumulative master file increases, it will provide a basis for analyzing the usefulness of computer search and retrieval techniques.

Directories. Professional societies have traditionally provided directories of their members. In some cases these directories are merely lists of names and addresses, but in other cases they give such information as institutional affiliation, special fields of interest, research activity, and some bibliographical references. In 1957, the Econometric Society experimented by publishing a bibliographical directory of members listing publications for the previous 10-year period. The American Economic Association publishes a *Handbook* which includes for each individual the doctoral dissertation and three major publications. The American Statistical Association lists the affiliation and the field of interest of its members.

Directory information is very costly to prepare and publish; preparation costs alone range from about \$3 to \$20 per individual. Because of their cost, directories are published only at fairly long intervals, and they become obsolete well before new ones are published. From the producer's point of view, updating of directories using a manual system has proven difficult, and it has generally been found easier to start over.

From the user's point of view, directories are both incomplete and highly duplicative. The purpose of looking an individual up in a directory is normally to find out something about him other than the fact that he is or is not a member of the organization in question. A directory which covers only members of a particular organization is an incomplete reporting on the members of the profession. Yet individuals who are joiners may have duplicate listings in a number of different directories. Despite these drawbacks, however, the need for information about members of the profession is such that the existing directories are found to be very useful.

Employment registers constitute a specialized form of directory that has developed in recent years. The usefulness of such special registers would be greatly increased if they were integrated with the standard directory information in a more systematic manner. This is especially important for new entrants to the labor market.

⁸ "An Early Announcement Service in Economics: The American Agricultural Economics Documentation Center," Fred Abel, Economic Research Service, USDA (mimeographed).

Existing directories have not satisfactorily established the link between biographical and bibliographical information. The *Index of Economic Articles* and the UNESCO bibliography contain no author identification other than name. The directories provide identification and some biographical information, but they present little if any bibliographical information. A merging of these different bodies of data would be very useful indeed.

Conferences. With the increase in the number of economists, the development of greater specialization, and the availability of rapid and low cost travel, the number of conferences held has expanded considerably. The annual meeting of the Allied Social Sciences Associations has grown to the point where it no longer serves the function of scholarly interchange. Attendance at some of the meetings has been of the order of 10,000 people, and hundreds of papers are presented. The major functions of these meetings have become the provision of a job clearinghouse and an opportunity for younger economists to present papers and to meet other members of the profession. The professional societies are finding the publication of the proceedings difficult and expensive, and there is a serious question as to whether such publication can be continued in the future.

Because the annual meetings no longer provide a satisfactory forum for the presentation of scholarly papers, more specialized conferences, workshops, and colloquia have developed. Such meetings are not usually sponsored by the professional societies; rather they are arranged by specialized groups doing research in specific areas. Thus for example, the National Bureau, Brookings, the Urban Institute, the Social Science Research Council, the Cowles Foundation, and others arrange specialized meetings from time to time. Many of these meetings do not receive much publicity, so that only those who actually attend the meetings are aware of the papers presented at them. To some who are interested in specific topics but are not informed about such conferences, the arrangements seem to be unduly exclusive. Even if specific meetings would have to be restricted in order to reduce the number attending, it would be extremely useful if the papers presented could be given wider circulation.

Working papers. Working papers present much the same sort of problem as papers which are presented at small conferences, workshops, and colloquia. They often give the first semi-public view of research in progress. Most major research groups have working paper series, distributed in mimeographed or offset form. It has been estimated that three to five years elapse between the time when research appears in a working paper and when it is published in journal or book form. Recently the Econometric Society has initiated a listing of working papers produced by the major centers of econometric research, with the understanding that these will be available on request from the research organizations which produce them. It is still too early to evaluate this approach. Bonomo's proposal for a clearinghouse is very much more ambitious.⁹ Whether it is feasible would depend in large measure on the comprehensiveness of the coverage it achieved and its ability to disseminate information to the profession as a whole. The crux of the matter is whether the high quality working papers which are produced would

⁹ Vittorio Bonomo, "A Proposal to Establish a Clearinghouse for Research Papers in Economics," Virginia Polytechnic Institute and State University.

be submitted to the clearinghouse, and conversely whether there might not be a flood of low quality papers.

Data documentation. Bodies of data have always been important for economists. Pre-computer, however, such data were generally either available as published documents or totally inaccessible because they existed only in the worksheets and working papers of individual economists. Traditionally, the publications of the government, including items such as the *Survey of Current Business*, the *Federal Reserve Bulletin*, the *Monthly Review of Labor*, Census volumes, and publications of regulatory agencies have provided much of the basic data with which economists have dealt. To the extent that such data appeared in well-known publications which were part of the bibliographical system, the data and its documentation were part of the open communication network available to economists.

In recent years, however, the computer has led to a major change in the availability of information. The Census Bureau, in addition to published volumes, is now issuing data in the form of computer tape. Computer tapes have replaced the elaborate worksheet as the economist's research tool. This change in media and research technology is important since, unlike worksheets, computer tapes generated for a given research project can be reproduced in usable form. In a great many instances the computer tapes are and should be in the public domain. Often they are created with the cooperation of government agencies using funds provided by foundations or research projects supported by the federal government, and it is of benefit to the economics profession as a whole that such data should be widely available for other economists to use.

In 1965 a report by the Social Science Research Council Committee on the Preservation and Use of Data¹⁰ urged that an interuniversity consortium be created to provide a clearinghouse for information about the availability of data which are of direct interest to social scientists. This recommendation has not yet been implemented, but the need for some mechanism is becoming increasingly evident. What is required is a mechanism somewhat similar to that which has been suggested for working papers. The important bodies of data which are available in computerized form need to be documented, so that those who are planning research in a given area will have a fuller appreciation of the kind of information which is available.

THE NEED FOR A CENTRAL REGISTER IN ECONOMICS

The communications media discussed above are all highly interrelated. They involve, first and foremost, individual economists who are both producers of economic research and consumers of it. If communication is to be effective, it is important to know who the economists are, where they are, what they are doing, and what fields they are interested in. Such a central register is basic to the establishment of effective communication. Specifically, a census of the profession is required to provide the basic biographical and bibliographical information on each member of the profession. The National Science Foundation has collected some of the

¹⁰ "Report of the Committee on the Preservation and Use of Economic Data to the Social Science Research Council," April 1965, published as Appendix 1 in *The Computer and the Invasion of Privacy*. Hearings before a Subcommittee of the Committee on Government Operations, House of Representatives, Eighty-Ninth Congress, Second Session, U.S. Government Printing Office, 1966.

relevant information for the National Register, but, despite its name, the National Register is not publicly available and aside from some statistical tabulations is of little use to the economics profession. It is a private register for use by the government agencies, for purposes unknown to the profession as a whole. This is in marked contrast to the directories which are published by the AEA and the ASA. Even if the National Register listing of economists were made publicly available, however, its value in its present form would be limited. Some of the information it collects, e.g., salaries, is not relevant to the communication problem in economics, and bibliographical information is neglected. Furthermore, the reliance of the National Register on voluntary returns based on mailing lists of professional societies results in very partial coverage of the profession. Perhaps for some of these reasons, the NSF effort has been discontinued.

It would be possible, however, to bring together existing biographical and bibliographical sources of information to create an open central register that would serve as a base for a communications system. The current bibliographical and directory activities of professional societies, major research organizations, and universities can provide the basis for such a central register. Furthermore, if it becomes obvious that such a central register is a publicly available facility which can be queried by individuals and is used as the basis for the communication network in the profession, the cooperation of economists in providing information about themselves and their work would be much more readily obtained.

The uses of a central register. One of the major uses of a central register would be to facilitate the orderly processing of the current information flow, in a way that will lead to the generation of cumulative indexes of economic literature by subject and by author. Currently this information flow is being handled by the *Journal of Economic Literature*, but if a central register were available the efficiency and comprehensiveness of coverage could be greatly improved. Sending to each author for correction and updating a list of books, articles, and working papers which he had authored, for instance, would be likely to improve coverage and accuracy. If economists were able to see what was on file for them, they would generally be more willing to cooperate.

The central register could maintain on a current basis the other types of biographical information needed for directory purposes, e.g., address, fields of specialization, research activity, etc., without the duplication that now results from the existence of separate directories for individual societies, or the cost of manual preparation each time a directory is prepared. Because the maintenance of the central register would proceed on a continuous and systematic basis, the information in it could be kept completely up to date.

A central register could also serve as the basis for integrating other types of information relating to the field of economics. Thus, for example, economic research organizations as well as individual economists should be listed. Bibliographic coverage requires this, since a government agency, research organization, or even a business establishment may be the author responsible for a given publication. Information about bodies of data, conferences, and working papers put out by research organizations could be added to the central register at relatively low marginal cost. Such information, furthermore, would take on greater significance when combined with other information in the central register.

The existence of a central register would permit selective dissemination of information to those interested in following developments in a given field. Since the new information coming in would be identified and classified, and the economists interested in various categories of information would also be identified, it would be possible to direct the information flow in a more efficient manner than is now done. The feasibility of a system of distributing unrefereed papers, similarly, would be greatly enhanced since lists of available papers could be created easily.

From the point of view of users, computerization of the central register could make possible selective retrieval on an interactive basis. It is quite reasonable to suppose that within the foreseeable future the bibliographical and biographical portions of a central register could be queried by remote terminal and the information displayed visually on a CRT. Conceivably, abstracts of the literature could be made available on such a basis. In any case, computer retrieval and indexing would make it possible for the individual to go to published abstracts or microfilm and look up the relevant information.

Finally, a central register would have considerable administrative use for the professional societies themselves. For example, the handling of pre-registration for conferences could be done centrally for a group of societies which were meeting together without requiring each society to send out information individually to its members, duplicating the mailing for those individuals who are members of more than one society. For some associations, it may be found that the production of mailing labels or the development of separate machine readable files derived from the central register would be a practical alternative to present administrative arrangements.

In summary, a central register would create a general facility for the economics profession as a whole which would reduce duplication of effort among existing professional organizations and would provide the basis for a communication network in the profession.

THE COMPUTER BASIS FOR A CENTRAL REGISTER

The development of computer technology during the past decade has made the development of a central register for economics a feasible undertaking. A great many organizations are currently engaged in computerization of their basic information systems. However, in a study undertaken by Alan Westin for the National Academy of Sciences which investigates the relation between computerization and the invasion of privacy, it was found that computerization has not proceeded as far as is generally assumed, and that in a great many areas the level of computerization is quite primitive. In a forthcoming book on this subject, Alan Westin and his associates chronicle the computerization efforts of a number of major companies. These case histories reveal dramatically the difficulties which have confronted organizations attempting the computerization of their records.

In view of the difficulties which computerization raises, the recommendation that a central register be created is not sufficient. The basis of such computerization needs to be examined in some detail, in terms of the problems which are posed, the feasibility of the solutions which are suggested, and the probable costs of operation. Considerable insight into these questions can be obtained by relating the

experiences of the Econometric Society, the International Association for Research in Income and Wealth, the National Bureau of Economic Research, and the *Journal of Economic Literature* with a computerization system called SIPPS (System of Information Processing for Professional Societies) which has been designed to provide for general computerization of the activities of professional societies.

Computerization of the Econometric Society. During the 1960s the Econometric Society experienced a period of very rapid growth. In an attempt to cope with the administrative problems which this growth entailed, the Econometric Society decided in 1965 to undertake the computerization of its basic administrative files. The Society encountered great problems in using a system of many separate manual files. It was, therefore, considered essential that the computerized system should (1) integrate all of the functions required for the operation of the society, (2) operate on the flow of information into the organization, and (3) completely supplant all manual files. The system which was designed was a general system of information processing which was independent of the kind of information to be processed. It was called A System of Information Processing for Professional Societies (SIPPS).

The central feature of SIPPS is a single integrated master file containing all of the information relating to all individuals or organizations with whom the Society deals. The master file is composed of a set of subfiles, each subfile containing all of the different kinds of information for one individual or organization. An information tag is attached to each piece of information which is entered into the system. This information tag consists of three basic elements: (1) what subfile is the information to be filed in, (2) what kind of information is being filed, and (3) what is the recording date of the information. Designating the information type is essential for computer processing of the file. For example, if address labels are to be made, the computer has to be able to recognize address information. If bills are to be generated, financial transactions have to be identified. Use of an explicit information type in the information tag (instead of relying on position) makes the system open ended, so that additional kinds of information can be introduced without altering its operation. The time-dating of all information is also essential. Such information as address changes can then be added to the file without in any way changing information already in it. Processing programs take the recording date into consideration. The label program, for instance, operates on the latest address information available. Thus, like manual files, the computer file grows with time, and reflects the total information flow.

The initial keypunching for the Econometric Society was done in 1966. It involved four major sets of information: member and subscriber lists, addressograph plates, financial records, and correspondence logs. It was felt that if these four pieces of information could be brought together in a single subfile for each member and subscriber, the fragmentation of the records could be corrected and filing could be done by computer rather than by hand.

At first, account numbers were used to identify individual members and subscribers, but the difficulty in using account numbers and the prevalence of keypunch errors soon made it evident that a better method of identification was needed. What evolved was the use of the name, in the case of individuals, and in the

case of organizations a keyword based upon the name of the organization. In those instances where individuals or organizations have the same name, numbers are used with the identifier to distinguish between them, e.g., JONES J J 1 and JONES J J 2. Such a system of alphabetic identifiers has the advantage that a misspecification generally is easily perceived, and can usually be corrected. A misspecification of an account number, on the other hand, not only results in missing information in the account which is misspecified, but usually introduces wrong information into some other account.

For the correspondence log, a system was instituted in which each piece of incoming and outgoing correspondence was microfilmed and a log entry made as to the name of the correspondent, the microfilm number, the date, and the subject of the letter. The function of the correspondence log is central to the complete computerization of an organization. Although a correspondence log does require that all incoming and outgoing letters and manuscripts be microfilmed and listed, this task is not expensive nor time consuming. Microfilming costs a fraction of a cent per letter and is done automatically. Logging correspondence in and out is not a difficult or lengthy process. Once the microfilming and logging of correspondence are done, no subsequent filing is required. The microfilm files of correspondence serve as the archives of the organization, and the computerized correspondence log provides an index to the archives.¹¹

SIPPS programs were originally written in FORTRAN and MAD for use with tape files on an IBM 7094-7040 direct coupled system. The system was clumsy because of the difficulties of sorting data and manipulating tapes. In addition, both the keypunch and the computer were restricted to a limited character set which excluded lower case letters. This meant, for instance, that the computer could not produce an output which was suitable for photo reproduction. As a consequence, a shift was made to a third generation computer, a 360/50, to provide the basis for integrating into SIPPS additional kinds of information which required upper and lower case characters. The conversion from the second to third generation computer was not without its difficulties. The superior ability of the PL/I programming language available on the 360 in handling character strings led to the redesigning of SIPPS to provide information in human readable form as the basis for retrieval and processing by the computer. The basic master files were also converted from computer tape to disk files, improving the operation of the system.

In 1968 a biographical-bibliographical questionnaire was developed for members of the Econometric Society, and this was integrated into SIPPS. The bibliographical portion of this questionnaire used descriptors rather than a subject classification system as the basic retrieval device for econometric literature. This was done because it was not considered practical, given the present state of the art,

¹¹ For this purpose, three listings of the correspondence logs are generated. The first, in chronological order, shows the incoming and outgoing correspondence by date. The second is in alphabetic order, by the names of the individuals from whom correspondence is received and to whom it is sent. The third is a listing by subject. Since the listings contain the microfilm number of the document in question, retrieval is a relatively simple matter. Microfilm readers now have automatic search devices and provide hard copy if desired. Including the correspondence log in the master file also makes possible a check on the consistency and completeness of the individual subfiles. Thus, if there is a correspondence log entry indicating that a dues payment has been received, a financial transaction recording this payment should also appear.

to develop an adequate classification system for the field of econometrics. The Econometric Society had experimented earlier with the use of citations in connection with papers presented at its annual meetings. Unfortunately, an examination of the citations provided by the authors revealed a degree of gamesmanship which made their value extremely questionable. In any case, it did not seem practical to go to this level of detail in the bibliographical listings of each member.

The major problem posed in computerizing the biographical-bibliographical questionnaires was that of how to enter them into the computer. This phase of the work was supported in part by a National Science Foundation grant. In the course of solving this problem, a free-form system of entry was developed which freed the operator from the necessity of formatting the data or knowing about such things as information types. The free form program also screened the incoming data to insure that it was internally consistent and conformed to specifications.¹²

Because of the delays in developing a satisfactory input system and general financial considerations, not all of the biographical-bibliographical questionnaires of the Econometric Society were computerized. It became obvious that the cost of printing and distributing a directory was beyond the current financial resources of the Society, and it was concluded that the entry of the remaining questionnaires should have lower priority than other remaining tasks.

The resources of the Econometric Society were therefore devoted to the further development of SIPPS programs and to finishing the computerization of its own administrative files. A program which could bill members and subscribers and simultaneously edit and update the SIPPS files was written. To run this program on the full Econometric Society file costs between \$60 and \$80. The total file produces approximately 7000 bills, making the cost of the bills a cent a bill. When fewer bills are produced the cost per bill rises proportionately, since the cost of running the program is almost independent of the number of bills produced. But even when only a few bills are produced and the cost rises to six or seven cents a bill, this compares favorably with the cost of hand billing where an employee might turn out 50 or 60 bills per day.

Other programs which were developed included an authority file program to list all subfile identifiers, and a dictionary program listing the contents of any specific field of information with tabulations of the number of occurrences of each different item listed. At one stage a considerable amount of programming was done to convert the system to random access processing, and to provide on-line capabilities. Due to limitation of resources, however, this programming was never completed, and sequential batch processing still continues. The costs of sequential batch processing have, however, dropped considerably due to improvement in the efficiency of programs and to the ability to combine a number of different processing programs on a single pass of the file. At first, the cost of processing the file carrying out only a single task was \$350 to \$400. Currently, a number of tasks can be accomplished simultaneously for a total cost of \$40 to \$60. A great deal of

¹² The search for low cost input devices taking both upper and lower case characters absorbed much of the energy of the project. This was not only costly in terms of the resources required for learning to adapt to different input devices, but also in terms of delay, since once it had been determined that an input system was unsatisfactory it usually took a considerable length of time to find, order, and get delivery of something different.

the programming effort has gone into *ad hoc* programs which have been used only one time to correct the form of the file as experience was gained in the operation of the system. Within the past year, however, the system has stabilized and output is on a production basis.

The major difficulty in computerization of the Econometric Society arose from the necessity of continuing day-to-day operations during computerization. The manual system in its unsatisfactory fragmented form had to be maintained while the computerized master file was being developed, and considerable checking and editing has been necessary to insure that the information contained in the manual files is fully and correctly reflected in the master file. Currently, major segments of the manual system are being dropped, and the computerized file is taking over. The present Econometric Society master file consists of 11,000 subfiles with about 200,000 records. The system of entry of the administrative information is still punchcards, although free form entry is used to simplify the process and to reduce the error rate. Full free form entry using an off line magnetic tape terminal is scheduled to go into operation shortly.

Computerization of the IARIW. The computerization of the records of the International Association for Research in Income and Wealth was not initiated until 1968 when SIPPS was well established. For this reason, many of the problems encountered by the Econometric Society were avoided. Thus for example, the IARIW never used account numbers, but rather started the system using names as identifiers. Furthermore, the IARIW is a much smaller organization. Its total master file consists of about 2,500 subfiles consisting of 50,000 records, and processing the complete file costs between \$5 and \$10 per run. At the present time the IARIW has no manual files except for back issues sales and inventory. The computerized master file of the IARIW contains relationships, addresses, financial transactions, correspondence logs, and records of journal issues sent; it produces bills, mailing labels,¹³ authority files, and dictionaries using the general programs of SIPPS.

At the present time, the IARIW enters its information in free form off line on a magnetic tape computer terminal. Entry is considerably simpler than with punchcards, since information can be recorded by typewriter on magnetic tape off line and can be entered directly into the computer economically by regular telephone line. The conversion of the free form entries to standard SIPPS form costs approximately 1/4 of a cent per record. The monthly cost of computer time for the IARIW comes to about \$50.

Computerization of the National Bureau of Economic Research mailing lists. In early 1969 the NBER made the decision to computerize its mailing lists. Like many other organizations, its mailing lists were in the form of addressograph plates, and separate addressograph files existed for different mailing lists. For

¹³ Recently, for instance, for a conference in Sweden the label-making facility of the system showed itself to be of considerable value. The previous practice had been to reproduce conference papers centrally and send them out in a single mailing to participants. Since mailing labels can now be produced on a selective basis easily and simply, authors were told that they would be provided with a set of mailing labels if they were willing to reproduce and send out their own papers. Such an arrangement was found to be considerably more satisfactory for the individual authors, since it gave them more time than they would have had otherwise to prepare their papers, and in most cases the organizations with which they were affiliated were quite willing to provide the reproduction services. Fifty sets of mailing labels were produced, each containing about 175 labels. The cost for a set was about 75c. In point of fact, the cost of the postage required to send the mailing labels to the authors exceeded the cost of producing them.

example, separate sets of plates were maintained for subscribers, contributors, occasional papers, press list, income and wealth conference, etc. Different NBER employees maintained the different lists, and the same individual or organization was often represented in a number of different lists. This meant, for instance, that an address change for an individual had to be entered on each of the lists in which he appeared. In addition, a general mailing required that the addressograph labels be sorted by hand to prevent duplicate mailings.

In computerizing the NBER mailing lists, a single master file was created and the relevant relationships (subscriber, contributor, occasional paper, press list, etc.) were attached to each subfile. The label program which is currently used not only permits the selection of specific subfiles by relationship and geographic location, but it also provides for inserting into the subfile a record indicating that the individual or organization has been sent a specific mailing. Running the label program to create 4,000 labels costs approximately \$10 in computer time to select the appropriate subfiles from the master file, \$2 for a geographic sorting if desired, and \$8 to print, making a total production cost of approximately $\frac{1}{2}$ cent per label.

The National Bureau uses the same authority file and dictionary programs as the Econometric Society and the IARIW. Since new information is continually added to the Bureau file—address changes, records of labels produced, new accounts, cancellations—the file grows over time. Recently a purge program was developed to take the master file of 5,500 subfiles and 80,000 records and produce a new operating file containing only the current information. This reduced the size of the file to 40,000 records. In this connection it is important to note that the computer file has a dual function. On the one hand, it produces archival records which contain the complete records relating to a subfile for audit and historical purposes. But at the same time, smaller and more efficient files can be produced for current administrative purposes such as the production of mailing labels and bills.¹⁴

COMPUTERIZATION OF THE CURRENT PERIODICAL LISTING IN THE JEL

The *Journal of Economic Literature* (JEL) is faced with the task of taking over the *Index of Economic Articles*, until now published at Yale. Since the contents of current periodicals appear in the JEL classified by journal and by subject, and indexed by author, it would seem appropriate that this information be used to produce the cumulative annual compilations. Up to now these tasks have been done separately by two different organizations, but the economy and efficiency of combining them is obvious.

Initial computerization of the current periodical listing was undertaken in December 1970, utilizing SIPPSS and free form entry by terminal on a 360/50 computer at the University of Pittsburgh. The symbols which are used are such things as *a* for author, *t* for title, *j* for journal, etc. The first file which was created

¹⁴ Currently the NBER is developing a more sophisticated label program which, like the Econometric Society and IARIW billing programs, will provide for automatic edit and update and in addition will permit the submission of multiple label jobs simultaneously, thus making it possible to produce a number of different sets of labels with one pass of the file. Such a program will not only reduce computer costs, but will also reduce the time of the personnel who submit the jobs. After initially using punchcards, the NBER moved on to terminal entry of information.

contained subfiles of journals listing authors, titles, subject indexes, etc., for each article in a given issue of a journal. This file is used to produce the listing of articles by journal in the JEL. In order to produce an author listing, this file is resorted by subject classification and author. The quarterly files of listings will be merged to provide annual cumulative indexes.

SUMMARY OF THE EXPERIENCE OF PROFESSIONAL SOCIETIES WITH SIPPS

The different organizations which have been using SIPPS have found themselves confronted with generally similar problems. The concept of a single master file divided into subfiles has been directly relevant despite the differences in the type of information which is being entered and the uses which are being made of it. The open-endedness of the system, which permits the introduction of new kinds of information, has allowed the system to grow to fit the needs of different groups without impairing the utility programs needed to edit, update, process, and retrieve information. For most organizations, the free form entry system has simplified the task of entering information so that those using the system do not need to burden themselves with a knowledge of formats, information types, or technical specifications. The free form entry system reduces the number of characters which have to be entered by approximately 50 percent, and makes it possible to build in consistency and editing checks on the information being entered. With the advent of off-line magnetic tape terminals, the problem of entry devices has been resolved satisfactorily. In cases where low-cost or free computer terminal entry is available, this has also proved satisfactory. The use of subfile identifiers based on names, the identification of types of information, and the dating of information have proved to be characteristics which all the users have employed to good advantage. The operating cost of the computerized system is relatively modest for production purposes. As in the case of all computer work, however, the cost of developing programs has been substantial. This suggests that cooperation in program development would be highly desirable. Past experience further suggests that general table-driven programs are in the long run considerably more economical than specialized *ad hoc* programs, even though they may initially cost more to produce.

IMPLEMENTATION OF A CENTRAL REGISTER FOR ECONOMICS

In developing a central register for economics which can serve as the basis for a communication network, the essential requirement is that the computerization of the different parts of the system should be done in such a manner that it all fits together. As already suggested, one of the major elements in the development of a central register is bibliographical information. The *Journal of Economic Literature* is now creating master files of current periodicals in which the subfiles represent authors. The cumulative processing of such files will bring together the publications of a given author over time. This basic author file of bibliographical information is effectively the beginning of a central register. Additional bibliographical information relating to books, working papers, and conferences could be merged without any difficulty. Directory and mailing list information can also be computerized in the same general form and integrated into the master file. The

integration of pre-registration lists or employment registers can also add to the completeness of the file. For such a use, addresses would not need to be entered for individuals already in the file. As in the case of the National Bureau and IARIW files, multiple relationships may be used for a given individual where appropriate.

In addition to using the same system of computerization for all different kinds of information, it is important to use the same system of identification so that a specific individual or organization has the same identifier in the files of different organizations. For most purposes determination of the identifier is simple enough. However, common authority files listing the identifiers used are very useful in insuring that a specific individual or organization is referred to in a consistent manner.

Given the general type of computerization represented by SIPPS and a consistent set of identifiers, it is possible to build up a central register out of the individual computerization efforts of different groups carrying out different functions. Although coordination is required, the extent of decentralization can be quite great. What is needed, however, is some general coordinating mechanism, a mechanism which could be provided either by the Allied Social Science Association or by the Social Science Research Council. The gradual development of a central register for economics could then evolve from the current efforts of different groups.

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