Information Processing & Management Vol. 19, No. 1, pp. 9–26, 1983
Printed in Great Britain.

0306–4573/83/010009–18$03.00/0
Pergamon Press Ltd.

THE STRUCTURE AND FUTURE OF THE INFORMATION ECONOMY

MICHAEL D. COOPER
School of Library and Information Studies, University of California, Berkeley, CA 94720, U.S.A.

(*Received for publication* 26 *April* 1982)

Abstract—The structure of the U.S. economy is analyzed to determine whether a shift has occurred from a service to an information economy. National Income Accounting concepts are reviewed to facilitate a critical comparison of the works of Machlup and Porat. Evidence about the future of an information economy is reviewed. It is concluded that the growth of the information economy will not continue at the same rate it has in the past and further that the growth will be in information products, not information services. It is also concluded that it is unwarranted to restructure the National Income Accounts to reflect a change to an information economy.

INTRODUCTION

From agriculture to manufacturing to services to information? If we believe the economists, the structure of the United States economy has changed in the last century from one where agricultural production was the major output to one where the output of information products and services dominates. The purpose of this paper is to examine the shifts in structure of the economy, with particular attention to whether we have moved away from a services-based economy to an information economy and to determine whether we should restructure the National Income Accounts to reflect this transition.

As background to the discussion, information will be provided on the way in which the U.S. government prepares its National Income Accounting. Evidence pointing to the existence of an information economy will be reviewed and compared and conclusions drawn about its future growth. Finally, the paper will address the question of whether the U.S. National Income Accounting procedures should be revised to reflect the existence of an information economy. This latter issue will be resolved in terms of the current and potential uses made of the information and the effect of modification on the users.

STRUCTURAL CHANGES IN THE U.S. ECONOMY

Each organization in the United States is classified by the type of product or service it supplies. The categorization takes the form of a Standard Industrial Classification (SIC) code which identifies its industrial group[1]. The major industry categories are agriculture; mining; construction; manufacturing; transportation; communication; public utilities; wholesale and retail trade; finance, insurance, and real estate; services; and government.

Narrowly defined, services include medical, legal, and engineering services, household services, repair services, hotels, etc. For purposes of this paper the major industry sectors have been consolidated into four: agriculture, industry (mining, construction, manufacturing, transportation, communications, and public utilities), services (wholesale and retail trade; finance, insurance, and real estate; and services), and government (federal, state, and local). Later in the paper a fifth sector, information, will be introduced.

Early in the history of the United States the major industries were agriculture and mining. As time passed agriculture waned in importance as manufacturing gained. After World War II another shift occurred as the services sector grew.

Table 1 shows the growth of the economy from 1948 to 1980 as measured by Gross National Product (GNP), the market value of all goods and services produced in the United States. Table 2 presents the same information in 1972 constant dollars, that is, after adjusting for inflation. In 1980 GNP amounted to $2.6 trillion current dollars, with the services sector producing the largest proportion of GNP, closely followed by industry. (See Tables 3 and 4). The data show a

Table 1. Gross National Product by industry group (billions of dollars)

Year	Gross National Product	Agriculture	Industry	Services	Government
1948	259.1	24.0	119.0	96.4	20.2
1954	366.3	20.7	166.7	137.1	36.9
1958	448.9	21.9	197.3	178.7	47.1
1963	594.7	22.0	258.9	240.4	65.9
1967	796.3	24.3	341.2	328.3	96.3
1972	1,171.1	35.4	467.9	504.3	154.9
1973	1,306.6	53.9	522.4	552.2	166.5
1974	1,412.9	52.2	556.4	603.7	181.7
1975	1,528.8	53.4	588.2	670.6	200.4
1976	1,706.5	52.7	605.6	747.6	217.4
1977	1,899.5	55.1	756.0	825.7	237.3
1978	2,127.6	66.6	850.3	927.9	258.9
1979	2,413.9	78.4	963.7	1,045.3	280.7
1980	2,626.1	77.2	1,039.4	1,157.2	303.4

Source: (7) pp. 178-183 for 1948-1972. *Survey of Current Business* 57:7(July 1977)43-44 for 1973-1976; 59:7(July 1979)51-52 for 1977-1978; 61:7(July 1981)26 for 1979-1980.

Note: Rows do not add to Gross National Product because of omission of minor categories. Values of series' may be inconsistent between years due to readjustment of published data.

Table 2. Gross National Product by industry group (billions of 1972 constant dollars)

Year	Gross National Product	Agriculture	Industry	Services	Government
1948	487.7	28.0	198.3	192.0	69.0
1954	613.7	31.1	243.5	235.8	94.9
1958	679.5	32.0	260.7	277.7	101.7
1963	830.7	32.8	331.3	339.8	118.3
1967	1,007.7	32.6	412.8	410.5	143.5
1972	1,171.1	35.4	467.9	504.3	154.9
1973	1,235.0	35.9	503.1	526.2	157.3
1974	1,217.8	35.7	479.3	530.7	160.0
1975	1,202.1	37.1	455.6	536.3	162.7
1976	1,274.7	36.8	496.3	565.7	164.0
1977	1,340.5	38.3	527.2	593.3	165.5
1978	1,399.2	38.7	556.0	624.3	168.6
1979	1,483.0	39.6	588.4	654.3	174.9
1980	1,480.7	40.2	571.5	662.9	176.3

Source: (7) pp. 184-185 for 1948-1972. *Survey of Current Business* 57:7(July 1977)44 for 1973-1976; 59:7(July 1979)52 for 1977-1978; 61:7(July 1981)26 for 1979-1980.

Note: Rows do not add to Gross National Product because of omission of minor categories. Values of series' may be inconsistent between years due to readjustment of published data.

Table 3. Percentage distribution of Gross National Product by industry group (using current dollars GNP estimates)

Year	Agriculture	Industry	Services	Government
1948	9.3	45.9	37.2	7.8
1954	5.7	45.5	37.4	10.1
1958	4.9	44.0	39.8	10.5
1963	3.7	43.5	40.4	11.1
1967	3.1	42.8	41.2	12.1
1972	3.0	40.0	43.1	13.2
1973	4.1	40.0	42.3	12.7
1974	3.7	39.4	42.7	12.9
1975	3.5	38.5	43.9	13.1
1976	3.1	35.5	43.8	12.7
1977	2.9	39.8	43.5	12.5
1978	3.1	40.0	43.6	12.2
1979	3.2	39.9	43.3	11.6
1980	2.9	39.6	44.1	11.6

Source: Derived from Table 1.

Note: Rows do not add to 100% because small sectors have been omitted.

shift away from agriculture into industry and finally into services.[1] From 1975 to 1980 the percent distribution of each sector's share of GNP remained relatively constant with respect to one another.

We can also analyze structural shifts in the economy by examining employment trends. Table 5 shows that the number of agricultural workers has declined since the 1930s but remained relatively constant during the period 1975–1979. Likewise in the past 50 years the number of employees in industry has nearly doubled while the number in services has tripled.

The mix of workers in the four industry sectors has also changed since 1929, but relatively little since 1967 (Table 6). Between 1967 and 1979 government workers remained at about 19–20% of the work force, and the number in agriculture at around 2%. The mix between industry and service workers has held steady at roughly 35–43% respectively over the past few years.

THE INFORMATION SECTOR OF THE ECONOMY

Figures presented in the preceeding section show that the U.S. economy has changed in the type of output produced and the industries in which workers are employed. A major concern of this paper is whether there has been an additional shift from a services to an information economy.

There are a number of problems in dealing with this question, not the least of which is the definition of an information sector of the economy. The previous definitions of industries could have been structured in terms of the SIC codes of the industries that made up the group. Furthermore, definitions of each industry could have been presented to sharpen the concept.

When it comes to defining the information industry the problems are much more difficult. The U.S. Department of Commerce's Bureau of Economic Analysis does not define an

Table 4. Percentage distribution of Gross National Product by industry group (using 1972 constant dollar GNP estimates)

Year	Agriculture	Industry	Services	Government
1948	5.7	40.7	39.4	14.1
1954	5.1	39.7	38.4	15.5
1958	4.7	38.4	40.9	15.0
1963	3.9	39.9	40.9	14.2
1967	3.2	41.0	40.7	14.2
1972	3.0	40.0	43.1	13.2
1973	2.9	40.7	42.6	12.7
1974	2.9	39.4	43.6	13.1
1975	3.1	37.9	44.6	13.5
1976	2.9	38.9	44.4	12.9
1977	2.9	39.3	44.3	12.3
1978	2.8	39.7	44.6	12.0
1979	2.7	39.7	44.1	11.8
1980	2.7	38.6	44.8	11.9

Source: Derived from Table 2.

Table 5. Full time equivalent employees by industry (thousands)

Year	Total FTE Employees	Agriculture	Industry	Services	Government
1929	35,338	2,952	16,809	12,373	3,204
1933	27,215	2,486	11,225	9,610	3,893
1939	35,915	2,368	14,876	12,498	6,172
1948	48,097	2,072	22,913	16,293	6,812
1954	52,743	1,897	23,346	17,686	9,941
1958	53,842	1,773	22,551	19,462	10,184
1963	58,588	1,664	23,703	21,732	11,553
1967	67,781	1,297	26,975	25,566	13,948
1972	72,348	1,229	27,116	29,428	14,586
1973	75,484	1,332	28,565	30,797	14,799
1974	76,476	1,405	28,524	31,518	15,039
1975	74,290	1,411	26,142	31,418	15,332
1976	76,728	1,555	26,962	32,843	15,385
1977	79,469	1,475	28,149	34,292	15,575
1978	83,125	1,486	29,593	36,226	15,845
1979	85,956	1,528	30,653	37,646	16,149

Source: (7) pp. 206-209 for 1929-1972. *Survey of Current Business* 57:7(July 1977)47 for 1973-1976; 59:7(July 1979)55 for 1977-1978, and (8) p. 53 for 1979.
Note: Rows do not add to total FTE Employees because minor categories have been omitted.

[1]This phenomenon has been pointed out by numerous writers. See, for example, Refs [2–6].

Table 6. Percent distribution of full time equivalent employees by industry

Year	Agriculture	Industry	Services	Government
1929	8.4	47.6	35.0	9.1
1933	9.1	41.2	35.3	14.3
1939	6.6	41.4	34.8	17.2
1948	4.3	47.6	33.9	14.2
1954	3.6	44.3	33.5	18.8
1958	3.3	41.9	36.1	18.9
1963	2.8	40.5	37.1	19.7
1967	1.9	39.8	37.7	20.6
1972	1.7	37.5	40.7	20.2
1973	1.8	37.8	40.8	19.6
1974	1.8	37.3	41.2	19.7
1975	1.9	35.2	42.3	20.6
1976	2.0	35.1	42.8	20.1
1977	1.9	35.4	43.2	19.6
1978	1.8	35.6	43.6	19.1
1979	1.8	35.7	43.8	18.8

Source: Derived from Table 5.
Note: Rows do not add to 100% because minor categories have been omitted.

information industry. Consequently, each person writing about the information industry has his or her own definition. Not only is there no common definition, but there is no agreement on a label. Some prefer knowledge industry, information economy, information industry, information society, or possibly post-industrial society (as shall be discussed in the next section).

The first person to develop the concept of an information economy was Fritz Machlup in his classic *The Production and Distribution of Knowledge in the United States* [9]. Deliberately broad, Machlup defines this new sector of the economy as "... a group of establishments—firms, institutions, organizations, and departments, or teams within them, but also in some instances, individuals and households—that produce knowledge, information services or information goods, either for their own use or for use by others." ([10], Vol. 1, p. 228).[2]

An alternate approach to the definition and analysis of the information economy appears in the works of Porat [11–19]. Porat's fundamental unit of analysis is an information activity. "Information is data that have been organized and communicated. The information *activity* includes all the resources consumed in producing, processing and distributing information goods and services." ([11], Vol. 1, p. 2). Porat deals with information activities rather than industries because he considers them the building blocks from which to define the information sector of the economy. The activities of industries are consolidated into a Primary Information Sector for industries whose major activity is information, and a Secondary Information Sector for activities of industries that are not wholly devoted to information.

Considerable ambiguity is raised by Daniel Bell in his introductory discussion of a post-industrial society, but it is just that ambiguity which lies at the heart of this paper. In the 1976 foreword to his book, *The Coming of Post-Industrial Society*, Bell notes: "... I rejected the temptation to label these emergent features as the 'service society' or the 'information society' or the 'knowledge society' even though all these elements are present, since such terms are only partial, or they seek to catch a fashionable wind and twist it for modish purposes." ([20], p. ix). Leaving aside the possibility that 'post-industrial society' may be just as modish a label as 'information society' or 'knowledge society', let us consider the ambiguity raised by Bell's suggestion that any of these terms could serve as labels and could thus be synonymous, a suggestion which clearly points up the difficulty in making distinctions among them.

It should be noted that Bell may not really mean to make a parallel between the information and service economy, for his definition implies more emphasis on information: "The concept 'post-industrial' is counterposed to that of 'pre-industrial' and 'industrial.' A pre-industrial sector is primarily *extractive*, its economy based on agriculture, mining, fishing, timber, and other resources such as natural gas or oil. An industrial sector is primarily *fabricating*, using energy and machine technology, for the manufacturing of goods. A post-industrial sector is one of *processing* in which telecommunications and computers are strategic for the exchange of information and knowledge." ([20], p. xii).

[2]This definition is taken from Vol. I of Machlup's updated series of volumes rather than the 1962 volume. No definition of 'knowledge' is given in this paper because the complexity of the discussion would lead far from its purpose.

NATIONAL INCOME ACCOUNTING

Careful measurement of the scope and magnitude of the U.S. economy is crucial to validate the claims that ours is a services or information economy. This section reviews the structure of U.S. National Income Accounting as a prelude to the analysis of the works of Machlup and Porat.

Just as an individual or a business firm keeps track of income and expenditures, the U.S. Government keeps track of market transactions with the National Income and Product Accounts which collect National Income Accounting data. These accounts measure the market value of goods and services produced by the economy and are used to calculate Gross National Product, a figure summarizing the total output of the economy for a year. Perhaps the most important principle underlying National Income Accounting is that this government bookeeping system records only market transactions. If a candy bar is purchased, that transaction is included in the accounts, but if a member of a household cleans the house, that transaction is not. Like any system, there are exceptions to the market transaction rule but these are generally few. If a person rents a home to live in, the rental transaction is recorded. If a person lives in a house that he or she owns, no rental transaction takes place, but the value of the transaction is estimated and included in the accounting.

The objectives of a national accounting system are numerous. ([21], pp. 1–2). First, it needs to be designed so that the operation and interactions of the economic system can be analyzed. It also needs to reflect the interrelationships between transactions, i.e. that individuals use the salary they make to purchase goods and services that are produced by businesses. Those businesses in turn purchase goods and services from other firms and pay employees for their labor. Meanwhile the government collects taxes from individuals and businesses and provides services of various types. The system also has to establish limits on the type and nature of transactions that will be recorded in the accounts (e.g. recording net inventory changes rather than exact counts of inventories), and it needs to impute transactions (as noted above with respect to owner-occupied homes) when necessary. The system also needs to be constructed so that the data in it can be manipulated in many different ways and that there are no inherent limitations on the analysis because of the methods of data collection used.

There are three categories of organizational units and four categories of transactions that are classified in the National Income and Product Accounts. Businesses, such as corporations, partnerships, and sole proprietorships, are one category of organizational unit; households and nonprofit institutions and government (federal, state, and local, except government enterprises) comprise the other two.

Transactions are those related to the production of goods and services, those that occur when income is received or transferred, those related to imports or exports, and those occurring as a result of investment or savings. The transactions are recorded in five accounts: (1) The National Income and Product Account; (2) The Personal Income and Outlay Account; (3) Government Receipts and Expenditures Account; (4) Foreign Transactions Account; and the (5) Gross Savings and Investment Account.

The interrelationship and structure of the accounts are easily understood. Each of the Personal Income and Outlay, Government Receipts and Expenditures, Foreign Transactions, and Gross Savings and Investment Accounts summarize a certain segment of economic activity. The total values from each of those four accounts are transferred to the National Income and Product Account. It is from this latter account that National Income and Gross National Product are calculated.

The Personal Income and Outlays Account, like all accounts, has two sides. One side records the expenditures or outlays of individuals for taxes, consumption, savings, and the like, and the other side records the sources of income: wages and salaries, proprietors income, rental income, dividends, and interest, among others.[3]

The Government Receipts and Expenditures Account shows, on one side, the purchases of goods and services by government, payments made to individuals (transfer payments), and interest paid. The other side of the account records the taxes received by government.

[3]The description of components of this and the subsequent accounts are intended to be indicative rather than comprehensive. For precise definitions see Ref. [7].

The Foreign Transactions Account balances the value of exports with that of imports of goods and services. And the Gross Savings and Investment Account records the gross private domestic investment which is the sum of capital goods purchased by businesses and the change in the value of inventories held. The other half of this account records the way in which funds were accumulated to allow capital investments. The sources of the funds are personal savings, corporate profits, and depreciation.

The National Income and Product Account summarizes the other four accounts (Fig. 1). One side of the account is termed the income side and the other, the product side. The income side records the types of income generated in the production of the economy's goods and services. It includes compensation of employees, proprietors income, rental income, corporate profits and net interest. These categories total to National Income and after adjusting for capital consumption allowances, etc. yield Gross National Product. This side of the account is also termed 'Value Added' because it measures the additional value added to the goods and services produced by the economy.

The product side of the National Income and Product Account summarizes the personal consumption expenditures, gross private domestic investment, net exports of goods and services and government purchases of goods and services from the other accounts. It too totals to Gross National Product and reflects the final demand or final product flows in the economy.

MACHLUP AND THE KNOWLEDGE INDUSTRY

Fritz Machlup's, *The Production and Distribution of Knowledge in the United States* [9] defined for the first time the scope of a 'knowledge industry' which included education, research and development, communications, information machines, and information services. Machlup's goal was to elucidate the concepts of 'knowledge' and 'information', to define the industry in detail, to address the conceptual issues in synthesizing a new way of grouping industries, and to measure the magnitude of the information industry, not just in terms of output or sales but by total employment, value added, and income originating in the industry. Among the problems that Machlup faced were lack of physical output from many sectors, a lack of market transactions, and thus market prices for some information activities. ([9], pp. 44–45).

In spite of all these problems and many more, Machlup succeeded in arriving at an important concept and quantifying the size of what he defined as the knowledge industry.

The breadth of Machlup's definition of the knowledge industry is best demonstrated by examining in detail the composition of some of the sectors. Education, for example, includes eight categories: education in the home, education in school, training on the job, instruction in church, training in the armed forces, education over television, self education, and learning

Income side	Product side
Compensation of employees	Personal consumption expenditures
Proprietors' income	Gross private domestic investment
Rental income of persons	Net export of goods and services
Corporate profits and inventory valuation	Government purchases of goods and services
Net Interest	
NATIONAL INCOME	
Business transfer payments	
Indirect business tax and nontax liability	
Less: Subsidies less current surplus of government enterprises	
Capital consumption allowances	
GROSS NATIONAL PRODUCT	GROSS NATIONAL PRODUCT

Note: National Income is the sum of the first five quantities on the income side of the account. Each side of the account totals to Gross National Product.

Fig. 1. The National Income and Product Account.

from experience. Clearly Machlup's concept of education is broad and bears little relation to the normal economic measurement of educational expenditures by government agencies. One major difference is the imputation of value for non-market transactions. The value assigned to education in the home is derived by calculating the wages foregone by parents staying at home and educating children rather than working. Exceptions can be taken to some of Machlup's approaches. For instance, some would question whether education takes place in a church and whether that value should be counted toward the size of the knowledge industry.

By contrast, the approach used to estimate expenditures for research and development, information machines, and information services conforms rather well with National Income Accounting procedures for measuring a sector.[4] Information machines include, among other things, printing trade machines, telephone equipment, office machines, and computers. Information services include legal, engineering, accounting, medical, financial, wholesale, and government.

Table 7 summarizes the results of Machlup's estimates. Using 1958 data he determined that the size of the knowledge-production industries amounted to $136 billion, roughly 28% of Gross National Product. Most of the value (44%) created in the knowledge industry had its origins in the education sector.

PORAT'S INFORMATION ECONOMY

Machlup's role was one of conceptualizing an information economy and showing the extent to which it permeates the economy. In 1977 Porat made a significant contribution toward refining the concept and developing a comprehensive methodology for analysis of its size[11–19].[5] His objectives were to define and measure information activities in the United States, to examine the structure of the information activities relative to the rest of the economy, and to examine the implications of an economy evolving from manufacturing to information.([11], p. 1).

Porat's framework and approach were nowhere as broad as Machlup's. Porat was trying to work within the framework of the National Income and Product Accounts structure to build a set of accounts that were consistent yet which measured information activity. ([11], p. 5). His approach was to aggregate information activities into primary and secondary information sectors. The primary information sector was defined to "... include those firms which supply the bundle of information goods and services exchanged in a market context." ([11], p. 4). The secondary information sector was defined to include what Porat calls 'quasi-firms'—groups within an organization that provide information services but whose services are never sold in an established market.

In order to determine which industries or parts of industries should be included in the primary information sector, Porat went through a detailed listing of industry categories and products arranged by SIC number.[6] He selected those industries he considered to be candidates for primary information producers. In some cases industries could be transferred completely to the primary information category. In other cases the industries had to be partitioned. Table 8 lists the major and secondary categories that Porat defined as the primary information sector.

Table 7. Machlup's 1958 estimates of the size of the knowledge industry (millions of dollars)

Industry	Total Value	Percentage of Total	Percentage of GNP
Education	60,194	44.1	12.6
Research and Development	10,990	8.1	2.3
Media of Communication	38,369	28.1	8.0
Information Machines	8,922	6.5	1.9
Information Services	17,961	13.2	3.8
Total Knowledge Production	136,436	100.0	28.5
Total 1958 GNP	478,900		

Source: (9), pp. 354-357. (22), p. 233 for 1958 GNP.

Note: Final column does not add to 100% due to rounding.

[4]Conformity to National Income Accounting guidelines was *not* one of Machlup's goals.

[5]Porat's approach to the analysis of the information economy has been extended to other countries. See Ref. [23].

[6]Porat looked at the 7-digit SIC classification, which is the finest level of detail available.

Certain categories in the figure need clarification, including public information and electronic investment goods. Within the public information services section of the information distribution and communication industries is found library and information centers, and within the electronic investment goods section of the information goods industry is the electronic computing equipment industry.

It is instructive to understand how Porat arrived at estimates of the amount of primary information activity within a specific industry. Finance and Insurance is a relatively complex example ([12], pp. 17–43). This industry includes subindustries such as banking, credit agencies, security brokers, and insurance companies. Porat notes that some components of these subindustries perform an information activity and some do not. In the Banking industry, a myriad of services are provided for customers (deposit accounts, loans, trust management, etc.) and certain administrative activity required for the bank to function. Porat's approach is to look at each activity and if it is information-related ascribe its costs and revenues to the primary information sector. This is a complex task. To accept Porat's results it is necessary to analyze each industry and decide if the allocation is correct.

The secondary information sector is much more difficult to measure. This sector is composed of quasi-firms that operate within organizations and only 'sell' their output within their parent organization. Calculation of the percentage of GNP contributed by the secondary sector requires that one know the value produced. Lacking this, Porat uses two other quantities to approximate the value. The first is the amount of money paid to information workers in

Table 8. Primary information sector major industries

Knowledge Production and Inventive Industries
R&D and Inventive Industries (private)
Private Information Services
Information Distribution and Communication Industries
Education
Public Information Services
Regulated Communication Media
Unregulated Communication Media
Risk Management
Insurance Industries (components)
Finance Industries (components)
Speculative Brokers
Search and Coordination Industries
Search and Non-Speculative Brokerage Industries
Advertising Industries
Non-Market Coordinating Institutions
Information Processing and Transmission Services
Non-Electronic Based Processing
Electronic Based Processing
Telecommunication Infrastructure
Information Goods Industries
Non-Electronic Consumption or Intermediate Goods
Non-Electronic Investment Goods
Electronic Consumption or Intermediate Goods
Electronic Investment Goods
Selected Government Activities
Primary Information Services in the Federal Government
Postal Service
State and Local Education
Support Facilities
Information Structure Construction and Rental
Office Furnishings

Source: (11), p. 23.

noninformation industries, and the second is the depreciation taken on information machines in noninformation industries.

Development of the secondary sector estimates require several sources of data. First one begins with the information activities that are performed within noninformation firms. Porat develops such a list which includes activities such as data processing, advertising, letter typing, research and development, accounting, and library service.[7] The second piece of data needed is a list of information workers. Porat develops a taxonomy which includes knowledge producers (e.g. scientists, engineers, lawyers, physicians, computer programmers), knowledge distributors (e.g. educators, librarians, communications workers), market search and coordination specialists (e.g. inspectors, brokers, sales, people), information processors (e.g. secretaries, clerks), and information machine workers (e.g. typesetters, printers, keypunch operators, telephone operators).[8]

A final source of data required is a list of information machines and the industries producing the machines. This data can be derived from an input-output matrix.

Input–output matrices, or more formally Input–Output Flow Tables, contain data similar to the five National Income Accounts but in a different form. The tables show the transactions that take place *between* various categories of producers, as well as the distribution of producer products to individuals, investors, foreigners, and government. In addition, the tables show how much value is added to each type of producer's goods; that is the amount of employee compensation, profit, depreciation, and indirect business taxes paid by each producer.[9]

Reformating the National Income Accounts tables into input–output tables is extremely valuable for analytic purposes. Given data in this and similar forms, it is possible to determine the effect of specific changes on the economy: for example, what would be the effect of an $x billion reduction in defense spending on the economy? Which industries would feel the greatest impact? What would be the impact on individual incomes?

With these kinds of data Porat first develops a list of noninformation industries and with the aid of an industry-occupation matrix of employee compensation and the list of information workers, is able to calculate the total compensation paid to information workers in noninformation industries.[10] Then using an input–output matrix he determines the amount of depreciation of information machines used in noninformation industries. Adding employee compensation to the equipment cost per year yields an estimate of the secondary information sector's size.

Porat's report contains a wealth of data, only part of which can be summarized here. For the year 1967 he estimated the primary information sector's share of Gross National Product at 21.9 percent using final demand as the numerator.[11] Alternatively when value added by the information sector[12] is used, the percent of GNP that is information-related rose to 25.1 percent. Depending on the conceptual approach one subscribes to, the percentage of information activities in GNP ranges between 22 and 25.

Table 9 summarizes the 1967 final demand or product side of the National Income and Product Account (Gross National Product), and includes Porat's data on the information economy. The last column of the table shows that roughly 17 percent of all consumer expenditures and 37 percent of all government expenditures were for information. In addition, 18 percent of all buildings and machines were information-related.

Table 10 presents the value added, or income side, of the National Income and Product Account. The table shows that nearly 29 percent of all employee compensation and 43 percent of all corporate profits stem from information activities.

Table 11 analyzes the information value added broken down by industry. Overall 25.1 percent of GNP originated in the information sector in 1967 according to Porat. Rubin and

[7]See ([11], p. 150) for further details.

[8]See ([11], Chapter 7) for details. It is beyond the scope of this paper to delve into questions related to information professionals.

[9]See (24) for details.

[10]The industry-occupation compensation matrix reports the total amount of money an industry spends for labor.

[11]Final demand is the sum of personal consumption expenditures, gross private domestic investment, exports, and government purchases of goods and services.

[12]Value added is the sum of compensation of employees, proprietors income, rental income, corporate profits, and interest.

Table 9. Information sector's contribution to Gross National Product, 1967 (millions of dollars)

	Total final demand	Information final demand	Information percent of total
Gross National Product	795,388	174,585	21.9
Personal consumption expenditures	490,358	83,742	17.1
Durable goods	69,646	5,261	7.6
Nondurable goods	212,593	4,006	1.9
Services	208,119	74,485	35.8
Gross private domestic investment	120,829	21,583	17.9
Fixed investment	110,730	19,958	18.0
Structures	57,430	9,871	17.2
Producers durable	53,300	10,087	18.9
Change in business inventories	10,099	1,625	16.1
Net export of goods and services	4,937	2,942	59.6
Government purchases of goods and services	180,188	66,308	36.8
Federal	90,924	26,796	29.5
State and Local	89,264	39,512	44.3
Statistical adjustment	-924		

Source: (11), p. 50.

Table 10. Information sector's contribution to national income by type of income, 1967 (millions of dollars)

	Total national income	Information national income	Information percent of total
National income	655,805	176,319	26.9
Compensation of employees	491,915	136,488	28.9
Private	376,514	99,328	26.4
Military	18,842	4,432	23.5
Government civilian	76,559	32,728	42.7
Proprietors' income	60,974	9,187	15.1
Business and professional	48,894	9,187	18.8
Farm	12,080	0	0
Rental income of persons with capital consumption adjustments	19,376	0	0
Corporate profits and inventory valuation adjustment	79,261	33,675	42.5
Profits	77,330	33,675	43.5
Inventory valuation adjustment	1,744	n.a.*	
Capital consumption adjustment	3,675	n.a.	
Net interest	24,279	-3,031	

Source: Adapted from (11), p. 53.

*Note: n.a. - not available

Table 11. Total and information value added by industry, 1967 (millions of dollars)

	Total value added	Information value added	Information percent of total
Total GNP for all industries	795,388	200,025	25.1
Agriculture	26,733	0	0
Mining	13,886	0	0
Construction	36,102	8,527	23.6
Manufacturing	223,729	32,691	14.6
Nondurable goods	90,595	11,762	13.0
Paper and allied products	8,005	1,539	19.2
Printing and publishing	10,718	10,223	95.4
Other	71,872	0	0
Durable goods	133,134	20,929	15.7
Furniture	3,380	528	15.6
Machinery excluding electrical	23,980	3,198	13.3
Electrical machinery	19,959	12,123	60.7
Instruments	5,606	4,309	76.9
Miscellaneous manufacturing	3,305	771	23.3
Other	76,904	0	0
Transportation	32,040	0	0
Communication	17,632	17,609	(a)*
Public utilities	18,429	0	0
Wholesale and retail trade	129,863	16,053	12.4
Wholesale trade	51,802	8,584	16.6
Retail trade	78,061	7,469	9.6
Finance, insurance and real estate	108,840	41,425	38.1
Services	86,992	43,021	49.4
Personal and miscellaneous repair services	9,751	853	8.7
Miscellaneous repair services	11,919	10,703	89.8
Motion Pictures	1,690	1,525	(a)
Amusement and recreation services	3,607	485	13.4
Medical and other health services	21,392	5,754	26.9
Miscellaneous professional services	12,738	12,181	95.6
Educational services	5,446	5,170	(a)
Nonprofit membership organizations	7,527	6,348	84.3
Other	12,922	0	0
Government and government enterprises	95,827	40,699	42.5
Federal	40,559	15,771	38.9
General government	35,865	10,232	28.5
Government enterprises	4,694	3,539	75.4
State and local	55,268	26,928	48.7
General government	49,222	26,928	54.7
Government enterprise	6,046	0	0
Rest of world	4,510	0	0
Statistical adjustment	802		

Source: Adapted from (11), p. 55-56. Some subcategories have been omitted so totals in subcategories may not add to industry totals.

*Note: Porat found discrepancies between the figures supplied in the National Income Accounts and the Input-Output worktape. For the values indicated with an '(a)' he assigned 100 percent of the industry to the information sector.

Taylor[25] recently updated Porat's work and found that in 1972 this value had declined to 24.8 percent.[13] The sectors with the highest information value added in 1967 are services, with 49 percent and government at 43 percent. Significant portions of some industries' output are in the form of information.

MACHLUP AND PORAT: AN ANALYSIS

To compare the works of Machlup[9] and Porat[11–19] is, to some extent, to compare apples and oranges. The two address the same general topics, but their approaches are much different. In Machlup's work the concept of an information economy is explored for the first time. Reading and then rereading Machlup after a lapse of ten to twenty years makes one realize that we now take for granted much of what was presented in his original work. No doubt each reader could quibble with the scope of the definitions, but few would take issue with the major ideas.

[13]Rubin and Sapp[26] update other issues addressed by Porat.

Machlup presented the ideas and the justification for the ideas, and performed calculations to determine the scope of the information sector. It is with the latter that comparisons can be made between the two authors.

Scope and definition

The major difference between Machlup's and Porat's work is in the approach they take to the data analysis. Machlup's major goal was to define the information economy while Porat's was to measure the size of the economy using concepts drawn from National Income Accounting. Machlup divided the information industry into five sectors (education, research and development, communications, information machines, and information services), while Porat began with the idea of information activities and grouped them into primary and secondary information sectors, depending on the presence of a market transaction for information involved.

Some of the differences in approach come out clearly when Porat compares his values of the size of the information economy with those of Machlup for 1958. Table 12 reproduces part of Porat's comparison in which he converts his concepts into those used by Machlup. A major difference between the two authors is that Machlup imputes values for certain items for which market transactions do not occur, such as the wages foregone by mothers raising their children. This alone accounts for almost all the $39 billion difference in their estimates for education. Another difference is that Machlup includes certain types of intermediate purchases as investment rather than omitting them from total demand.[14] Adjusting the data in this way, Porat found Machlup's calculations to result in 29 percent of GNP belonging to the information sector and his own to result in 16 percent for the primary information sector. Porat notes that the difference between the two values is partially accounted for by the secondary information sector ([11], p. 47). Porat's original calculations of the 1958 size of the primary and secondary sectors show $84.9 billion and $85.6 billion respectively before adjustment of Machlup's concepts. ([11], p. 171). The ratio between the sector values is roughly equal so one would expect another 16 percent for the secondary sector, making Porat's estimate even higher than Machlup's.

Machlup's comments on Porat's study appear in the first of an eight volume series which will eventually update the 1962 work ([10], pp. 237–241). Machlup is critical of Porat for the liberties taken with the National Income Accounting conventions even though Porat says he intends to follow them closely. Specifically in dispute are Porat's estimation procedures for certain sectors. Reviewing the accounting procedures and myriad data sources used by the Bureau of Economic Analysis, one cannot but feel that the estimating techniques used by either author are not truly out of line and that calculating the GNP is not a cut and dry procedure.[15]

Machlup comments critically on three points that Porat raises about the 1962 study. First, the issue of the strictness with which each study intends to or should adhere to National Income Accounting concepts is addressed with each author suggesting that the other is taking

Table 12. Comparison of information industry analyses (millions of dollars)

Industry	Machlup's Estimate	Porat's Estimate of Primary Information Sector
Education	60,194	21,232
Research and Development	10,990	7,330
Media of Communication	37,563	18,994
Information Machines	8,922	8,732
Information Services	15,542	15,567
Total Knowledge Production	133,211	71,855
Percentage of GNP	29%	16%

Source: Adapted from ([11], p. 46.

[14]The example of intermediate demand that Porat uses to illustrate the issue is Advertising. ([11], p. 44). Businesses purchase advertising space from newspapers. In National Income Accounting terms this purchase is intermediate—it is not related to or included in final demand calculations. Machlup treats it as an investment made by the firm and adds it to final demand.

[15]Data sources used to calculate GNP are reviewed in [27–31].

unnecessary liberties. The authors have both common and different purposes. Machlup is trying to describe the scope of the information economy, and Porat is trying to use National Income Accounting and other data to operationally measure it.

A second point relates to Porat's technique for measuring the secondary information sector. Machlup notes:

"Porat, contrary to my methodological resolution, does include in his secondary information sector data on employee compensation of information workers, labor income of proprietors performing information tasks, and capital consumption allowances taken on information machines, in 'noninformation industries.' In other words, he mixes information *inputs* in industries outside the information sector with *outputs* of industries in the information sector" ([10], p. 240).

Machlup's point is well taken since it appears that Porat makes the same mistake he accuses Machlup of making with respect to intermediate goods.

The final point is a dispute over whether value added or final demand is the correct measure of size of the information economy. Porat calculates it both ways and the difference is around three percent—very small indeed.

THE FUTURE OF AN INFORMATION ECONOMY

The first section of this paper showed that a shift had taken place from an agricultural-based to a service-based economy, and in the preceding sections and evidence accumulated by Machlup and Porat was presented to show that a significant portion of the Gross National Product is information-related. Further, the evidence suggests that information products and services are to be found throughout the economy, as are information workers. This part of the paper addresses the likely future of an information economy. It looks at the historical data accumulated on the growth of the sector and compares it to the growth of other sectors. Then attention is turned to the future, and by using data and ideas about the growth of the service sector of the economy conclusions are derived.

Porat has calculated the portion of National Income generated by the information sector for selected years from 1929 to 1972, and a modified version of that data is presented in Table 13, with percentage distributions of it in Table 14.[16] The data are presented in current dollars (that is, unadjusted for inflation) because no time series are available to deflate the values in the information sector.[17] What can be observed is the steady growth in National Income at about 23 percent per year over the period 1948–1972. The average annual growth rate is highest in the information sector at 24 percent, next highest in the government sector at 22.9 percent, and third in the services sector at 12.7 percent.

Table 13. National income of industry group (billions of dollars)

Year	Total National Income	Agriculture	Industry	Services	Government	Information
1929	86.8	8.5	33.4	25.4	2.9	15.8
1933	40.3	3.9	12.3	11.6	3.0	9.2
1939	72.6	6.0	26.3	20.7	5.2	14.1
1948	225.9	22.3	92.3	60.1	12.1	38.0
1954	305.3	17.1	122.5	78.4	22.5	62.9
1958	370.8	18.6	139.5	97.5	30.0	84.9
1963	484.0	18.5	180.3	125.8	36.9	118.9
1967	655.6	20.7	235.6	167.8	52.9	173.9
1972	956.7	30.6	320.2	251.3	81.3	266.3

Source: Adapted from (11), pp. 66-68. The information sector column of the table (column 7) was computed by subtracting the information portion of each sector from that sector's total National Income in Porat's table and adding it to the new information sector in this table.

Note: Rows do not add to total National Income due to rounding.

[16]Recall that National Income is the sum of employee compensation, proprietors income, rental income, corporate profits and net interest. Gross National Product is the sum of National Income and business transfer payments indirect business taxes, capital consumption allowances and a few other small items. In 1978 National Income amounted to 81 percent of GNP's $2,128 billion.

[17]Series are available for all the other industries.

Table 14. Percent distribution of national income by industry group

Year	Agriculture	Industry	Services	Government	Information
1929	9.8	38.5	29.3	3.3	18.2
1933	9.7	30.5	28.8	7.4	22.8
1939	8.3	36.2	28.5	7.2	19.4
1948	9.9	40.9	26.6	5.4	16.8
1954	5.6	40.1	25.7	7.4	20.6
1958	5.0	37.6	26.3	8.1	22.9
1963	3.8	37.3	26.0	7.6	24.6
1967	3.2	35.5	26.3	8.5	27.8

Source. Derived from Table 13.

A comparison of the growth of GNP in constant dollars (Table 2) with National Income growth in current dollars (Table 13) is instructive.[18] The constant dollar average annual growth in GNP was 5.6 percent over the 1948–1972 period, while services grew at 6.5 percent, government at 5.0 percent, and industry at 5.4 percent per year. After adjusting for inflation (i.e. using constant dollar GNP estimates), the differences are very large. Extrapolating the constant dollar growth in the information sector suggests a figure in the range of 6–10 percent per year.

Another issue that arises is whether there is a shift in the distribution of National Income or GNP between the various sectors. The constant dollar GNP figures of Table 3 suggest there has been little change in the distribution over the period 1972–1980, with about 40 percent of GNP in industry and 43 percent in services. Table 14 shows the percentages including information. When compared to the position depicted in Table 3 for the period 1972–1980 (i.e. little shift in distribution between sectors), it appears that the information sector will level off rather than continue to produce a higher percentage of National Income.

The quantitative evidence extrapolated from Porat's 1972 estimates through 1980 suggest that the information economy is not the growth sector that one imagines. In constant dollar terms it is probably growing at the same rate as Gross National Product, which is still significant considering other sectors are growing more slowly.

How does one explain the change? Have we not been led to believe that this is the information age and that information is the major growth industry? If we read the advertisements by large U.S. corporations, we would believe that everyone is involved in the information explosion and that there are enormous amounts of money, machinery, and people involved.[19]

A useful way to analyze these issues is to divide the information economy in two ways. First consider information products and information services, and then analyze information consumers, information producers, and government information users.

Goods and services produced in an economy are normally classified as intermediate or final in nature. An intermediate good or service is produced by one organization and supplied to another to be used in the development of a final product. The information sector, as we have seen in the classifications developed by Machlup and Porat, consists of organizations that supply both information products and services. It is likely that the growth pattern of these two sectors will be radically different. The reasons are straightforward.

If a particular activity is performed or an item supplied, there is a mix of labor and capital involved in producing the product or service. As the cost of labor increases, the producer and consumer have a number of choices. The producer can decide that the labor cost increase is reasonable, and pass it onto the consumer. Or the producer can decide that the cost is too high and begin to substitute (or plan for the substitution of) equipment for labor on the theory that equipment will cost less than labor. The consumer can either accept or reject a higher priced product or service and consequently indicate the limits on the price willing to be paid.

[18]Porat's data on the size of the information economy is provided by industry in terms of National Income. No constant dollar figures for the information sector are available, and no National Income figures in constant dollars by industry are available. This is the best comparison possible.

[19]Typical of this type of advertising is that of the Bell System in *Smithsonian* 12:8 (November 1981) 154–155. The advertisement explains that we are no longer an industrial but an information society. The contribution of the Bell System is in the form of electronic switching and other communications equipment.

Applying this to the information economy we can first observe that this sector is relatively labor intensive. While the relative price of labor is bound to increase, it is not as clear that the price of information machines will continue to increase (considering price versus performance). Thus the likely growth in the information economy is in the area of intermediate and final information products rather than services because of the probable substitution of machinery for information professionals. This does not mean the demand for information professionals will not grow, only that it will not grow as fast as the demand for information machines.

A second approach to the analysis of the future structure of the information economy can be made by analogy with an analysis of the service economy developed by Stanback[6]. He suggests that if one examines the structure of the service economy in terms of consumers, producers, and public organizations, the structure and future growth patterns are much more apparent.

Consider the use of information products and services by consumers. There is a long history of consumers in the United States favoring the purchase of physical items of all types; two homes, two cars, and multiple television sets are examples. (See Ginzberg's forward to (6), pp. xi–xii). It is unlikely that U.S. consumers will change their purchasing habits when it comes to information machines versus information services.

Certain types of products and services have what is termed complementarity, and this is especially true for consumer goods like automobiles. If one buys a car one also has to have it serviced. If one plays tennis one needs tennis balls, a racket, and so forth. Clearly, there are degrees of complementarity, and in the case of acquiring an education one consumes few goods beyond normal besides writing implements, paper, and books. But that too has changed, and there is clearly a complementarity question involved in the analysis of information products versus services. Acquiring an education may involve library assistance (information services) as well as using a computer for bibliographic retrieval (information machines). The choice depends on availability, relative price, and time.

The work of Linder with respect to time allocation theory is relevant[32]. Some of Linder's ideas were first applied to library problems by N. (De Wath) Van House[33]. The crux of Van House's argument is that as the relative price of information services (library services) increases with respect to the time required to retrieve information, the more likely it is that a user would obtain the information by, say, buying a book rather than waiting for it to be returned to a library.

These arguments apply to the relative growth of consumer information products versus information services. When the user's available time becomes more expensive and scarce, there will be a tendency in some cases to substitute goods for services. There are situations where the reverse is true, a person with large amounts of money will pay someone else to do almost everything.[20] But one suspects, without concrete evidence, that the central tendency is toward substitution of machines for labor.

The overriding factor in the use of information products or services by producers is the relative cost of each. Should the cost of labor increase, capital will be substituted. Complementarity arguments hold here as well. With the shift to a greater reliance on technology as a substitute for labor, the producer may cause the creation of jobs in the information machines sector.

The future growth of information products and services by the government or public sector has to be viewed within the current context of the scaling down of the size of government. The growth in the government sector was brought about by an increased demand for educational, health, welfare, police, fire, and sanitary services. These in turn were needed because of an increasing rate of population growth, and a movement to urban areas where services that the private sector could not supply were provided by government. Now with population growth declining and pressure to reduce federal, state, and local government spending, it it likely that past trends will not continue.

Insofar as information products and services are concerned, education and research and development are likely to suffer declining support. On the other hand, rationalization of

[20]Lord Peter Wimsey's 'Bunter' comes to mind.

services will mean a more heavy emphasis placed on information machines as a substitute for labor.

An analysis of the future of the information economy cannot be complete unless consideration is given to the effect of productivity changes.[21] Stanback suggests that the productivity gains in the service sector do not match those made in nonservice activities [6]. There is reason to believe that the same holds for the provision of information services versus information products.

In conclusion the future growth in the information industry will take place in the area of information products. The evidence from the consumer, producer, and government sectors all suggest acquisition of information machines over information services.

RESTRUCTURING THE NATIONAL INCOME ACCOUNTS

The final topic addressed in this paper is whether National Income Accounting concepts and methods should be revised to reflect the presence of an information sector in the economy just as there is a services or agriculture sector. The best approach to answering that question is to determine who currently uses the National Income data, what they use the data for and whether current or potential users would benefit from such a change.

There are several major groups of individuals interested in the problem. One group is interested in the concept of an information economy and the problems of defining knowledge, information and the knowledge industry, more than they are concerned with quantitative information about its size or growth. Researchers are interested in the accounts and the emergence of an information economy because of the potential for testing hypotheses and developing models of economic behavior. The public at large is interested in the accounts because they provide data on economic well-being.

The two major groups of users of the data are those who need it to make business decisions and those who need it to make public policy decisions.[22] The variety of uses of the data for business purposes is large.[23] A decision maker has to consider factors such as production levels, employment levels, plant capacity, product demand, investment decisions and plant and equipment expenditures in the normal course of affairs. The National Income Accounts data can give the business person valuable information on the conditions in the world external to the business, with the hope that more rational actions result.

From a public policy standpoint, the accounts are extremely valuable. They serve as a basis for determining whether full employment, price stability, and economic growth are being realized. They help in the short term analysis of fiscal, monetary, and wage-price policy, and long term analysis of demands for skilled labor, and financing for capital formation ([27], p. 6). Many federal, state, and local government agencies use the data to evaluate the economy's performance.

If the National Income Accounts were to be restructured to include an information sector, the results would be valuable to researchers interested in the information economy and structural changes in the economy, but it is doubtful that they would be of much use to other groups. Previous sections of this paper have shown that by proper definition and conceptualization it is easy to show that there is a set of activities which can be categorized as information-related. These activities have to do with production and dissemination of knowledge and information, and they use existing institutions, machinery, and labor.

How useful is it for a business conditions analyst or a public policy maker to know that a piece of machinery is being used for information production purposes rather than some other purpose? What is the difference between providing an information service and any other type of service? One difference is that information rather than shoes or ice cream is being produced. But other than the fact that it is information and not ice cream, is it not sufficient to know certain types of workers perform information activities and certain types of machines do information processing? Is not the level of employment of workers in industries[24] the produc-

[21]Productivity is normally defined as the amount of output produced by a worker in an hour.

[22]The extent to which the information is actually used in decision making is not addressed here. See Refs. [34, 35] for an introduction to this issue.

[23]See Ref. [36] for examples.

[24]Industries are defined as agriculture, industry, service, and government, as before.

tion of machines in industries and the provision of services from industries the question? Knowing that there are information functions within all organizations does little to help the analyst better understand business conditions. Knowing that information activities will fall or decline in the future seem relatively unimportant compared to knowing whether the employment level in a particular industry will be greater or less in the future. From this perspective, there is little that would be accomplished by restructuring the National Income Accounts on a permanent basis. Continuing *ad hoc* studies should definitely be encouraged.

CONCLUSIONS

This paper has shown that by re-grouping the outputs of existing industries it is possible to form a new information industry category. Some of the outputs that come from the information industry are 'new' in that they did not exist in previous years. Many are the same outputs re-grouped into a new category. The evidence suggests that the concept of an information economy is new but many of the products and services in it are the same. It is not clear that there has been a shift from a services to an information economy, rather a relabeling of existing products and services.

The information economy can be divided into information products and information services and the evidence suggests future growth will take place in the information products portion of the sector. The implication of this finding for the library profession is that we cannot expect the demand for the services of librarians to increase simply because we have entered an information age. The concept of an information economy has many meanings and only a small part of it pertains to traditional library activities. The skills that a person with library training possesses are certainly relevant in the broad information economy. The challenge is to market those skills.

Finally, this paper has demonstrated that it is unwarranted at the present time to consider restructuring the National Income Accounts to reflect information activities. The majority of users of the accounts would find little use in such repackaging.

REFERENCES

[1] U.S. Executive Office of the President. Office of Management and Budget. *Standard Industrial Classification Manual.* U.S. Government Printing Office, Washington, D.C. (1972).

[2] ELI GINZBERG, The pluralistic economy of the U.S. *Scientific American* 1976, **235**(6), 25–29.

[3] ELI GINZBERG, *Good Jobs, Bad Jobs, No Jobs.* Harvard University Press, Cambridge, Mass. (1979).

[4] ELI GINZBERG and GEORGE J. VOJTA, The service sector of the U.S. economy. *Scientific American*, 1981, **244**(3), 48–55.

[5] VICTOR R. FUCHS, *The Service Economy.* Columbia University Press, New York (1968).

[6] THOMAS M. STANBACK, *Understanding the Service Economy: Employment, Productivity, Location.* Johns Hopkins Press, Baltimore, Maryland (1979).

[7] U.S. Department of Commerce. Bureau of Economic Analysis. *The National Income and Product Accounts of the United States, 1929–74 Statistical Tables.* A Supplement to the *Survey of Current Business.* U.S. Government Printing Office, Washington, D.C. (1977).

[8] National Income and Product Accounts, 1976–79. *Survey of Current Business*, Special Supplement, July (1981).

[9] FRITZ MACHLUP, *The Production and Distribution of Knowledge in the United States.* Princeton University Press, Princeton, New Jersey (1962).

[10] FRITZ MACHLUP, *Knowledge: Its Creation, Distribution, and Economic Significance. Volume I Knowledge and Knowledge Production.* Princeton University Press, Princeton, New Jersey (1980).

[11] MARC URI PORAT, *The Information Economy: Definition and Measurement* U.S. Department of Commerce. Office of Tleecommunications. OT Special Publication 77–12(1). U.S. Government Printing Office, Washington, D.C., May (1977).

[12] MARC URI PORAT, *The Information Economy: Sources and Methods for Measuring the Primary Information Sector (Detailed Industry Reports).* U.S. Department of Commerce. Office of Telecommunications. OT Special Publication 77-12(2). U.S. Government Printing Office, Washington, D.C., May (1977).

[13] MARC URI PORAT, with the assistance of MICHAEL ROGERS RUBIN, *The Information Economy: The Interindustry Transactions Matrices* (1967). U.S. Department of Commerce. Office of Telecommunications. OT Special Publication 77-12(3). U.S. Government Printing Office, Washington, D.C., May (1977).

[14] MARC URI PORAT, with the assistance of MICHAEL ROGERS RUBIN. *The Information Economy: The Technology Matrices* (1967) U.S. Department of Commerce. Office of Telecommunications. OT Special Publication 77-12(4). U.S. Government Printing Office, Washington, D.C., May (1977).

[15] MARC URI PORAT, with the assistance of MICHAEL ROGERS RUBIN, *The Information Economy: The 'Total Effect' Matrices* (1967) U.S. Department of Commerce. Office of Telecommunications. OT Special Publication 77-12(5). U.S. Government Printing Office, Washington, D.C., May (1977).

[16] MARC URI PORAT, with the assistance of MICHAEL ROGERS RUBIN, *The Information Economy: The Labor Income by Industry Matrix of Employee Compensation* (1967) U.S. Department of Commerce. Office of Telecommunications. OT Special Publication 77-12(6). U.S. Government Printing Office, Washington, D.C., May (1977).

[17] MARC URI PORAT, with the assistance of MICHAEL ROGERS RUBIN, *The Information Economy: The Labor Income by Industry Matrix of Employee Compensation* (1970). U.S. Department of Commerce. Office of Telecommunications. OT Special Publication 77-12(7). U.S. Government Printing Office, Washington, D.C., May (1977.

[18] MARC URI PORAT, with the assistance of MICHAEL ROGERS RUBIN, *The Information Economy: National Income, Workforce, and Input–Output Accounts.* U.S. Department of Commerce. Office of Telecommunications. OT Special Publication 77-12(8). U.S. Government Printing Office, Washington, D.C., May (1977).

[19] MICHAEL ROGERS RUBIN, *The Information Economy: User's Guide to the Complete Data Base.* U.S. Department of Commerce. Office of Telecommunications. OT Special Publication 77-12(9). U.S. Government Printing Office, Washington, D.C., May (1977).

[20] DANIEL BELL, *The Coming of Post-Industrial Society: A Venture in Social Forecasting.* Basic Books, New York (1979).

[21] NANCY RUGGLES and RICHARD RUGGLES, *The Design of Economic Accounts.* Columbia University Press, New York (1970).

[22] *Economic Report of the President.* Transmitted to the Congress January 1981. U.S. Government Printing Office, Washington, D.C. (1981).

[23] Organization for Economic Cooperation and Development. *Information Activities, Electronics and Telecommunications Technologies: Impact on Employment, Growth and Trade.* Volume I. (Information Computer Communications Policy No. 6) Report No. 93 81 031. Organization for Economic Cooperation and Development, Paris, France (1981).

[24] The Input–Output Structure of the U.S. Economy: 1967, *Survey of Current Business* February 1974, 24–56.

[25] MICHAEL ROGERS RUBIN and ELIZABETH TAYLOR. *The U.S. information sector and GNP: an input–output study. Inform. Proc. Management* 1981, **17**(4), 163–194.

[26] MICHAEL ROGERS RUBINS and MARY E. SAPP. *Selected roles of information goods and services in the* U.S. national economy. *Inform. Proc. Management* 1981, **17**(4), 195–213.

[27] U.S. General Accounting Office. *A Primer on Gross National Product Concepts and Issues.* Report GGD-81-47, U.S. General Accounting Office, Washington, D.C., 8 April (1981).

[28] *The National Economic Accounts of the United States: Review, Appraisal, and Recommendations.* A report by the National Accounts Review Committee of the National Bureau of Economic Research. National Bureau of Economic Research, General Series No. 64.

[29] U.S. Department of Commerce. Office of Federal Statistical Policy and Standards. *Gross National Product Data Improvement Project Report.* Report of the Advisory Committee on Gross National Product Data Improvement. U.S. Government Printing Office, Washington, D.C., October (1977).

[30] ROSANNE COLE, *Errors in Provisional Estimates of Gross National Product.* National Bureau of Economic Research, New York (1969).

[31] ALLAN H. YOUNG, *Reliability of the Quarterly National Income and Product Accounts of the United States,* 1947–71. U.S. Department of Commerce. Social and Economic Statistics Administration. Bureau of Economic Analysis. July (1974).

[32] STAFFAN BURENSTAM LINDER, *The Harried Leisure Class.* Columbia University Press, New York (1970).

[33] NANCY VAN HOUSE DEWATH, *Demand for Public Library Services: A Time Allocation and Public Finance Approach to User Fees.* Ph.D. Dissertation, School of Library and Information Studies, University of California, Berkeley, California (1979).

[34] LAURENCE E. LYNN, *Knowledge and Policy: The Uncertain Connection* (Edited by LAURENCE E. LYNN), Study Project on Social Research and Development, Vol. 5, pp. 1–11. National Research Council, National Academy of Sciences, Washington, D.C. (1978).

[35] CAROL H. WEISS, "Improving the Linkage Between Social Research and Public Policy." In: *Knowledge and Policy: The Uncertain Connection* (Edited by LAURENCE E. LYNN), Study Project on Social Research and Development, Vol. 5, pp. 23–81. National Research Council, National Academy of Sciences, Washington, D.C. (1978).

[36] JOHN P. LEWIS, *Business Conditions Analysis.* McGraw-Hill, New York (1959).