PROBLEMS OF IDENTIFYING AND MEASURING INTERMEDIATE (PRODUCER) SERVICES IN THE COMPILATION AND USE OF INPUT-OUTPUT TABLES*

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The paper is mainly concerned with statistical problems relating to intermediate services that arise in the construction of national input-output (I–O) tables. Though these problems are sometimes discussed in the literature, their precise nature is usually not spelled out in any detail and this is done in the paper. The problems are closely related to the company-establishment statistical dichotomy permeating the ultimate sources and allocation of intermediate services. Important examples can be found regarding the statistical treatment of head offices, research and development expenditures, and international trade of intermediate services. Presently used procedures for Canadian and U.S. I–O compilation show evidence of statistical inconsistencies and lack an appropriate framework to utilize full information. The paper suggests a possible approach for reconciling company and establishment data based on industrial organization linkage studies at the microlevel. Considerable empirical support is offered, using various official Canadian statistical publications, to show that the suggested approach is both feasible and has desirable properties.

The paper goes on to argue that the contemporary information technology revolution has profound implications for I–O compilation and use with special reference to intermediate services. Four major implications are explained in the context of the growing microelectronics technological change and related literature. Some basic suggestions are put forward with regard to joint-cost allocation and intertemporal comparisons problems with respect to I–O compilation. It also appears that some fundamental rethinking of commonly accepted standard industrial classification conventions may be called for in the near future if I–O tables are to remain relevant and viable. The paper thus features a somewhat broader view of I–O statistical problems than usual and attempts to show that this view is potentially appropriate to questions of economic policy formulation.

> The Exxon Corporation doesn't really sell oil, chemicals, electronic typewriters and motors; rather, it owns an array of companies that sell those things. It is, in effect, a fabulously wealthy investment club with a limited portfolio. Each year, it makes investments in 13 affiliated companies that are expected to return that money plus a suitable profit. Those that can show they can make more with more, get more. Those that cannot, do not. It is just that simple, and just that complicated.†

I. INTRODUCTION

This paper is essentially an essay on certain statistical problems relating to input-output (I–O) compilation and use. The paper is mainly written from the viewpoint of a user of I–O tables; more precisely, a user who has a special interest in problems of I–O compilation but no direct practical experience in the area. While this lack of compilation experience is obviously a disadvantage, it may also have the advantage of permitting a somewhat wider view of I–O statistical problems.

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†From "Inside Exxon: Managing an $85 Billion-a-Year Empire", by A. J. Parisi, *The New York Times Magazine*, August 3, 1980.

The paper is particularly concerned with the identification and measurement problems of intermediate (producer) services. There is now considerable popular interest in the service sector of a nation's economy and it is increasingly recognized that producer services are of growing importance relative to the traditional consumer services (see e.g. Ginzberg and Vojta [9]). In fact producer services directly, as well as indirectly, enter international trade. In this paper we try to show that a systematic discussion of producer services, in the context of input–output compilation and use, permits a partial synthesis of a wide variety of topics that are ordinarily not related to each other. The discussion attempts to go beyond problems of statistical integration in order to consider areas such as industrial organization and technological change that appear to be relevant. Indeed, our considerations may be characterized as being on the *boundary* between input–output and other areas of applied economic research. Before continuing it might also be stated that the empirical illustrations given in the paper mainly reflect the writer's knowledge of Canadian, and, to some extent, American I–O statistical procedures. But there are also references to the United Nations *System of National Accounts* (SNA) and other supporting documents.

The scope of producer services discussed in this paper is rather limited. In terms of the International Standard Industrial Classification (ISIC), we focus particularly on the commodity services attached to Major Division 8 as described in United Nations [56]. This means that the paper mainly investigates statistical problems relating to: banking and financial services, insurance and real estate operations, computer and information processing services and rentals, advertising and sales promotion activities, and other professional services to business management. In addition, for reasons that will become apparent later, we are also concerned with telecommunication services (part of Major Division 7). The industries producing these services can be called producer service industries to the extent that the services are purchased and consumed as intermediate inputs by other industries. As an indication of the relative importance of these particular producer service inputs, it is possible to calculate the *ratio* of the subtotal of these inputs to the total of all (real)[1] intermediate commodity inputs. This has been done using the row summations of the Canadian intermediate input transaction matrix for the years 1961, 1971 and 1977 (expressed in current prices). The calculations show:

Year	Ratio
1961	0.151
1971	0.176
1977	0.190

Thus the producer services covered in this paper are of some growing importance.

One more observation may be relevant. For those interested in the triangulation of input-output tables (see e.g. United Nations [57]), *all* industries of the

[1]Dummy intermediate commodity inputs are eliminated in this calculation. Note that producer service industries in this study do not include transportation, distribution, storage and trade margins.

business sector consume significant quantities of producer services as intermediate input. Producer service industries as a whole supply much greater quantities of their output to all other industries than they consume as intermediate input supplied by the other industries. Thus producer services have a relatively high potential for yielding "spillover-effects" in a productivity growth analysis which accounts for interindustry linkages (see Postner [29]).

II. The Basic Problem

First it should be clear that we are primarily concerned with the compilation of input tables (i.e. the use matrix) where a distinction is drawn between intermediate commodity inputs and the industry of use. Now input tables, and the complementary output tables, are compiled by bringing together a wide array of data collections in a double-entry accounting system. There are important commodity balance checks and national income accounting constraints. Generally speaking it seems recognized that the statistical data available from the large variety of sources is more complete and more reliable with respect to intermediate material inputs than with regard to intermediate service inputs. The recent U.S. Department of Commerce *GNP Data Improvement Project Report* [61] contains a leading recommendation (p. 18):

> The Census Bureau should collect as an integral part of each economic census the purchases of services by establishments.

This recommendation was strongly endorsed by the National Academy of Sciences *Panel To Review Productivity Statistics* [23, p. 13]:

> The Panel endorses the recommendation of the GNP Data Improvement Project calling for the Census Bureau to collect . . . data on the purchases of intermediate services as well as materials by establishments.

Since everyone is agreed, what precisely is the problem? Unfortunately, neither of the two references spells out the nature of the difficulty.

We know that I–O tables represent a disaggregated accounting of production. The statistical reporting unit (and tabulating unit) is the establishment. It is desirable that the establishment be sufficiently homogeneous with respect to production (or, its undertaking) to permit classification at a fine level of industrial disaggregation. Given this target, what can we expect the establishment to "report?" The answer to this question essentially depends on industrial organization, ownership and intracompany accounting procedures. We know that the industrial economy of modern nations is dominated by a collection of large corporations or enterprises (both publicly and privately owned) most of which operate "establishments" in a number of different industries.[2] These enterprises, and their constituent companies and divisions, typically do not maintain records in a form which makes it possible for their establishments to report on the full

[2]The evidence, in the Canadian case, will be presented in a later section. There are also problems relating to what is meant by enterprise-ownership or -control, requiring a network (or directed graph) analysis.

range of production account variables.[3] Hence, in order to maintain the goals of industrial homogeneity *and* disaggregation, statistical agencies receive and accept *less* than the full range of production variables from reporting establishments. Generally speaking, the statistical reporting unit must be capable of providing "principal statistics"—value of output, cost of materials used and data relating to labour employed.[4] In particular, the purchased service inputs (or their indicators), which are the main concern of this paper, are typically *not* obtained at the establishment-reporting level. These intermediate inputs are usually only known and decided in a more aggregate form somewhere higher up the hierarchy of the multi-establishment (multi-industry) organization. The I–O statistician must obtain the information by methods other than establishment-reporting.

To quote again from the *GNP Data Improvement Project Report* [61, p. 18]:

> In the absence of such information, the I–O analyst must allocate the output of a large variety of purchased services among industry subsectors . . . These allocations are made on the basis of minimal information from establishments providing the services and with a maximum of judgmental input on the part of the estimator.

Actually this quotation is not entirely fair to the I–O statistician. The fact is that a good deal of ingenuity goes into compiling intermediate service inputs in order to overcome the lack of direct information. Anyone reading the paper by Philip Ritz [33] on the *1972 U.S. I–O Study* could see that![5] Similarly a Canadian *I–O Study of the Atlantic Provinces, 1965*, by Kari Levitt [16] is a remarkable effort.[6] For example, it is sometimes clear from the detailed nature of an intermediate commodity service output, to which particular industry the service should be allocated as an input. This is illustrated by: architectural services, construction equipment rentals, crop dusting services, natural resource royalty payments, and title abstract insurance. There is also some useful information from the *suppliers* of producer services which provides guidelines for the industrial input allocations. A good example for Canada is computer processing services and computer equipment leasing, rental and maintenance as seen in the annual publication Statistics Canada [44]. Special periodic surveys could be taken of company headquarters expenditures on intermediate service inputs, but the scope of such surveys is limited and the allocation problem is not resolved in a consistent framework (see next section for further discussion).

The documentation of I–O compilation procedures also reveals another favourite method. There is a tendency to resort to corporation financial statistics or corporation taxation data. For example Ritz [33] deploys such sources to indicate the distribution of both actual and imputed financial service charges. Levitt [16] does likewise, although the financial indicator used is different. It is also possible to directly examine corporation accounting records and on that basis approximate intermediate service inputs. This appears to have been done

[3]Briefly, the full range of account variables should be sufficient to calculate "pure value added" from production. See Statistics Canada [43].

[4]Value of output less cost of materials used equals "census valued added."

[5]To be perfectly fair, the Ritz study was not available at the time of the GNP Data Improvement Project.

[6]See also the I–O source data documentation in Statistics Canada [45].

for various Canadian industries (as inferred from Statistics Canada [45]). The use of corporation accounting and financial data is of great importance for the purpose of this paper and we will have much more to say on the subject in a later section. For the moment it must be stressed that the I–O compilation procedures mentioned in this paragraph do not take systematic account of the multi-industry multi-establishment nature of enterprise or corporation source data.[7] Thus the procedures are only valid for industries dominated by legal entities operating in single industry classifications, or we must accept I–O tables with a crude level of industrial disaggregation. In this paper it is assumed that we wish to construct and exploit the potential of highly disaggregated I–O compilations. We also consider that the industrial economy is dominated by a collection of large corporations or enterprises of the type mentioned earlier. In particular, production and financial data gathered from small single industry companies cannot provide accurate guidelines for estimating intermediate service inputs for industries dominated by large multi-industry multi-establishment corporations.

There is one other important aspect of intermediate service input estimation procedures. Given a total output of a particular producer service, the output is often proportionally allocated to industrial users on the basis of a "principal statistic" available for establishments comprising the industries. For example Ritz [33] distributes part of telecommunication services on the basis of "number of nonproduction employees" and a similar method is used to allocate most of professional services to business management (including the service output of nonprofit trade associations). The combination of "principal statistics" from establishments and "financial statistics" from companies could be a powerful tool for compilation purposes as we shall try to show later.

III. Some Additional Problems

In this section we discuss some additional problems concerning producer services in the compilation and use of input–output tables. Four such problems are distinguished, but it is also clear that the problems are interrelated.

III.1. *Head Offices*

Large multi-establishment firms are typically characterized by central and regional administrative head offices which provide a variety of service functions to the affiliated units. Most writers who comment on this subject claim there has been a tendency in recent years to augment head office administrative and sales service functions, but no supporting data are offered. For the Canadian manufacturing sector we have been able to measure the growth of total employment over all establishments and also for those particular establishments or ancillary units referred to as head offices (or similar functions as seen in Statistics Canada [47] and [48]). Sure enough the employment growth rate for head offices during the most recent time period 1972–78 is substantially greater than that

[7]The multi-industry corporation is completely industrially classified according to the *single* industry where the corporation has more operations as compared to any other *single* industry.

for all establishments:

	Annual Average Growth Rate
Head offices	3.8 percent
All establishments	1.1 percent

In fact, almost 20 percent of the total employment increment in Canadian manufacturing, 1972–78, is accounted for by the growth of head office employment. This experience may be even more evident in other countries where the manufacturing sector is not subject to a large degree of foreign ownership or control.[8]

Since head offices are becoming more important, it is relevant to examine their industrial classification. According to statistical practice (see United Nations [56] and Statistics Canada [46]), the operations of the central ancillary office of a company are completely assigned to that particular industry most responsible for the "census value added" of the company as a whole. It is easy to see that this convention can lead to ambiguity when the company is a large multi-establishment corporation with operations in a number of different industries no one of which dominates the others. As head offices grow, a greater proportion of the company's service functions are transferred to and channeled from these offices. To the extent that head office services are purchased, and not entirely generated by the company's own labour force, the services are directly related to the concerns of this paper. These purchased services typically include: data processing, professional consulting services, advertising, telecommunication expenses, and insurance and real estate payments. If head offices operate as responsible accounting units and charge cost recovery prices for their service functions, it would seem more reasonable to classify head offices as multi-activity producer service output entities.[9] If this is not the case, then head office revenue and expenses should be allocated over *all* component industries according to the relative industrial importance of the company's establishments. Some suggested allocation procedures are mentioned in a later section.

There is one further point. A holding company sometimes functions as a head office organization. If such a company is related to establishments in both manufacturing and nonmanufacturing industries, then Statistics Canada classifies the company to a component of the financial services industry. This is a step in the right direction. But the scope of such reclassification is limited because holding companies are mainly concerned with financial manipulations (pieces of paper), while most producer services have substantive operating characteristics.[10]

[8]Domestic head offices of foreign-owned companies tend to be small; the domestic head offices become branch offices of the foreign-located headquarters office. See McMullen [20] for a good analysis.

[9]Some of the services are created internally, some are purchased and resold without change, and others are purchased and resold after further (service) processing.

[10]For example, our old friend Exxon Corporation's head office operations in Manhattan contain significantly more than a holding company's deliberations. The transition from parent company to holding company is described in Penrose [28].

III.2. *Research and Development*

How does research and development (R&D) fit into our scheme? First, standard commodity classifications usually do not recognize a commodity service as being distinctly R&D. Sometimes, in I–O compilation, a dummy commodity item is created with a corresponding dummy industry. The real commodity input composition of the industry then defines the dummy commodity. For example, Statistics Canada [42] sets up a dummy commodity industry called "laboratory equipment and supplies." To the extent that the input composition of the industry contains producer services, then R&D is related to the concerns of this paper. However most industrial R&D current expenditures on intermediate consumption which can be classified as one of the producer services probably falls within professional services to business management. There are also royalties and similar payments for copyrights, patents, industrial designs and technological transfers. Strictly speaking these payments should *not* be included as part of I–O production accounts. But, on the other hand, the payments or fees often also cover complementary technical and managerial services and there is no way to distinguish the property income payments from production account services (see O.E.C.D. [24] for the practical evidence). In this case all items become part of R&D expenditures related to producer services.

Most nations run special surveys of industrial R&D expenditures. The relevant problem here is, once again, that the basic statistical information is collected at the company or enterprise level. Indeed there is evidence that industrial R&D activity is becoming more centralized within individual enterprises and, probably, more concentrated within the economy. For example, in Canada 25 reporting firms accounted for over 52 percent of total R&D expenditures for the business sector in the year 1977 (see Statistics Canada [49]). These firms tend to be large multi-industry enterprises and yet each of their R&D expenditures is completely assigned to one component industry (on the basis of census value added). Thus company- or enterprise-reported R&D data is inconsistent with establishment-reported production data particularly at fine levels of industrial disaggregation.

In addition it might be noted that industrial R&D expenditure surveys often do not cover all industries. The Canadian survey mentioned above excludes the financial sector and has incomplete coverage for other producer service industries (telecommunications is included). This appears to be a definite limitation particularly at a time when industrial boundaries are becoming increasingly blurred due to the widespread deployment of computer-oriented activity functions (discussed again later in this paper).

III.3. *International Trade*

Canada, among other nations, experiences a significant and growing international trade in producer services. For the year 1976, Canadian imports of producer services equalled 1,850 million dollars, or approximately 5 percent of total allocated[11] imports. This proportion may look small, but it just so happens

[11] Unallocated imports, mostly tourist expenditures abroad and certain intergovernmental service transactions, are excluded from this calculation.

that Canada's trade (and, perhaps, other nations' trade) in producer services makes a critical difference when international trade is subject to a Leontief-paradox I–O analysis.[12] One might still ask how all this is related to problems of I–O compilation?

By examination of corporation financial reports (see Statistics Canada [50]) it is possible to trace the destination of Canadian producer service imports on the basis of domestic- versus foreign-owned corporate user. We calculate for the year 1976 that some 83 percent of producer service imports were directly consumed by foreign-owned corporations (almost all of which was imported from U.S. by U.S.-owned corporations operating in Canada). This occurred even though the degree of foreign ownership of total Canadian industry, measured by the share of nonfinancial assets held by foreign-owned corporations, equalled about 30 percent in 1976. Thus international trade (or at least imports) in producer services probably represents intracorporate transactions of multinational corporations. Specifically, these transactions include: management and administrative fees, charges for professional engineering and consulting services, technology transfer and related payments, and machinery and equipment rentals. There are other transactions that fall into certain categories of financial services. Of course the valuation of these transactions is open to all the ambiguities of intracorporate transfer prices particularly where comparable "arms-length prices" are non-existent (see O.E.C.D. [24] for an excellent treatment of the issues).[13]

There is, then, available important information on producer service inputs at the corporation-reporting level. This information requires a sharp distinction between domestic-control and foreign-control (and even a disaggregation by nation of foreign control). A recent comparative study of foreign and domestic firms in Canada using a corporate micro-data base is also relevant (see Shapiro [55]). In order to allocate imported producer services to individual industries, it is necessary to know the precise industrial composition of corporations, particularly those that are subject to foreign ownership. Once more it is not valid to judge the industrial classification of large corporations on the basis of the usual value added criterion. Knowledge of industrial organization and ownership appear to be essential elements for a full-information approach to I–O compilation.

III.4. *Industrial Prices*

The final problem of this section is not directly related to producer services and so will be discussed very briefly. In the construction of industrial price indexes (usually for the manufacturing sector) there appears the question of selecting the appropriate reporting unit. It would seem that the "establishment," referred to earlier, is the natural reporting unit and, indeed, Statistics Canada [51] claims that industry selling price indexes for manufacturing are completely constructed on that basis. This is difficult to accept. Within large multi-

[12]This is discussed in complete detail in Postner [30].

[13]A good account of the issues in the Canadian context can be found in Mathewson and Quirin [18].

establishment companies, the individual establishment is typically a (homogeneous) production unit. Such a unit will *not* have access to the full pricing information required, including discounts from list price, special rebates, promotional pricing deals and other allowances. The unit will typically not be able to distinguish between order prices and delivery prices. This information must come from higher up the organization, such as the central sales office or divisional headquarters (see United Nations [58] for this viewpoint). In fact Ruggles [35] has shown that almost 70 percent of the U.S. wholesale price index reporters are headquarters (though this probably includes a large proportion of single-establishment companies).

Thus even in this context establishment-based data are of limited value and for a complete picture of the (price) situation, statistical agencies must have recourse to the structure of industrial organization.

IV. The View from Industrial Organization

This section surveys the opportunities and problems involved in utilizing an industrial organization approach to I–O compilation (at least with respect to producer service inputs). The viewpoint has been influenced by an early paper by Bartels and Fürst [3] stressing the essential institutional background and policy potential of national accounts including I–O tables. The present writer was also impressed by the work of a team of Canadian economists (see Gigantes *et al.* [8]) dealing with interrelationships between construction of operational models and data possibilities. The work contains far-reaching recommendations concerning business information systems and appropriate data strategy. Nevertheless the viewpoint of this section is more modest. Our scope is limited largely to statistical data that are already available or can be made available after some further tabulations. One other observation can be stated. It is remarkable that the two economic research areas of input–output analysis and industrial organization were both developed at Harvard University during the 1930s (by Wassily Leontief and E. S. Mason respectively). The two fields deal with industrial structure and performance and often use a similar vocabulary. Yet the two research areas have led almost entirely separate existences. This writer has been able to find *only one* research study[14] that embodies in a substantive way the methodological traditions of both input–output and industrial organization. Perhaps the time has arrived for further studies of that nature.

IV.1. *Background Documentation*

From the development given so far in this paper, it should be clear that there is a role for company- or corporation-based data for the purposes of I–O compilation. The main task is to carefully define and limit this role but, at the same time, provide for further extensions. Indeed, the particular producer services with which we are mainly concerned are on the *borderline* between establishment-based production account statistics and company-based financial and income–outlay account statistics. Consider, for example, the expenses of

[14]The study referred to is a recent Harvard University Ph.D. thesis by A. Lemelin [13].

financing capital formation such as floatation costs for loans—this is one of the financial producer service inputs. So are broker's commissions—a transfer service cost with respect to transactions in land and financial claims (as defined in United Nations [59]). It has already been seen that royalties (strictly speaking, an income from property) are often closely related to certain managerial and technical services. Net rents for the use of land are also supposed to be included in income from property, but we know that such payments are often difficult to distinguish from rents for buildings and even heavy machinery. Similarly there is the perennial problem of when long-term leases "become" purchases of machinery and equipment. In fact one of the most important producer service inputs must be *imputed*, namely the imputed service charges of commercial banks and other financial institutions. The statistical data required to perform the imputation come directly from income and outlay accounts. The situation is very similar with respect to the imputed service charge for casualty insurance. Thus it appears that the producer services discussed in this paper are a vital connection for purposes of statistical integration. Our main interest, however, is elsewhere.

The first question is whether adequate data are available at the company- or corporation-based reporting level either to measure producer service inputs at this level or to provide an indicator of the producer service inputs. We must remember that corporation-based data cannot be suitably classified at fine degrees of industrial disaggregation, particularly for the large multi-industry corporations (discussed below). Therefore we must initially consider corporation *microdata*. The Canadian annual publication [52] on corporation financial statistics is based on financial statements filed by corporations for income tax purposes and represents some 360,000 corporations (in the year 1978). Included are joint ventures of participating corporations, all public and private corporations, and all provincial, federal and municipally-owned corporations. The coverage is virtually complete for most sectors of the economy except for those where unincorporated businesses are significant (agriculture, forestry, fishing, some retail trade and some services). Note that consolidated financial statements for groups of corporations under common ownership or control (enterprises) are *not* acceptable in Canada.

Corporation financial data contain detailed income and retained earnings statistics. For our purposes we are mainly interested in the breakout of service expenses,[15] namely: rent expense for land and building (including leased real estate), rent expense for machinery and equipment (including leased machinery and equipment), royalties, management and technical fees, advertising and sales promotion costs, casualty insurance premium payments, and commission expenses paid to financial institutions. In addition we need an indicator of the imputed service charges of commercial banks. Ritz [33] uses cash deposits held (p. B-23):[16]

> on the assumption that the largest depositors were the chief beneficiaries of the services for which these charges were an imputed payment.

[15]Service expenses are supposed to be reported gross rather than net.

[16]It is not clear how Ritz reconciles this company-based statistic with the establishment-based operation of I–O compilation. A similar remark applies to Levitt. See discussion below for our suggested reconciliation based on a microdata approach.

This indicator (cash deposits held) can be obtained from detailed balance sheet statistics of the Canadian corporation financial data publication. Levitt [16] uses as an indicator (p. 172):

> the allocation was made roughly on the basis of estimated interest payments and the size of bank loans,

which are originally reported in the detailed income and retained earnings statistics (interest payments) and the detailed balance sheet statistics (bank loans). Thus it appears that most producer service inputs with which this paper is concerned can be obtained directly or indirectly from corporation financial statistics at the microdata level. It is assumed that an official I–O compilation procedure need not worry about confidentiality restrictions, but there certainly are real problems of feasibility and reconciliation to which we now turn.

In the Canadian case, we are not calling for complete examination of all 360,000 corporations. Attention can be focused only on the largest corporations. The best available Canadian data measure the dominating role of the leading corporate *enterprises* rather than the individual corporate units. The following statistics for the leading Canadian enterprises are based on straight aggregation (*not* consolidation) of the affiliated individual corporation financial data. We know (from Statistics Canada [50]) that the leading 500 Canadian[17] enterprises, consisting of some 3,500 individual corporations, account for almost 55 percent of total sales by all Canadian nonfinancial corporations in the year 1978. (Financial holding companies are eliminated to avoid double-counting.) The percentage of total sales accounted for by these same enterprises reaches 85 percent for the mining sector and about 70 percent for both manufacturing and utilities. Thus it is sufficiently revealing to submit only the corporations classified to the leading 500 enterprises for detailed examination.[18] Moreover, Canadian industrial organization is such that not much is gained by going, say, to the leading 1,000 enterprises (composed of some 4,500 individual corporations). The coverage of total sales increases to about 60 percent from the original 55 percent; the coverage of total Canadian assets goes to 70 percent from the 65 percent accounted for by the leading 500 enterprises.

The next question is to what extent are the leading Canadian enterprises industrially diversified? This question has been intensively studied for those enterprises based and operating within the Canadian mining and manufacturing sectors (as seen in Statistics Canada [54]). The great majority of the top 500 such enterprises have establishments in more than one four-digit industry group level and many operate establishments in at least five four-digit industries. The multi-industry enterprises among the top 500 alone account for over 60 percent of total value added in Canadian mining and manufacturing. Furthermore, industrial diversification is not limited to the four-digit level; virtually all the large diversified enterprises are diversified at the two-digit level as well as at the four-digit level. Note that this description grossly *underestimates* the extent

[17]This, of course, includes both Canadian- and foreign-controlled enterprises composed of corporations operating in Canada.

[18]Note that these corporations are all not necessarily the "leading" corporations; it would be better to deal directly with corporations rather than indirectly through enterprises.

of Canadian industrial diversification since no account is taken of Canadian mining- or manufacturing-based enterprises operating establishments in *other* sectors of the economy (due to limitations of presently available data tabulations).[19] Indeed some of the most diversified Canadian enterprises, officially "based" in manufacturing, are fully integrated oil and natural gas "industries" with establishment activities in: extraction, refining, transportation, storage, wholesaling, retailing, and real estate operations. A good example is the "number three" Canadian industrial corporation Imperial Oil Limited, 69.6 percent owned by our old friend Exxon Corporation. Before continuing it should be added that there is also considerable evidence regarding the corporate ownership- or control-concentration and industrial diversification patterns inherent in the U.S. economy. The best reference is the work of the industrial organization economist F. M. Scherer [37].

IV.2. *Towards An Application*

After this excursion into the field of industrial organization, we are now prepared to put the "pieces together." How is all this related to the problem of identifying and measuring intermediate service inputs in the compilation of I–O tables? Section B explained the basic problem of this paper—producer service inputs are generally not observable at the establishment-based[20] reporting unit level essential for highly disaggregated I–O tables. Some very ingenious schemes have been implemented by I–O statisticians to resolve this problem, but there is also evidence of inconsistent use of corporation financial data.[21] We will show that all the ingredients are presently available (at least in Canada) to utilize corporation financial data in a more consistent fashion and that such utilization has desirable "by-product effects." Earlier in this section we saw that corporation-based detailed income statements and balance sheets contain information directly or indirectly related to intermediate service input charges and expenses. These data must be examined at the *microlevel* in order to consistently allocate multi-industry corporation statistics to establishment-based units. The link between the two types of reporting units is effected by an establishment-based microdata panel; each member of this data base is assigned a corporation identification code. We also saw that it is sufficiently revealing to limit examination to those establishments identified and operated by the *leading* corporations of the economy. In the Canadian case, presently available tabulations show the link between establishments and enterprises. Since enterprises are merely collections of closely affiliated corporations and are, by definition, mutually exclusive with

[19]A related Statistics Canada publication [53] shows diversification within the overall economy at the one-digit industrial level.

[20]We overlook the fact that certain industries are created on a "kind-of-activity" basis such as agriculture and construction. But the problems of producer service input measurement still remain. Much of the exposition in this paper is orientated towards the problems of the manufacturing sector—where most of I–O industrial disaggregation occurs.

[21]Statisticians are, of course, aware of the inconsistencies and therefore tend to deploy corporation data only where "there is nothing else."

respect to establishment composition, it certainly appears possible to retabulate and match establishments with individual corporations.[22]

This still leaves the question of precisely how corporation-based data relating to producer service inputs is to be allocated to the particular establishments (and, therefore, industries) identified with each corporation. Consider the following basic *three-step procedure.* Suppose a control total (over all industries of the business sector) for a specific intermediate service input is given. We wish to distribute this total to each and every industry of the I–O table. An example might be "professional services to business management." First the control total is allocated to individual corporations in proportion to "management and technical fees" as observed in the corporations' financial statements. Then each corporation's allocation of "business services" is distributed to the establishments identified with that corporation according, say, to the proportion of nonproduction workers in each establishment as compared to all establishments comprising the particular corporation. (One might imagine that own-employed nonproduction workers and purchased business services are complements in production.) The final step is to utilize the classification of establishment units to the individual industries and aggregate the allocations assigned to all establishments of the same industry. Thus a combination of "principal statistics" from establishments and "financial statistics" from corporations can be deployed for I–O compilation purposes. This suggested procedure has both consistency and full-information properties. A very similar three-step procedure holds for the important case "imputed service charges of commercial banks and other financial institutions." A control total can be allocated to individual corporations according to "size of bank loans" (following Levitt [16]) each of which distributes its imputed bank service charge to component establishments according, say, to the value of their relative contribution to census value added or, perhaps, according to their recent additions to gross output.

A number of brief comments are now in order. The above suggested allocation procedure is very simple. Some more sophisticated cost allocation mechanisms are discussed in the next section of this paper. We recognize that I–O control totals are not just "given," but evolve after appropriate adjustments and refinements. The suggested allocation procedure could easily be made part of an iterative framework (although there is no absolute guarantee of convergence). Another point is that the above procedure neglects "undercoverage" and, in fact, the procedure is only practical working with the leading corporations. (For Canada we would probably need the leading 1,000 corporations measured in terms of total census value added by establishment-based composition.)[23] It will, therefore, be necessary to add a residual "dummy" corporation to the suggested procedure whose multi-industry composition represents all establishments of the economy *except* those identified with the leading 1,000 corporations.

[22]This was, in fact, done in the early work of John McVey [21] at Statistics Canada. Presently available matching procedures appear to cover about 75 percent of the total business sector economy with relatively low coverage of industries with significant unincorporated business operations (agriculture, construction, trade and some services).

[23]This should be roughly equivalent to the overall economy coverage of the leading 500 enterprises.

In effect the residual allocation of a producer service input takes no account of the remaining corporation-establishment activity complex and is equivalent, say, to allocating residual "business services" *directly* to industries according to their relative nonproduction workers' employment. The direct allocation method alone (used, e.g. in Ritz [33]) will not yield the same results as an allocation method based on the corporation-establishment complex except in very special cases. This leads to the question as to whether the complex relationship between each of the leading corporations and their component establishments (and, therefore, multi-industry composition) must be re-estimated for each I–O table? We know this relationship is affected by corporate mergers, amalgamations, acquisitions, divestitures and even establishments' births and deaths. But the limited evidence available shows[24] that such changes in industrial organization occur gradually and are relatively small. It seems possible to construct base year multi-industry composition *coefficient* matrices for the leading corporations which can serve as useful approximations for periods of, say, up to five years.[25]

Finally, we consider whether there is any better information available than corporation financial statistics to serve as an intermediary through which the allocation process is channeled. Recent discussions concerning large diversified corporations' line-of-business reporting, or segmented reporting, are relevant (see Scherer [38]). The Canadian Royal Commission on Corporation Concentration [34] has rejected a rigorous line-of-business reporting program that would be useful (if practical) for our purposes. In any event, no such data are presently available on a reasonably comprehensive and systematic basis such as already exist for corporation financial statistics (see also the O.E.C.D. [25] survey). Nevertheless it is desirable to seriously consider future improvements. In effect we need a new type of reporting unit for financial and related information which closely *parallels* the function of the statistical reporting unit used for "principal production statistics," namely the establishment. The new unit would be the *smallest* operating entity for which a reasonably complete set of "principal financial statistics" can be obtained (either through direct reporting or standardized allocation methods).[26] Similarly, the new units should be mutually exclusive and exhaustive with respect to their universe. Their operating functions would probably coincide with the division of multidivision companies or with investment centres or profit centres of large corporations that operate on such a basis. However, a reading of the *Harvard Business Review* [32] is enough to note the wide diversity of existing intracorporate structures and practices.

V. The View From Technological Change

Like everyone else, the present writer has been swamped by literature portraying the so-called microelectronics revolution (also called the information

[24]See the most recent work of McVey [22] for the situation in Canadian manufacturing and mining.

[25]A typical coefficient matrix will be sparse (easy to store) and have dimensions equal to the number of industries (say, 200) and the number of leading corporations (say, 1,000). It may be necessary to construct distinct matrices for each and every producer service input commodity which is to be distributed by the suggested procedure.

[26]Statistics Canada has considerations along these lines; see Côté [5].

technology revolution). It is easy to develop nightmares over repeated warnings about the growing convergence of the electronic computer and telecommunications fields. Nevertheless the situation is not a joke and, in fact, presents opportunities and problems for input–output compilation and use. The discussion in this section will remain within the sober vocabulary of economics and statistics; we will not be carried away by microelectronics jargon. It should also be added that the following discussion is distinctly more speculative than that of previous sections; so our suggestions should be regarded as tentative.

V.1. *Background Discussion*

The microelectronics technological revolution raises a number of issues relevant to input–output compilation and use. These issues are not really new, but arise in an extreme (and, possibly, exaggerated) form so that one cannot avoid being stimulated towards some basic rethinking of accepted conventions. This paper will not attempt to document the claims and predictions associated with the recent microelectronics and supporting literature. Indeed there is a remarkable consensus in this literature to which the reader is directly referred.[27] Instead we examine the economic *implications* of present and future supposed technological changes so far as these implications are related to producer services in an I–O context. The emphasis is on identification problems of producer services output.

The first implication of the microelectronics literature is that the service sector of the economy will be most affected. There is emphasis on a diminished role for strictly manufacturing and material production activities as compared to pre- and post-production service activities. In particular, the merging technologies of electronic computer/telecommunications systems impact all service functions related to the creation, collection, manipulation, storage, retrieval, and distribution of *information*. This raises the question as to whether these service functions are adequately identified in I–O compilations as producer service commodities with corresponding producer service industries. To answer this question it seems appropriate to briefly examine the current state (and even, the historical development) of input–output practice.

We know that input–output is largely oriented towards describing and measuring the phenomenon of industrial interdependence. For example, I–O methods are capable of tracing the processing of natural resources through the fabrication hierarchy of industrial classification. This applies to both renewable and nonrenewable resources.[28] Considerable effort has been expended trying to determine the fundamental triangulation (or bloc-triangulation) pattern of interindustry transactions. To achieve these goals, special care has been given to the segregation and identification requirements of the traditional primary and secondary intermediate commodity disaggregations. There are, for example, well-known instances where I–O compilation calls for the statistical disintegration

[27]The international literature is best illustrated by Kimbel [11], Barron and Curnow [2] and the just released O.E.C.D. [26]. For Canada, Serafini and Andrieu [40] and Rabeau [31] provide good surveys.

[28]See Postner [30] for I–O measurements of "initial processing" and "additional processing" of Canadian natural resources in an international trade context.

of vertically integrated mining-manufacturing establishment-units. This is the case for Canadian base metal mining and related smelting and refining. In effect, some intraestablishment (nonmarket) technical relations are "broken-out"[29] to reflect the existence of counter-part market transactions involving other establishments. Similarly there are examples where industries are defined on a strictly activity-basis. This means that if such activities are carried out even as part of the *own-account* (internal) operations of certain industrial establishments, both the output and corresponding inputs are removed and aggregated together with the industry where the activity is considered primary. The Canadian construction industry, including maintenance and repair construction, is defined on this basis. These cases all involve *material* commodities and have the effect of raising aggregate recorded gross output.[30] One might say that I–O practice is biased towards the "double-counting" (and, therefore, exhibited interindustry connections) of material goods at various stages of their fabrication. The present writer suspects that this bias is a vestige of the Material Product System (MPS) even though our examples come from the System of National Accounts (SNA). The fact is that I–O empirical applications rarely display "interesting" utilization of the producer service industries. The latter's role is essentially passive, usually supporting production in the nonservice industries. True, there are commodity transactions between individual producer service industries, but these transactions lack a directional hierarchy. Whoever heard of a primary service commodity undergoing "further processing"?

Such is the state-of-the-art as it exists today. There is, however, reason to believe that if I–O is to remain relevant to future economic problems, then special care must be *extended* to the segregation and identification of producer services. Consider an example in the spirit of the microelectronics technological change literature. The well-known Ruggles and Ruggles text [36] contains the statement (p. 80):

> There has been a growing tendency to pull administrative and research personnel out of the establishment and centralize them. The computer and modern communications systems permit accounting, design specification, customer relations, billing, and even payroll to be done by the central office.

This statement is confirmed by empirical evidence in our previous section III. Moreover, a case study of the effects of *informatics* on a large corporate head office in Canada (see Menzies [19]) is also consistent with this general theme. We know that the producer service functions of multi-establishment corporate head offices are typically not segregated and identified for I–O compilation purposes; the functions are considered internal and integrated with the corporations' principal activity (often one of the manufacturing industries). Yet the microelectronics revolution is also permitting the relatively small single-industry and single-establishment companies to contract-out their (formerly internal)

[29]Sometimes referred to as "raising new establishments."

[30]Total national income is, of course, unaffected by the manipulations required for I–O practice. Also note that the issues discussed here lie *beyond* the problem of whether a constant industry technology assumption or a constant commodity technology assumption (or some mixture) is best to combine estimated make and use matrices.

administrative, overhead, and related business financial services requirements.[31] Thus reasonably counterpart market prices for head office producer service functions are becoming available together with estimates of their input structure. It would seem both desirable and possible to "break-out" head office producer service functions as explicit producer service commodities.[32]

A second major implication of microelectronics technological change is the creation of entirely new producer services (without previous counterparts either internal or external). With the advent of computerized records and related communications, the problem of *encoding* to preserve secrecy has become commercially important. All the applications such as electronic mail, electronic funds transfer, and even corporations' computer-conveyed memos between headquarters, require new and sophisticated encryption services. Another example comes from Telidon—the Canadian-designed videotex system (that uses a telephone line to hook a television set to distant computers and memory banks, turning the television screen into a video display terminal). One of the most interesting applications of this system concerns the dissemination of the specialized business services information provided by nonprofit trade associations.[33] But first the information must be appropriately packaged and managed by a new kind of software service. Finally, in Canada, certain natural resource corporations are subject to federal guidelines before applying for federal financial aid. The guidelines concern the extent of the corporations' Canadian-resident ownership. In response, a major financial trust company has developed a computer system to measure, on a daily basis, the changing Canadian ownership rate (by tracking daily purchases on the stock market) of any corporation that subscribes to its service. Since these examples all embody entirely new producer services, they cannot consistently be aggregated with any existing classification of service commodities.[34]

A third important implication is that technological change is resulting in an erosion of traditional industrial classification boundaries. The prime example comes from the computerization of deposit-taking institutions.[35] Chartered banks and some near-banks in Canada now offer a wide variety of computer-conveyed business and financial services: bookkeeping (telaccount), account reconciliation, payroll accounting, billing and accounts receivable, accounts payable and preauthorized debiting, cash consolidation and funds transfer plans, as well as advisory and management services. In effect, the large chartered banks have turned their in-house computer departments into quasi-independent profit centres that offer data processing services to their outside customers. The large Canadian insurance companies appear to be playing a similar game. Another example concerns the videotex suppliers' market mentioned earlier: a virtual

[31]This will be discussed again later when considering the impact of technological change on deposit-taking institutions.

[32]This would affect both the use and make matrices of I–O tables; our analysis in this paper is mainly limited to the use matrix.

[33]See the description in De Melto *et al.* [6]; data on associations can be found in Statistics Canada [41].

[34]The next subsection contains some suggestions relating to the problem of intertemporal comparisons.

[35]Our references include Binhammer and Williams [4] and Lambie [12].

"melting pot" of the telecommunications industry (including common carriers, broadcasters and cable companies), the computer data processing industry (both hardware and software), and the information service industry providers (mostly financial institutions, advertisers, publishers and retailers). And in the future, we will be hearing much more about electronic funds transfer systems (EFTS): a clearing network of pre-authorized debit-credit accounts with remote service or point-of-sale characteristics. The system can only work with at least some integration of activities presently characterizing financial institutions, telecommunications carriers, computer processors and manufacturers, and potential business users of EFTS.

One way input–output is supposed to handle problems of the above nature is by permitting industrial establishments to produce secondary commodities and, indeed, commodities could greatly outnumber industries. The trends outlined in the preceding paragraph undermine traditional industrial homogeneity ratios, but it may seem that this could be overcome by more liberal use of *specific redefinition* schemes (as done in Ritz [33]).[36] Such schemes, however, cannot clarify industrial cost structures if the output of major industries is completely confounded by "secondary" commodities and if it is not initially certain to which industry a commodity should be assigned as "primary." Thus the need arises for *distinct* cost structures for individual producer service commodities in a given classification as originating from individual industries in a corresponding classification. This information requires the development of official accounting guidelines. To quote, for example, from Binhammer and Williams [4, p. 88]:

> Banks were asked to ensure that their accounting procedures properly allocate all costs and revenues between their banking operations and computer services offered their customers and that these be available for inspection . . .

Some recent innovations in accounting allocation procedures will be mentioned in the next subsection. If, however, the computer services of commercial banks become a major aspect of their operations, it would then seem desirable to "segregate-out" all such secondary computer services activities (*both* internal and external) and aggregate with the computer service industry where this activity is considered primary. Such a procedure is analogous to the present treatment of all construction activities.[37] On the other hand, the problems of de-integrating an EFTS complex of activities (analogous to the disintegration of base metal mining-smelting-refining) raise issues that probably cannot be resolved in the traditional I–O industrial classification format.

A fourth (and final) economic implication of the microelectronics revolution, including computer/telecommunications convergence, concerns the need for government *regulation* of industrial standards, ownership, rate structure and accessibility. There is also the well-known fear of increased invasion of privacy as larger volumes of information become available in computer files. The United

[36]Implicitly, the Ritz scheme deploys the constant commodity technology assumption. This assumption, strictly speaking, requires that the number of commodities equal the number of industries.

[37]Ritz [33] refers to this as "carving up" establishments.

Nations SNA [59] take the view that (p. 72):

> Governmental units engaged in providing services of a regulatory character ... are not to be considered industries though the payments for these services may cover the full current costs of operating the agencies. These payments ... are not considered to be purchases of services.

This view is questionable and may result in a significant underestimation of important producer services in the future.[38] According to some microelectronics experts, it may become difficult to distinguish government licensing and regulation from government *participation* with private enterprise (in joint ventures and consortia) with respect to the operation of major national and international computer/telecommunications networks.

V.2. *Some Basic Suggestions*

This subsection contains some basic suggestions that appear relevant to the problems of I–O compilation when examined from the viewpoint of future technological changes.

At a number of points in this paper issues were raised that, directly or indirectly, touch on the well-known problem of common-cost allocation. Indeed, the whole of section IV, together with the suggested three-step allocation procedure, is partly concerned with this matter. The purchased producer services of large multi-industry corporations are one important component of the corporations' common-cost overhead and must be allocated to individual establishments for I–O compilation purposes. In this section the issue is a little different; we are concerned with individual establishments (e.g. a chartered bank) producing two or more commodities (e.g. banking services and data processing services). We need to allocate *all* costs, including all common costs, between the various commodity operations.[39] There is reason to believe that recent and future technological changes will magnify the importance of problems of this nature. This problem is nothing new and, in fact, is perfectly familiar to the company accountant. What is new is that accountants are now experimenting with sophisticated joint cost allocation procedures based on axiomatic game-theoretic precepts. The literature goes considerably beyond the well-known Shapley value solution of n-person co-operate games.[40] It is even possible to derive, from first principles, some of the accountants' traditional allocation rules in special cases. Indeed these experiments are closely related to current economic research in the areas of cross-subsidization, economies of scope, and public utility pricing. It is, therefore, suggested that economic statisticians be aware of these developments in order to better understand the implicit bases of generally accepted (or, seemingly arbitrary) common-cost allocation procedures.

[38]If these activities are not classified as an industry, then the services will not be accounted for as commodities in input–output compilation. See, also, discussion in Kimbel [11].

[39]This problem also arises in a line-of-business reporting program; see Scherer [38].

[40]A good survey of game theory is Schotter and Schwödiauer [39]. Recent applications in accounting can be found in Jensen [10] and Balachandran and Ramakrishnan [1].

The spectre of revolutionary technological change raises the question as to whether it will be possible to perform intertemporal comparisons of input–output tables. After all, there are entirely new producer services becoming available, traditional industry classification boundaries are increasingly blurred, and there is need to modify and "break-out" the treatment of some other important categories of producer services. This, supposedly, calls for revised methods of constructing I–O tables and, indeed, the 1972 U.S. I–O table is difficult to compare with the previous 1967 table.[41] The originator of input–output, Wassily Leontief, would not appear to worry about this lack of comparability, because with the utmost frankness he says [14, p. 19]:

> Comparativism as a method of scientific inquiry is greatly overrated. In economic research, particularly of a quantitative kind, it offers convenient refuge to unimaginative minds. If one is at a loss in finding an effective analytical interpretation of a given set of facts, it is always possible to compare, particularly if one is ready to disregard destinations. But after the comparison is completed, what next? Too often one turns to the comparison of something else.

Aside from the notion that Professor Leontief's views on this subject may lead to unemployment among economists, the present writer believes that comparativism of input–output tables can be defended along *two* lines. First, e.g. consider a productivity growth study based on input–output analysis. We may wish to use the study for policy-projection or -prediction purposes. In order to discover where the economy (or productivity) is going, we must first learn where the economy is presently situated. Since the study is concerned with economic *change*, it is also desirable to learn how the economy arrived at its present situation. This would provide a basis for possibly changing the direction of where the economy is going and requires intertemporal comparisons. However, the *second* argument, to follow, is much more important.

Anyone who reads Professor Leontief's article from which the above quotation is taken will realize that conventional intertemporal comparativism is replete with pitfalls. In fact this whole section of our paper is devoted to showing that recent and prospective technological changes call for some profound industrial classification and statistical methodological modifications with respect to I–O compilation. Can anything be salvaged? The answer is: Yes! It is possible to perform economically meaningful intertemporal I–O comparative analysis even though the various compilations are subject to important modifications. In fact the technique for doing precisely this kind of analysis is a simple generalization of Leontief's ingenious method of *double inversion* [15].[42] Consider three I–O tables, each 5 years apart in time, namely: 1967, 1972 and 1977. It is then possible to perform a double inversion comparison of the 1967 and 1972 tables on the basis of that subset of industries and commodities which the two tables

[41] There are both classification and methodological differences; see Ritz [33].

[42] Leontief [15] works directly with industry × industry tables. But the double inversion technique is also applicable to combinations of make and use tables under either the constant industry technology assumption or the constant commodity technology assumption. Full applicability of the technique, however, does require that the make matrix satisfy certain reasonable conditions concerning the relationship of directly comparable commodities to directly comparable industries.

have directly in common. Remember that *all* industries and commodities in both years, including "incomparable" magnitudes, are fully taken into account by the double inversion procedure. Similarly it is possible to perform a double inversion comparison of the 1972 and 1977 tables on the basis of their directly comparable industries and commodities. Thus the years 1967 and 1972 are subject to a comparative I–O analysis; the years 1972 and 1977 are also subject to the same analysis; all this even though the I–O tables for 1967 and 1977 may have very little in common! In an extreme case, the years 1967 and 1977 may have nothing in common if the two subsets of 1972 I–O industries and commodities, used as directly comparable bases with 1967 and 1977 respectively, are mutually exclusive. In other words it is possible to achieve substantive intertemporal comparative analysis of input–output tables *without* assuming (or forcing) *transitivity*. Indeed, transitivity is not essential for intertemporal comparativism. Since this is the case, the compilers of I–O tables should feel free to introduce the necessary classification and methodological modifications with each new table and not feel bound to maintain an artificial complete and transitive comparability. The users of I–O tables should not be seduced by long time series of I–O tables that are supposed to be perfectly comparable. The double inversion procedure, when fully understood, can also be utilized to provide guidelines concerning how and when the essential modifications could be gradually introduced while preserving a large measure of (intransitive) direct comparability.

VI. Where To Now?

This paper has tried to develop some aspects of national input–output compilation and use that do not appear to be sufficiently emphasized in the statistical and economics literature. There are a number of conclusions that point in the direction of possible future extensions.

First it should be evident that the available statistical source and estimation documentation of I–O compilation procedures is often unsatisfactory. If I–O statisticians wish to maintain a constructive dialogue with I–O users, then the two sides must develop a common ground of mutual interests and understanding. Perhaps this paper, written from the viewpoint of an I–O user with special interests in the problems of I–O statistical compilation, can contribute towards this goal. It is true that more I–O documentation is now becoming available. But the I–O statistician should not think that more is not needed even if not asked; often the I–O user does not know "What to ask" because basic information is unavailable! It seems to the present writer that special I–O documentation programs, including grades of source information and bases of estimation, outlined by Gehrig [7], are certainly on the right track. The user co-operates with the statistician by means of an "information circle" cultivated within the I–O construction program.

Has the time finally arrived for a "synthesis" of input-output and industrial organization? This paper makes a *first* step in that direction. It is shown how detailed statistical knowledge of the industrial organization patterns of leading corporations can become a useful integral part of the I–O compilation mechanism. Even if the suggested procedure, by itself, does not significantly improve the

quality of I–O tables, there is an important lesson here. I–O tables are not an end in themselves; the end is: improved economic policy-making! We cannot expect to reach this end if I–O, both in compilation and use, is isolated from the real world of industrial organization. After all, the establishments, our basic production units, are linked by ties of ownership and control to companies and divisions, which make and perform all the nonproduction decisions for the establishment units. Indeed, there are a significant number of producer services, including research and development, on the *borderline* between production and nonproduction, through which these ties are effected. But these ties of ownership and control are simply cut off once we aggregate establishments into industries according to principal product—if industrial organization is not explicitly accounted for. Economic policy-making is *not* primarily directed towards the strictly technical production decisions of individual establishments; policy is more often designed to impact the pricing, income–outlay, and capital financial decisions of the parent corporation.[43] This paper certainly does not recommend aggregating establishments according to ownership; industry lines would become completely blurred and the resulting I–O "tables" would be nonsensical. Hence the need arises for *microdata*—a statistical linking of individual establishments with the particular corporations that control and finance them. The link is generated through an identification code maintained by a central statistical agency.[44] This paper shows how the link complex could transform certain corporation financial statistics into establishment and, therefore, industry producer service inputs. It may also be possible to use an establishment-corporation activity complex to transfer individual industry net operating surplus to corporation profits of the leading individual corporations. The route is open for economic policy applications.

Consider just one *application*, tax-based incomes policies to slow inflation. In fact such policies are usually limited to impact the largest corporations. The control apparatus is monitored through corporation financial statements filed as income tax returns. As we saw in section III of this paper, industrial pricing decisions can only be "checked" at the division- or company-reporting level. A problem for economic policy would then be as follows: working with, say, the leading 1,000 corporations may be "good enough" to compile producer service inputs for I–O tables, but is it "good enough" to control the rise of consumer prices for an open economy? To answer this question requires knowledge of both input–output and industrial organization. If two nations, such as Canada and the United States, decide to *co-ordinate* a tax-based incomes policy, then we must also consider both international trade, in an input–output framework, and the role of multinational industrial organization.

The final topic of this paper concerned technological change and the need to maintain the viability of I–O tables at a time of important developments. The previous section V is entirely future-orientated so that little needs to be added here. Two points, however, should be made. First, if we take the information

[43]The reader will note the influence of the Continental institutionalist tradition represented by Bartels and Fürst [3].

[44]Lipsey [17] has generated similar identification codes for U.S. data using a combination of public and private sources.

technology revolution seriously, questions could be raised concerning the continued relevance of standard industrial classification schemes. We may, in the near future, be hard pressed classifying and identifying the manifold business information service activities associated with nationally operated videotex and electronic funds transfer systems. It does not appear that simply more disaggregation of standard producer service commodities and industries can provide the answer. Rather, we need to introduce entirely new dimensions of information service activities, possessing a distinct *directional hierarchy* and capable of tracing an all-pervasive kind of wealth-creation associated with the production and use of information throughout the economy. Fortunately, some first steps in this direction have already been taken by the O.E.C.D. [27]. This work, though limited to an inventory of information occupations, does draw the essential distinctions between: information producers, information processors, information distributors, and information infrastructure. The second point is simply that the two major perspectives of this paper, namely industrial organization and technological change, have been "kept apart." This is purely a matter of convenience; the two perspectives *are* intimately related. Our goal, however, is to provide the essential ingredients of each perspective rather than attempt a full account of their present and future relationships.

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