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CONSTRUCTION OF REGIONAL

INPUT-OUTPUT TABLES FROM

ESTABLISHMENT-LEVEL

MICRODATA: ILLINOIS, 1982*

By

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CONSTRUCTION OF REGIONAL INPUT-OUTPUT TABLES FROM ESTABLISHMENT-LEVEL MICRODATA: ILLINOIS, 1982†

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ABSTRACT

This paper presents a new method for use in the construction of hybrid regional input-output tables, based primarily on individual returns from the Census of Manufactures. Using this method, input-output tables can be completed at a fraction of the cost and time involved in the completion of a full survey table.

Special attention is paid to secondary production, a problem often ignored by input-output analysts. A new method to handle secondary production is presented. The method reallocates the amount of secondary production and its associated inputs, on an establishment basis, based on the assumption that the input structure for any given commodity is determined not by the industry in which the commodity was produced, but by the commodity itself—the commodity-based technology assumption. A biproportional adjustment technique is used to perform the reallocations.

Keywords: input-output, secondary production, regional economics

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1 INTRODUCTION

Since Wassily Leontief, the "sole and unchallenged creator of the input-output technique,"[1] constructed the first U.S. input-output table (Leontief, 1936), input-output analysis has established itself as one of the most widely used economic tools.

At the national level, the U.S. Bureau of Labor Statistics, and later the Bureau of Economic Analysis, have been regularly preparing highly detailed survey-based tables for the U.S. economy. Tables for Western European countries and Japan were first built during the 1950s, and later input-output tables for developing and centrally planned countries appeared. As Polenske and Skolka (1976, xliii) noted, "the number of countries without at least one input-output table is now very small indeed."

Isard, Leontief, Chenery, Moses and others pioneered the use of input-output techniques at the regional level in the early to mid 1950s, and the field has been bursting with activity ever since. In his excellent review article, Richardson (1985) delineates three major phases in the history of regional input-output analysis. The first phase consisted of the intellectual development of the technique during the 1950s, mainly by the authors mentioned above. The second phase, during the 1960s, could be considered the "golden age" of the survey-based models. Regional models were built for Washington State (Bourque et al., 1967), West Virginia (Miernyk et al., 1970), Philadelphia (Isard, Langford and Romanoff, 1966-68), Kansas (Emerson, 1969), and Texas (Grubb, 1973), among others. Survey-based models are extremely expensive and time-consuming to build, though, and this led to the third major phase, the search for less

[1]The Royal Swedish Academy of Science, awarding Leontief the 1973 Nobel Prize in Economics.

expensive approaches for constructing regional input-output tables. The major push for this search occurred during the 1970s, although earlier attempts had been made during the 1950s and 1960s.

Today, regional input-output analysis in the United States is in a peculiar state. While a great deal of attention is directed to the development of increasingly sophisticated techniques, the production of survey-based tables has dwindled down to a mere trickle. In fact, no new survey-based model has been developed since the 1982 Washington State model (Bourque, 1987), and, as Richardson(1985, 630) noted, "the flurry of activity in regional input-output studies has shifted elsewhere." And, while the efforts towards the development of non-survey methods are producing encouraging results, there is still no substitute for a good survey-based table (if for no other reason, they still must be used as the yardsticks against which other types of models are measured).

This paper presents a new approach to regional input-output table construction which, while relying primarily on survey-based data, retains the low cost and speed of the non-survey methods. This approach was made possible by the Bureau of the Census' decision to make a previously inaccessible data source, the Longitudinal Research Database (LRD), available to the research community. The LRD contains the individual returns for the Census of Manufactures and the Annual Survey of Manufactures, and is the most complete source of information on U.S. manufacturing establishments ever assembled. While access to the LRD is strictly controlled—all analyses must be performed at the Bureau of the Census, and all results are carefully screened to ensure that the confidentiality of the data is preserved—its availability represents a major landmark for the study of U.S. manufacturing, and tremendously expands the horizon for regional input-output analysis.

Special attention is paid to the problem of secondary production, a problem that is usually neglected by input-output analysts, especially at the regional level. In the very few instances where secondary production was explicitly dealt with, mechanical simplicity was favored over sound economic assumptions, since, as Isard and Langford (1971, 70) noted, there is a "major effort and cost involved" in separating the inputs associated with primary and secondary products for each establishment. Some methods, such as the transfer method, do not attempt this separation at all, while others, such as the reallocation method, are usually based on the less than satisfactory industry-based technology assumption.

A new method to deal with secondary production is proposed. This method uses the more sound commodity-based technology assumption, and retains the mechanical simplicity of the other methods. Note that, while the table construction method presented here requires access to the LRD, the method to handle secondary production is of more general interest, since it can be used by any investigator working with establishment-level data.

2 THE LONGITUDINAL RESEARCH DATABASE

The LRD, housed at the Census Bureau's Center for Economic Studies, is a very large database containing establishment level data collected in the Census of Manufactures and the Annual Survey of Manufactures (ASM). It currently contains more than 2 million manufacturing establishment-year records, including information on over 800,000 unique establishments in the 1963-87 period.[2] For each Census of Manufactures

[2]A description of the LRD variables used in the construction of the 1982 Illinois Input-Output table is presented in Appendix C.

year (1963, 1967, 1972, 1977, 1982 and 1987) there is information on more than 300,000 establishments, and in non-Census years the number of establishments ranges from roughly 70,000 in the period 1973-78 to 55,000 after 1979, when budget constraints led to a major redesign of the sampling procedure.

1982 was chosen as the base year for the Illinois Input-Output table because it was the latest Census of Manufactures year for which LRD data were available when this project was initiated (data for the 1987 Census of Manufactures are now available, and a 1987 table is under construction).

The Census of Manufactures

The Census of Manufactures is conducted every five years, and covers all establishments with one or more paid employees primarily engaged in manufacturing. The Standard Industrial Classification (SIC) scheme is used as the basis for the definition of *manufacture* - "the mechanical or chemical transformation of substances or materials into new products."[3] Consistent with the SIC, the Census of Manufactures does not cover manufacturing activities when performed by retail establishments which sell most of their product on the premises directly to household consumers; by construction contractors at the site of construction; by educational and penal institutions; and by government owned and operated establishments. If an establishment engages in a combination of manufacturing and non-manufacturing activities, its primary activity—the one with the highest reported dollar volume of receipts—is used to determine whether or not the establishment as a whole fits within the manufacturing sector.

[3]Note that, as the SIC scheme changes, some establishments that were previously defined as engaging in manufacturing activities may be shifted out of that category, and vice-versa. For the 1982 Census, the *1972 Standard Industrial Classification Manual* and its 1977 supplement were used.

The SIC is an establishment classification system, and thus the Census of Manufactures is conducted on an establishment basis. An establishment is defined as a single plant or factory in which manufacturing operations are performed. Each establishment is required to file a separate report, and establishments that are part of a multiple establishment organization are instructed to report their operations as though the establishment were a separate economic unit.

The 1982 Census of Manufactures universe comprises approximately 345,000 establishments, 17,906 of which were located in Illinois. The amount of information requested from each establishment depends primarily on the company size and on whether the establishment is part of the ASM sample.

Approximately 140,000 small single-unit establishments (6,022 in Illinois) were designated as administrative record (AR) cases and were excused from filing a report. Selection was done on an industry by industry basis, using a variable cutoff based on annual payroll and total shipments data. Cutoffs were selected so that total shipments of the excused establishments accounted for no more than three percent of the value of shipments in the industry.[4] Information on physical location, payrolls and receipts (value of shipments) was obtained from the administrative records of other federal agencies, such as the Social Security Administration and the Internal Revenue Service, and other data were estimated using industry averages.

The remaining 205,000 establishments (11,884 in Illinois) were sent a report form. There are approximately 200 different report forms, covering approximately 450 types of manufacturing industries. The forms are identical except for the detailed questions on

[4]The cutoffs were selected at the national level, but tabulations by the author indicate that the relationship is roughly the same at the state level. For Illinois, the highest percentage of total shipments attributable to AR cases, at the 2-digit SIC aggregation level, was less than six percent (see table 2).

products shipped, materials used, and miscellaneous topics such as operations performed, equipment used, and delivery of products. A list of products primary to the group of related industries covered by the form, as well as secondary products and services likely to be performed by those industries, is included on the form. Respondents are asked to identify products, value of each product, and, sometimes, quantity of each product shipped. A blank space is provided to describe products not listed on the form. Likewise, the report contains a materials-consumed inquiry.

For establishments included in the ASM sample (55,000 nationwide; 3,239 in Illinois), the ASM form replaces the first page of the regular Census form. Large and medium establishments not included in the ASM sample (100,000) receive the regular Census form. The first page requests establishment data for items such as employment and payroll, but is not as detailed as the ASM form. Otherwise, the forms are identical.

When the variable cutoff for AR cases resulted in a large number of small establishments being included in the mail canvass, an abbreviated form was used. The small establishments received one of approximately 80 different forms, which requested summary product and material data, but no details on payroll, employment, cost of materials, inventories, and capital expenditures. Approximately 50,000 establishments received the abbreviated forms in the 1982 Census.

The LRD: Features and Limitations

The LRD's origin dates back to the late 1970s, when the Census Bureau started the development of a longitudinal database of individual establishments, under the direction of Richard and Nancy Ruggles, of Yale University. The database was composed of data collected in the Census of Manufactures and the ASM, and resulted in the Longitudinal Establishment Database (LED). In 1982, the Center for Economic Studies was created within the Census Bureau to maintain the LED and serve as a link to the

outside research community. In 1987 the LED structure was substantially changed, giving birth to the Longitudinal Research Database (LRD).

The very characteristic that makes the LRD so attractive—the enormous wealth of previously inaccessible information it contains—makes it at times unwieldy to work with. Nevertheless, the opportunity to work with individual Census of Manufactures returns, i.e., to be able to access data for each individual manufacturing establishment in the nation, is exciting and very rewarding. The data are protected by the Census Bureau mandate regarding confidentiality (Title 13, U.S. Code), and outside researchers (including federal employees outside the Census Bureau) must first become special sworn employees of the Bureau before being allowed access to them. All data manipulation must be conducted within the Census Bureau headquarters in Washington, D.C., and all results and tabulations are scrutinized to ensure compliance with federal non-disclosure rules.

The most serious limitation of the LRD is imposed by the design of the Census of Manufactures and the ASM. The Census Bureau's objectives for both have been to publish the most useful and accurate aggregates for the current year. Concern with individual establishment records is limited to the extent by which they affect the completeness and accuracy of the aggregates. Thus, many uncorrected establishments with incomplete or erroneous data may be left in the file, as long as they have no significant effect on the published aggregates.

Given that its primary focus is on the accuracy of aggregates, it should come as no surprise that the Census Bureau watches and reviews larger establishments much more closely than smaller ones, which are less likely to affect aggregate data. Computerized edit routines are used to estimate data for establishments that fail to report and to re-estimate data judged to be in error. Analysts review the results of the computerized edit

routines, and can also correct reported data values. Changes made to large establishments by the computerized edit routines are reviewed more closely, and questionable responses are likely to be resolved by telephone contacts with the respondent.

Hence, the LRD contains a mixture of raw (originally reported) data, computer-estimated data and analyst-corrected data. The ratio of reported versus estimated or corrected data is an important variable, since for many applications it would be preferable to rely exclusively on reported information, rather than use estimates based on assumptions that might be inappropriate to the problem at hand. Unfortunately the LRD does not contain flags to indicate which data items have been computer estimated or analyst corrected. On the other hand, its predecessor, the LED, did contain such flags, and a study by James Monahan evaluated the quality of the LED data in the context of reported versus non-reported data (Monahan, 1984).

Monahan produced extensive tabulations by year, SIC, total employment size class and by selected variables for reported and non-reported data. Mean, standard deviation, percentages of the number of occurrences reported and not reported, and percentages of the total value of the variable reported and not reported were generated for each industry for each year. Based on these tabulations, Monahan (1984, 6-9) concluded that:

1. Imputation rates vary by data variable. In general, salaries and wages, electrical energy, assets, total value of shipments, and cost of materials are imputed (computer-estimated or analyst-corrected) less than production worker wages, total employment, total capital expenditures and number of production workers.

2. Imputation rates for small establishments are much greater than those for large establishments. This should be expected, since the smaller establishments have less impact on the quality of the aggregates, which is the primary focus of the Census of Manufactures and the ASM. For 1981 (the latest year covered in Monahan's study), 22

percent of all industries had imputation rates greater than 20 percent for small (less than 100 employees) establishments, while only 3.5 percent of all industries had imputation rates greater than 20 percent for large (over 500 employees) establishments. Monahan suggests that it might be beneficial to the quality of the result to confine the analysis to large establishments whenever possible, and that small establishments may require further editing and correction before being used.

3. Imputation rates vary by industry. For 1981, 26 percent of all industries had an imputation rate of less than 2 percent on total value of shipments (TVS); 25 percent of all industries had an imputation rate between 2 and 5 percent; and 24 percent had an imputation rate of more than 10 percent.

When viewed in light of the enormous wealth of information the LRD contains, the above limitations are minor. As Robert McGuckin, director of the Center for Economic Studies, has noted, "the LRD is one of the most ambitious and comprehensive data sets available for the study of manufacturing, and promises to provide an exciting and stimulating research environment for many years." (McGuckin and Pascoe Jr., 1988, 1)

3 Construction Of The 1982 Illinois Input-Output Table

Figure 1 shows a schematic flow chart of the table construction process. The first step was the extraction of three files from the LRD file: a general statistics file, a prod-

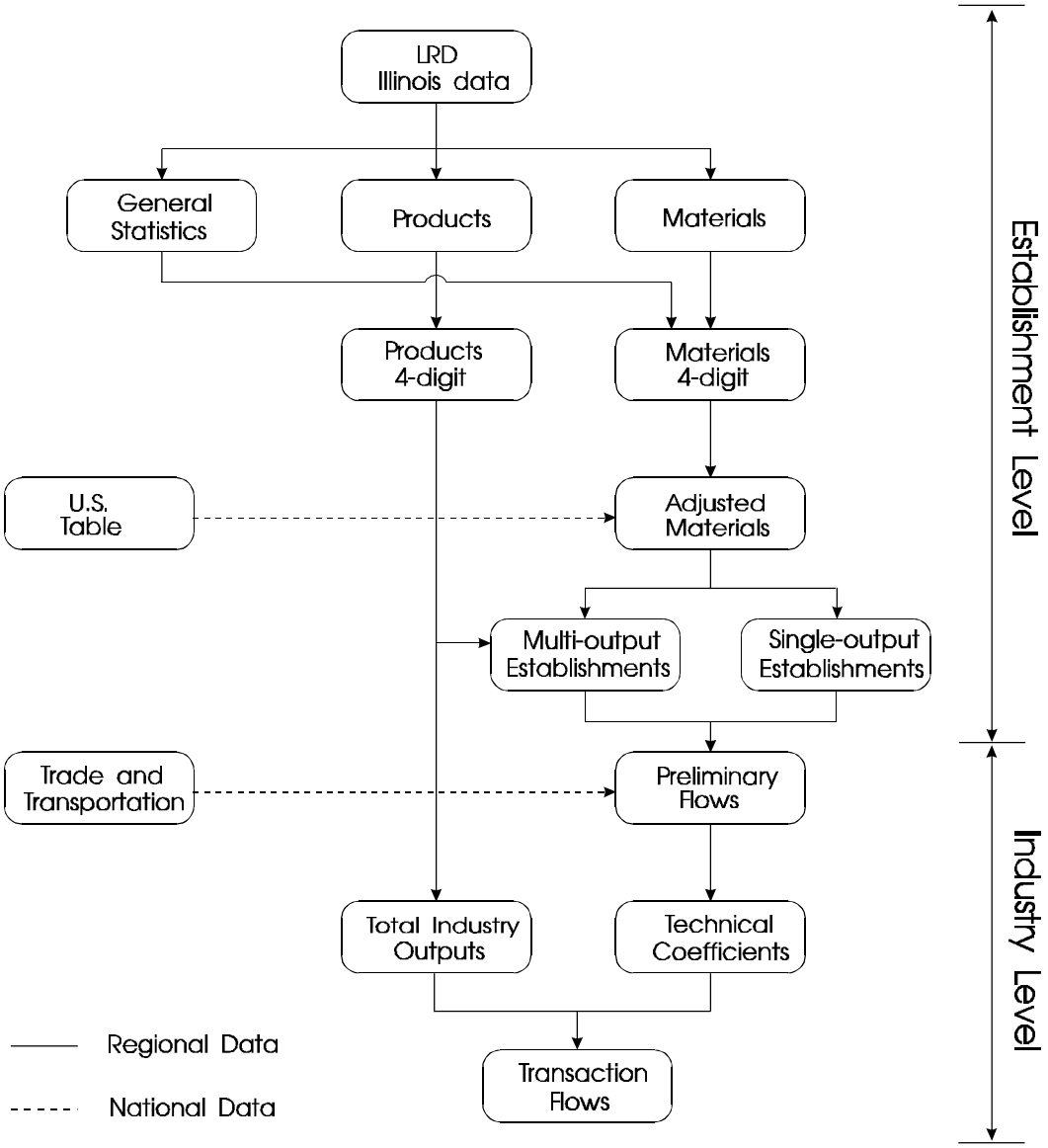

Figure 1 - Table construction flow chart

ucts file, and a materials file. The general statistics file contains the establishment's identification variables (that uniquely identify each establishment in the LRD), plus total output, total consumption of materials, payrolls, investment, and other variables, such as inventory changes.

The products file contains detailed information on each output produced at the establishment (coded at the 7-digit SIC level); and the materials file contains detailed information on all materials consumed by the establishment (coded at the 6-digit SIC level). The products and materials files were then aggregated to the 4-digit SIC level, Administrative Record establishments were removed from both files, and information from the general statistics file was combined with the new materials file, yielding a file with *all* inputs used by the establishment (both materials and value added categories such as salaries and wages, investment, etc.). The new materials file was then subject to several adjustments, such as the material residuals adjustment and the reallocation of special material codes. The next step involved splitting the materials file into a file containing single-output and a file containing multi-output establishments. The information on material consumption from the multi-output establishments was then merged with the detailed products data, and a RAS-procedure was used to allocate material consumption among the different outputs. This information was then merged back with the single-output establishments.

All the operations outlined above were performed at the establishment level. The establishments were then aggregated into industries, producing the preliminary transaction flows. National data on trade and transportation margins were then applied to the preliminary flows, and the technical, or input-output, coefficients were calculated, and finally multiplied by total industry outputs (obtained from the products file), yielding the final transactions table.

Administrative Records

Table 1 presents the number of establishments and the total output, cost of materials consumed, and value added for each major manufacturing industry group in Illinois in 1982 (see Appendix B for a listing of the 2-digit industry groups). Note that while these statistics are similar to the ones presented on table 5 of the published 1982 Census of Manufactures report for Illinois, the values do not match exactly, since the Census uses value of shipments as a measure of output, while this study uses value of production (that is, total shipments minus inventory changes of finished goods and work-in-progress). It should also be noted that the aggregates of total output and cost of materials consumed include extensive duplication, since products of some industries are used as materials by others. Total output here is total *industry* output, and thus includes secondary production. At this level of aggregation, however, secondary production is almost negligible.

As was seen in the previous section, some small single-unit establishments were designated as AR cases, and were excused from filing a Census of Manufactures report. Information was obtained from secondary sources on items such as payrolls and gross receipts, and other items were imputed based on industry averages. Detailed material consumption, the most important piece of information as far as input-output analysis is concerned, is not reported. Thus, the information obtained from an establishment designated as AR is of marginal value, at best. In fact, some Census Bureau analysts suggest that AR records could actually "contaminate" the data, and should, in general, be avoided.

AR establishments are selected so that their total shipments account for no more than three percent of the value of shipments in the industry. This cutoff rate is estab-

Table 1
Summary industry statistics for manufacturing industries in Illinois, 1982

Industry	Estabs	Output	Materials	Value Added
20	1055	19,187.3	12,377.3	6,810.1
21	1	(D)	(D)	(D)
22	82	140.3	74.4	65.9
23	458	937.1	483.3	453.8
24	556	541.5	280.7	260.8
25	426	1,311.3	679.8	631.5
26	453	3,349.6	1,855.9	1,493.8
27	3324	7,530.6	2,871.0	4,659.6
28	760	10,230.9	5,192.4	5,038.5
29	116	11,652.4	10,581.5	1,070.9
30	827	3,575.9	1,897.4	1,678.5
31	82	225.2	121.1	104.1
32	713	1,988.4	974.6	1,013.8
33	512	6,669.0	4,520.2	2,148.8
34	2532	8,947.2	4,445.1	4,502.1
35	3465	15,645.4	7,533.4	8,112.0
36	1039	10,097.7	4,853.3	5,244.4
37	309	5,053.9	3,252.7	1,801.2
38	452	2,347.0	963.9	1,383.1
39	744	2,250.4	1,157.4	1,093.0

Source: Longitudinal Research Database, Bureau of the Census. Output, cost of materials, and value added are in millions of dollars. The values for industry 21 were withheld to conform to Census non-disclosure rules.

lished based on the national industry totals, though, and there is no guarantee that this relationship will hold at the state level.

Table 2 shows the number of Illinois establishments designated as AR cases in each major industry group, and their total output, consumption of materials and value added. The numbers in parentheses are the percentages of the totals for the state of Illinois (presented in Table 1). The number of AR establishments is fairly high, ranging from about 20 to 45 percent of the total number of establishments in each industry, but their participation in output, material consumption and value added is very small, ranging from less than one percent to six percent of the industry totals. When examined at the 4-digit SIC level, however, this range is considerably larger (in a few cases, all the establishments in a 4-digit industry were classified as AR). Even then, for all industries with a large output, the participation of AR establishments is usually less than five percent. Thus, given the fact that AR establishments provide little, if any, useful information, and that they comprise a fair percentage of the total number of establishments—increasing processing time by a significant amount—it was decided to drop them from the sample and use only non-AR establishments to estimate the technical coefficients.[5]

A hybrid, columns-only approach

As described in the previous section, the 1982 Illinois Input-Output table was built using data from the LRD file, which, in turn, contains data from the Census of Manufactures. Thus, in a sense, the table is survey-based, since the Census of

[5]AR establishments *were* used to obtain total industry outputs.

Table 2
Participation of Administrative Record establishments in total output, consumption of materials, and value added, by major industry group
Illinois, 1982

Ind	AR Estabs		Output		Materials		Value Added	
20	269	(25.5)	148.5	(0.8)	96.9	(0.8)	51.6	(0.8)
21	0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
22	25	(30.5)	6.3	(4.5)	3.9	(5.2)	2.4	(3.6)
23	145	(31.7)	23.7	(2.5)	13.9	(2.9)	9.9	(2.2)
24	229	(41.2)	30.4	(5.6)	17.8	(6.4)	12.5	(4.8)
25	137	(32.2)	26.7	(2.0)	12.4	(1.8)	14.4	(2.3)
26	92	(20.3)	50.7	(1.5)	30.5	(1.6)	20.2	(1.4)
27	1524	(45.8)	224.5	(3.0)	82.3	(2.9)	142.2	(3.1)
28	191	(25.1)	105.7	(1.0)	54.3	(1.0)	51.4	(1.0)
29	7	(6.0)	2.5	(0.0)	1.8	(0.0)	0.7	(0.1)
30	288	(34.8)	88.6	(2.5)	47.0	(2.5)	41.6	(2.5)
31	19	(23.2)	4.0	(1.8)	1.9	(1.6)	2.1	(2.0)
32	213	(29.9)	56.4	(2.8)	29.2	(3.0)	27.2	(2.7)
33	96	(18.8)	35.4	(0.5)	21.4	(0.5)	14.0	(0.7)
34	652	(25.8)	168.0	(1.9)	82.8	(1.9)	85.2	(1.9)
35	1296	(37.4)	239.6	(1.5)	94.8	(1.3)	144.8	(1.8)
36	292	(28.1)	99.2	(1.0)	44.9	(0.9)	54.3	(1.0)
37	99	(32.0)	37.2	(0.7)	20.1	(0.6)	17.1	(0.9)
38	175	(38.7)	61.0	(2.6)	22.1	(2.3)	38.9	(2.8)
39	273	(36.7)	43.9	(1.9)	20.9	(1.8)	23.0	(2.1)

Source: Longitudinal Research Database, Bureau of the Census. Output, cost of materials, and value added are in millions of dollars. Values in parentheses are percentages of the totals for the state.

Manufactures is a full survey of manufacturing establishments.[6] However, the usual expense associated with conducting a full survey is avoided, since the survey has already been carried out by the Bureau of the Census. All manufacturing establishments in the United States are surveyed, and can be grouped at the state, SMSA, and county levels. Since the Census of Manufactures is carried out every five years, a consistent set of tables can be built not only across geographic boundaries, ranging from a national to county-level tables, but also across time.

On the other hand, the Census of Manufactures, as the name implies, canvasses only *manufacturing* establishments. Thus, additional data sources must be used to build the non-manufacturing portion of the table.[7] In this sense, the methodology incorporates some non survey elements. As Round (1983, 190) has noted,

> in practice virtually all input-output tables are hybrid tables constructed by semi-survey techniques, employing primary and secondary sources to a greater or lesser extent. Therefore, there can be few regional input-output tables, if any, that have not relied to some extent on the use of indicators, ad hoc judgment, or some form of data-smoothing technique.

This was very much the case in the construction of the Illinois table.

An input-output table can be constructed based on information on input purchases by producing sectors and on distribution of sales to consuming sectors; on input purchases alone ("columns only" approach); or on sales distribution alone ("rows only" approach). The nature of the LRD file dictated that a "columns only" approach be used on

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[6]It is worth noting that, since the Census of Manufactures canvasses *all* the manufacturing establishments in the country, there is no need to obtain total industry flows from secondary sources, as would be the case if a partial-survey method had been used. The total output for each industry is obtained simultaneously with the input-output coefficients.

[7]At the time of this writing, the main thrust was on the completion of a table covering the manufacturing sectors in as much detail as possible. Additional data sources for the non-manufacturing sectors, such as the other economic Censuses, are being examined, and eventually the table will be expanded to cover the full economic spectrum.

the construction of the 1982 Illinois table, since it contains detailed information on input purchases by the manufacturing establishments, but no sales distribution data.

Classification Scheme

The level of disaggregation of the information collected by the Census of Manufactures, on which the LRD is based, places an upper bound on the level of disaggregation of the input-output tables built using this information. Materials consumed are coded at the 6-digit aggregation level, and outputs are coded at the 7-digit SIC level.[8] Unfortunately, the material codes are not true SIC codes; they are composed of a 4-digit SIC code representing the industry that produces the material and two additional digits that uniquely identify each material produced in that industry. Thus, the most refined classification scheme possible for the manufacturing portion of an industry × industry table would correspond to a 4-digit SIC level. A few sectors were aggregated a bit further, in order to achieve compatibility with the sectoring scheme used by the Bureau of Economic Analysis' national Input-Output table, since information from that table was used to supplement the Census data.

Data availability for the non-manufacturing sectors is severely limited, and those sectors had to be aggregated to the 1- and 2-digit SIC levels. Thus, the sectoring scheme used for the 1982 Illinois table corresponds roughly to a 4-digit SIC level for manufacturing and 1- and 2-digit levels for the non-manufacturing sectors, resulting in approximately 400 sectors. A list of all sectors and the corresponding SIC and BEA codes can be found in Appendix A.

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[8]The Standard Industrial Classification system, as developed by the Technical Committee on Industrial Classification under the direction of the Office of Management and Budget, classifies establishments only to the 4-digit level. The 5-, 6-, and 7-digit levels are extensions created by the Bureau of the Census.

Material residuals

When the Census of Manufactures is carried out, each establishment is requested to report its consumption of materials used as inputs in the production process, as well as the total cost of all materials used. There is a separate form for each 4-digit SIC level industry, and a list of the materials most likely to be used as inputs by establishments in that industry is pre-printed on the form. All materials consumed not listed on the form are grouped together and reported with a special code ("materials not elsewhere classified"). Materials whose consumption falls below a specified minimum ($5,000 for the 1982 Census of Manufactures) are not reported separately, even if they are listed on the form, and are added up and reported as "materials not specified by kind."

Some small establishments received an abbreviated version of the Census form, and did not report detailed consumption of materials. For those establishments, a single entry corresponding to total consumption of materials was entered with a code of "material detail left blank." In addition, if the sum of the detailed material consumption did not match the reported total material consumption, a balancing record was added to the establishment.

Conversations with Bureau of the Census analysts indicate that the reported total material consumption is more reliable than the sum of the detailed material consumption. Therefore, the consumption of each individual material was scaled up or down, as needed, in order to force their sum to match the reported total consumption of materials. For each establishment in industry *i* let

T_i = reported total consumption of materials,

x_{ij} = amount of material *j* consumed by the establishment, and

$S_i = \sum_j x_{ij}$ = sum of consumption of materials

Then, if $T_i \neq S_i$ each x_{ij} is multiplied by a scaling factor $\alpha_i = T_i / S_i$, which guarantees that $\sum_j x_{ij} = T_i$. Thus, for each establishment, the sum of the detailed material consumption matches the total reported material consumption.

The other types of residuals ("materials not elsewhere classified," "materials not specified by kind," and "material detail left blank") pose a more difficult problem. It would be tempting to simply treat "materials not elsewhere classified" as a positive balancing record, and scale the consumption of the other materials up, as described above. However, since this item comprises the sum of the consumption of all the materials that were *not* reported separately by the establishment, it can represent a combination of any materials *except* the ones that were already reported by the establishment, and thus the above procedure is clearly inadequate in this case. It was decided to obtain a production function for each industry, and distribute the consumption of "materials not elsewhere classified" among all the materials present in the production function for the industry primary to the establishment being processed, but that were *not* reported by that particular establishment. This distribution is based on the proportions dictated by the relevant production function. Thus, a production function $f_j = (a_{1j}, a_{2j}, \ldots, a_{ij})$ was obtained for each industry *j*, where a_{ij} represents the amount of material *i* consumed for each dollar of commodity *j* produced. For each establishment in industry *j*, the amount of "materials not elsewhere classified" was distributed according to the a_{ij}'s for each material *i* present in the production function f_j but *not* reported as consumed by the establishment.

The rationale for this procedure is that, in the absence of other information about the composition of the "materials not elsewhere classified" item, it should be distributed among the materials known to be used as inputs by other establishments in the same industry, but that were not reported by the establishment in question.

The production functions were obtained from the 1982 U.S. Input-Output Table, prepared by the BEA. While it would be desirable to use regional production functions, based exclusively on Illinois data, this would create a catch-22 situation: in order to obtain the regional production functions (which are essentially the input-output coefficients) the material residuals must be distributed, but the production functions are needed to distribute the material residuals.

"Materials not specified by kind" were treated like "materials not elsewhere classified," since this item can represent consumption of any materials except the ones reported separately by the reporting establishment.

Establishments with "material detail left blank" were treated a bit differently. Since for those establishments no information whatsoever is available on the consumption of materials (except for the total material consumption), the total material consumption is distributed proportionally across all materials present on the production function for the industry to which the establishment belongs. This implies the assumption that the establishment in question consumes materials in the same proportions as the other establishments in the same industry. Since establishments with "material detail left blank" provide no detailed information on material consumption, one might ask why not simply drop those establishments from the sample altogether? The reason for not dropping them is that they do provide some useful information, such as total output, consumption of electricity, salaries and wages, and other value added components, and thus increase the accuracy of the estimated input-output coefficients.

Secondary production

The treatment of secondary production is one of the major problems faced by input-output analysts. Most establishments, especially in highly industrialized economies like the United States, produce more than a single output. Petroleum refineries, for ex-

ample, typically produce petrochemicals as a by-product to producing gasoline. Thus, the output of the establishments is not completely homogeneous. If secondary production is ignored, and each establishment is classified according to its primary product (the one whose sales exceeds those of all the others), the resulting coefficients (and implied production functions) will be a weighted average of the several sets of input-output coefficients underlying each of the distinct outputs. This results in a less precise picture of the economy, and could be especially troublesome for impact and projection analysis, since it overestimates some sectors of the economy while it underestimates others.

A special procedure was used to reallocate the amount of secondary production and its associated inputs from the industry where secondary production occurred to the industry to which the product is primary. The procedure is described in detail in Martins (1993) and Martins and Israilevich (1993), but basically involves obtaining production functions for each 4-digit industry group and using the resulting technical coefficients as the starting point for the coefficients for the multi-output establishments. This time regional production functions were used, since the material residuals had already been distributed as described above. To obtain the production functions, all multi-output establishments were dropped from the sample, leaving only *prime producers*, i.e., establishments that produce only their primary product. Thus, the technical coefficients obtained reflect the production of the primary product alone, and are not contaminated by inputs used in secondary production.

The redefinition of secondary products and their associated inputs can be viewed as a *constrained matrix problem* —"the problem of determining a matrix whose rows and columns are to sum to prescribed magnitudes." (Bacharach, 1970, 17) Let C be the $m \times n$ matrix of the c_{ij}'s indicating how much of input i the establishment consumed in the production of output j, $\mathbf{m}$ is a $n \times 1$ vector containing the total consumption of each

input m_i, and **x** is a $1 \times n$ vector containing the total outputs x_j. Vectors **m** and **x** represent the row and column constraints, that is, C must be estimated such that $C\mathbf{i} = \mathbf{m}$ and $C'\mathbf{i} = \mathbf{x}$.

Thus, for each multi-output establishment the row and column constraints are given by the vectors **m** and **x,** representing total consumption of each input and total production of each output. All that is left is the appropriate initial estimate of the matrix *C*, which breaks down the inputs among the several outputs.

Under the assumption of commodity-based technology, the input proportions for each output should be independent of where the output is produced, that is, they should be determined by the industry to which that output is primary. So, each column *i* in the matrix *C* should represent *i*'s input mix, or, in other words, should be an approximation of *i*'s production function. The production functions were obtained by calculating the input proportions for all the prime producers in each 4-digit industry, using the 1982 LRD data for Illinois. Thus, the resulting coefficients should reflect the *regional* production functions for each 4-digit industry in Illinois. In about a dozen industries the regional production functions indicated a negative value added coefficient. While it is hard to imagine a whole *industry* with negative value added,[9] in virtually all the cases where negative value added was observed the regional production functions were based on data from one or two establishments only, since only one or two establishments were prime producers of that commodity in Illinois. This might be due to two factors: either those establishments misreported their expenses and/or their receipts, or they did indeed

[9]In some industries, such as aerospace and shipbuilding, it may take more than one year to produce one unit of output, and thus establishments can have zero shipments in any given year. While this would result in negative value added, this would be a false indicator of economic activity in those industries. So, for industries with a long production cycles, alternate measures of output, such as value of work done, are used instead of value of shipments, and negative value added is avoided.

operate at a loss during the year. In either case, a negative entry on a production function does not make any economic sense, and the negative value added component was set to zero (in effect assuming that those establishments were just able to cover their operational expenses).

For each multi-output establishment, the RAS procedure is applied on a matrix containing the relevant a_{ij}'s from the regional production functions, using the **m** and **x** vectors as the *margins*:

$$\begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1} & a_{m2} & \cdots & a_{mn} \\ x_1 & x_2 & \cdots & x_n \end{bmatrix} \begin{matrix} \\ \\ \\ m_1 \\ \\ \end{matrix}$$

The resulting matrix *C* will then satisfy the row and column constraints, while the input mix for each commodity will be as close as possible to the input mix used by the industry to which the production of that commodity is primary. This technique is applied on each multi-output establishment, which is then in effect split into several establishments, each producing only a single commodity. The resulting establishments are then grouped into industries, which will now reflect only the production of their primary outputs.

Reallocation of special material codes

Some of the material codes used by the Census Bureau on the Census of Manufactures forms do not correspond to a 4-digit SIC code. These special material codes encompass a range of materials that would be covered in several different SICs, and had to be reassigned to a single 4-digit SIC. While this rearrangement was somewhat arbitrary, the only alternative would be to change the sectoring scheme so that each

special code would correspond to a single sector. This would result in a much coarser sectoring scheme, since some of the special material codes would correspond to a 2-digit SIC level, so it was decided to arbitrarily reassign the codes instead.

A special problem was posed by material code 1900. The materials represented by this code vary according to the industry in which the information was collected. For instance, for an establishment in industry 2011, a material code of 1900 represents "poultry, live, fresh, frozen, or prepared," while for an establishment in industry 3532 the same material code 1900 represents "iron and steel scrap, excluding home scrap." A list of what material code 1900 represents for each 4-digit SIC industry was obtained from the Census Bureau, and whenever the consumption of material 1900 represented more than one percent of the total industry output it was reassigned to the closest 4-digit SIC; otherwise it was reassigned to "materials not elsewhere classified" and treated as described above.

These procedures (including the material residual and secondary product procedures described above) are applied at the establishment level, and then the establishments are aggregated into 4-digit SIC industries. The final adjustment needed to obtain the transactions table is the conversion of transactions to producers' prices, as described below.

Trade and transportation margins

The transactions in an input-output table can be valued at either producers' or purchasers' prices. Producers' prices are the prices at which the seller completes the transaction. The purchaser incurs the producer's price plus trade and transportation margins. Thus, purchasers' price = producer's price + trade margin + transportation margin.

Most input-output studies use producer's prices, since this yields a more accurate representation of the technical requirements within each sector and isolates those technical requirements from changes in the goods distribution pattern of the economy.

The trade and transportation sectors are treated as "pass-through" sectors, and not as producing and consuming sectors in the economy, for if the flows through trade and transportation were actually traced the resulting table would show industries and consumers making most of their purchases from and sales to these two sectors. Thus, the trade and transportation margins for all inputs consumed by an industry are summed up and entered as service inputs for that industry.

The Census of Manufactures reports material consumption valued at purchasers' prices. Since no data on the trade and transportation margins is provided, the corresponding national margins were obtained from the Bureau of Economic Analysis and applied to each cell in the Illinois transactions table. Let w_{ij} represent the trade margin for commodity *i* consumed by industry *j*, expressed as the percentage of one dollar spent on commodity *i* (at purchasers' prices) that goes to the trade (wholesale and retail) sector; t_{ij} represent the transportation margin; and x_{ij}^{P} represent the amount (at purchasers' prices) of commodity *i* consumed by industry *j*. The interindustry flow, valued at producers' prices, is given by

$$x_{ij} = x_{ij}^{P} - \left(x_{ij}^{P} \cdot w_{ij}\right) - \left(x_{ij}^{P} \cdot t_{ij}\right) = \left(x_{ij}^{P} \cdot \left(1 - w_{ij} - t_{ij}\right)\right)$$

and the total margins for the trade *(W)* and transportation *(T)* sectors can then be obtained by

$$x_{Wj} = \sum_{i} \left(x_{ij}^{P} \cdot w_{ij}\right)$$

and

$$x_{Tj} = \sum_{i} \left(x_{ij}^{P} \cdot t_{ij}\right)$$

Derivation of coefficients and final flows

After the trade and transportation margins are subtracted from the preliminary transaction flows, the input-output technical coefficients are obtained by

$$a_{ij} = \frac{x_{ij}}{X_j}$$

where $X_j = \sum_i x_{ij}$, that is, the total output for industry *j*.

Since the establishments designated as Administrative Records had been removed from the sample, the total industry outputs obtained thus far are smaller than the actual total industry outputs. The actual totals are obtained from the products file, and then multiplied by each technical coefficient a_{ij}, producing the final transaction flows matrix.

4 SUMMARY

This paper presented a new method for use in the construction of hybrid regional input-output tables, based primarily on survey-quality data obtained from the individual returns from the Census of Manufactures. Using this method, tables can be completed in weeks, as opposed to the months or even years necessary for the completion of a full survey table, and at a fraction of the cost. This was made possible by the landmark decision of the Bureau of the Census to allow outside researchers to work with the Longitudinal Research Database, which combines data from several Census of Manufactures and Annual Survey of Manufactures.

Access to Census data sources might provide an opportunity to challenge Jensen's (1980) assertion that cell by cell accuracy in regional input-output tables, given the existing data sources, is untenable. While Jensen's comments reflect the realities of the

80's, the availability of the LRD data brings us closer than ever to the elusive goal of accurate, inexpensive regional tables.

Tables for different states and regions can be easily constructed using consistent accounting schemes and data sources, thus facilitating comparative analysis of regional economies. This type of work has not been a prominent feature in the regional science literature, since researchers have usually been forced to use tables built using different methodologies and different data sources, thus making comparisons a risky exercise. A consistent set of tables would certainly be a very valuable data source for the regional input-output community.

Although the above-mentioned factors are significant in their own right, the paper's main methodological contribution is a new method to deal with secondary production in input-output tables. Even though the potential consequences of ignoring secondary production are well known, regional input-output analysts have often brushed the problem aside. This is undoubtedly due to the fact that the task of reassigning the inputs associated with the production of secondary outputs is extremely time-consuming and expensive. The new methodology proposed is based on solid economic assumptions—namely, that the input structure for any given commodity is determined not by the industry in which the commodity was produced, but by the commodity itself (the *commodity-based technology assumption*). A mechanical procedure, based on the RAS method, was devised to perform the input redefinitions on an establishment by establishment basis, using the available data to the fullest. The vectors of total input consumption and total output production reported by each establishment are used as the margins in the RAS procedure, and the input-output coefficients obtained from the prime producers of each commodity—thus reflecting the input mix necessary to produce that commodity alone—are used as the initial coefficient estimates. The final estimates of the

coefficients will reflect the input structure used on the production of each separate output, and satisfy both margins reported by the establishments.

APPENDIX A

INDUSTRY CLASSIFICATION OF THE 1982 ILLINOIS INPUT-OUTPUT TABLE

	Industry	BEA Codes	SIC Codes
1	Agricultural products - crops and livestock	1, 2	01-02
2	Agricultural services, forestry and fisheries	3, 4	07-09
3	Metal mining	5, 6	10
4	Coal mining	7	11-12
5	Oil and gas extraction	8	13
6	Mining and quarrying of nonmetallic minerals	9, 10	14
7	Construction	11, 12	15-17
8	Guided missiles and space vehicles	130100	3761
9	Ammunition, except for small arms, n.e.c.	130200	3483
10	Tanks and tank components	130300	3795
11	Small arms	130500	3484
12	Small arms ammunition	130600	3482
13	Other ordnance and accessories	130700	3489
14	Meat packing plants	140101	2011
15	Sausages and other prepared meats	140102	2013
16	Poultry dressing plants	140103	2016
17	Poultry and egg processing	140104	2017
18	Creamery butter	140200	2021
19	Cheese, natural and processed	140300	2022
20	Condensed and evaporated milk	140400	2023
21	Ice cream and frozen desserts	140500	2024
22	Fluid milk	140600	2026
23	Canned and cured sea foods	140700	2091
24	Canned specialties	140800	2032
25	Canned fruits and vegetables	140900	2033
26	Dehydrated food products	141000	2034
27	Pickles, sauces, and salad dressings	141100	2035
28	Fresh or frozen packaged fish	141200	2092
29	Frozen fruits, fruit juices and vegetables	141301	2037
30	Frozen specialties	141302	2038
31	Flour and other grain mill products	141401	2041
32	Cereal breakfast foods	141402	2043

INDUSTRY CLASSIFICATION OF THE 1982 ILLINOIS INPUT-OUTPUT TABLE (CONTINUED)

Industry	BEA Codes	SIC Codes
33 Blended and prepared flour	141403	2045
34 Dog, cat, and other pet food	141501	2047
35 Prepared feeds, n.e.c.	141502	2048
36 Rice milling	141600	2044
37 Wet corn milling	141700	2046
38 Bread, cake, and related products	141801	2051, 5462
39 Cookies and crackers	141802	2052
40 Sugar	141900	2061-2063
41 Confectionery products	142001	2065
42 Chocolate and cocoa products	142002	2066
43 Chewing gum	142003	2067
44 Malt beverages	142101	2082
45 Malt	142102	2083
46 Wines, brandy, and brandy spirits	142103	2084
47 Distilled liquor, except brandy	142104	2085
48 Bottled and canned soft drinks	142200	2086
49 Flavoring extracts and sirups, n.e.c.	142300	2087
50 Cottonseed oil mills	142400	2074
51 Soybean oil mills	142500	2075
52 Vegetable oil mills, n.e.c.	142600	2076
53 Animal and marine fats and oils	142700	2077
54 Roasted coffee	142800	2095
55 Shortening and cooking oils	142900	2079
56 Manufactured ice	143000	2097
57 Macaroni and spaghetti	143100	2098
58 Food preparations, n.e.c.	143200	2099
59 Cigarettes	150101	2111
60 Cigars	150102	2121
61 Chewing and smoking tobacco	150103	2131
62 Tobacco stemming and redrying	150200	2141
63 Broadwoven fabric mills and fabric finishing plants	160100	2211-2231, 2261, 2262
64 Narrow fabric mills	160200	2241
65 Yarn mills and finishing of textiles, n.e.c.	160300	2269, 2281-2283
66 Thread mills	160400	2284
67 Floor coverings	170100	2271-2279
68 Felt goods, n.e.c.	170200	2291

INDUSTRY CLASSIFICATION OF THE 1982 ILLINOIS INPUT-OUTPUT TABLE (CONTINUED)

	Industry	BEA Codes	SIC Codes
69	Lace goods	170300	2292
70	Padding and upholstery filling	170400	2293
71	Processed textile waste	170500	2294
72	Coated fabrics, not rubberized	170600	2295
73	Tire cord and fabric	170700	2296
74	Cordage and twine	170900	2297
75	Nonwoven fabrics	171001	2298
76	Textile goods, n.e.c.	171002	2299
77	Women's hosiery, except socks	180101	2251
78	Hosiery, n.e.c.	180102	2252
79	Knit outerwear mills	180201	2253
80	Knit underwear mills	180202	2254
81	Knitting mills, n.e.c.	180203	2259
82	Knit fabric mills	180300	2257, 2258
83	Apparel made from purchased materials	180400	2311-2389
84	Curtains and draperies	190100	2391
85	Housefurnishings, n.e.c.	190200	2392
86	Textile bags	190301	2393
87	Canvas and related products	190302	2394
88	Pleating and stitching	190303	2395
89	Automotive and apparel trimmings	190304	2396
90	Schiffli machine embroideries	190305	2397
91	Fabricated textile products, n.e.c.	190306	2399
92	Logging camps and logging contractors	200100	2411
93	Sawmills and planing mills, general	200200	2421
94	Hardwood dimension and flooring mills	200300	2426
95	Special product sawmills, n.e.c.	200400	2429
96	Millwork	200501	2431
97	Wood kitchen cabinets	200502	2434
98	Veneer and plywood	200600	2435, 2346
99	Structural wood members, n.e.c.	200701	2439
100	Prefabricated wood buildings	200702	2452
101	Wood preserving	200800	2491
102	Wood pallets and skids	200901	2448
103	Particleboard	200902	2492
104	Wood products, n.e.c.	200903	2499

INDUSTRY CLASSIFICATION OF THE 1982 ILLINOIS INPUT-OUTPUT TABLE (CONTINUED)

	Industry	BEA Codes	SIC Codes
105	Wood containers	210000	2441, 2449
106	Wood household furniture	220101	2511
107	Household furniture, n.e.c.	220102	2519
108	Wood TV and radio cabinets	220103	2517
109	Upholstered household furniture	220200	2512
110	Metal household furniture	220300	2514
111	Mattresses and bedsprings	220400	2515
112	Wood office furniture	230100	2521
113	Metal office furniture	230200	2522
114	Public building furniture	230300	2531
115	Wood partitions and fixtures	230400	2541
116	Metal partitions and fixtures	230500	2542
117	Drapery hardware and blinds and shades	230600	2591
118	Furniture and fixtures, n.e.c.	230700	2599
119	Pulp mills	240100	2611
120	Paper mills, except building paper	240200	2621
121	Paperboard mills	240300	2631
122	Envelopes	240400	2642
123	Sanitary paper products	240500	2647
124	Building paper and board mills	240602	2661
125	Paper coating and glazing	240701	2641
126	Bags, except textile	240702	2643
127	Die-cut paper and board	240703	2645
128	Pressed and molded pulp goods	240704	2646
129	Stationery products	240705	2648
130	Converted paper products, n.e.c.	240706	2649
131	Paperboard containers and boxes	250000	2651-2655
132	Newspapers	260100	2711
133	Periodicals	260200	2721
134	Book publishing	260301	2731
135	Book printing	260302	2732
136	Miscellaneous publishing	260400	2741
137	Commercial printing	260501	2751, 2752, 2754
138	Lithographic platemaking and services	260502	2795
139	Manifold business forms	260601	2761
140	Blankbooks and looseleaf binders	260602	2782

INDUSTRY CLASSIFICATION OF THE 1982 ILLINOIS INPUT-OUTPUT TABLE (CONTINUED)

Industry	BEA Codes	SIC Codes
141 Greeting card publishing	260700	2771
142 Engraving and plate printing	260801	2753
143 Bookbinding and related work	260802	2789
144 Typesetting	260803	2791
145 Photoengraving, electrotyping, and stereotyping	260804	2793, 2794
146 Alkalies and chlorine	270101	2812
147 Industrial gases	270102	2813
148 Inorganic pigments	270103	2816
149 Industrial inorganic chemicals, n.e.c.	270104	2819
150 Industrial organic chemicals	270105	2861-2869
151 Nitrogenous and phosphatic fertilizers	270201	2873, 2874
152 Fertilizers, mixing only	270202	2875
153 Agricultural chemicals, n.e.c.	270300	2879
154 Gum and wood chemicals	270401	2861
155 Adhesives and sealants	270402	2891
156 Explosives	270403	2892
157 Printing ink	270404	2893
158 Carbon black	270405	2895
159 Chemical preparations, n.e.c.	270406	2899
160 Plastics materials and resins	280100	2821
161 Synthetic rubber	280200	2822
162 Cellulosic man-made fibers	280300	2823
163 Organic fibers, noncellulosic	280400	2824
164 Drugs	290100	2831-2834
165 Soap and other detergents	290201	2841
166 Polishes and sanitation goods	290202	2842
167 Surface active agents	290203	2843
168 Toilet preparations	290300	2844
169 Paints and allied products	300000	2851
170 Petroleum refining	310101	2911
171 Lubricating oils and greases	310102	2992
172 Products of petroleum and coal, n.e.c.	310103	2999
173 Paving mixtures and blocks	310200	2951
174 Asphalt felts and coatings	310300	2952
175 Tires and inner tubes	320100	3011
176 Rubber and plastics footwear	320200	3021

INDUSTRY CLASSIFICATION OF THE 1982 ILLINOIS INPUT-OUTPUT TABLE (CONTINUED)

	Industry	BEA Codes	SIC Codes
177	Reclaimed rubber	320301	3031
178	Fabricated rubber products, n.e.c.	320302	3069
179	Miscellaneous plastics products	320400	3079
180	Rubber and plastics hose and belting	320500	3041
181	Leather tanning and finishing	330001	3111
182	Boot and shoe cut stock and findings	340100	3131
183	Shoes, except rubber	340201	3143-3149
184	House slippers	340202	3142
185	Leather gloves and mittens	340301	3151
186	Luggage	340302	3161
187	Women's handbags and purses	340303	3171
188	Personal leather goods	340304	3172
189	Leather goods, n.e.c.	340305	3199
190	Glass and glass products, except containers	350100	3211, 3229, 3231
191	Glass containers	350200	3221
192	Cement, hydraulic	360100	3241
193	Brick and structural clay tile	360200	3251
194	Ceramic wall and floor tile	360300	3253
195	Clay refractories	360400	3255
196	Structural clay products, n.e.c.	360500	3259
197	Vitreous plumbing fixtures	360600	3261
198	Vitreous china food utensils	360701	3262
199	Fine earthenware food utensils	360702	3263
200	Porcelain electrical supplies	360800	3264
201	Pottery products, n.e.c.	360900	3269
202	Concrete block and brick	361000	3271
203	Concrete products, n.e.c.	361100	3272
204	Ready-mixed concrete	361200	3273
205	Lime	361300	3274
206	Gypsum products	361400	3275
207	Cut stone and stone products	361500	3281
208	Abrasive products	361600	3291
209	Asbestos products	361700	3292
210	Gaskets, packing and sealing devices	361800	3293
211	Minerals, ground or treated	361900	3295
212	Mineral wool	362000	3296

INDUSTRY CLASSIFICATION OF THE 1982 ILLINOIS INPUT-OUTPUT TABLE (CONTINUED)

Industry	BEA Codes	SIC Codes
213 Nonclay refractories	362100	3297
214 Nonmetallic mineral products, n.e.c.	362200	3299
215 Blast furnaces and steel mills	370101	3312
216 Electrometallurgical products	370102	3313
217 Steel wire and related products	370103	3315
218 Cold finishing of steel shapes	370104	3316
219 Steel pipe and tubes	370105	3317
220 Iron and steel foundries	370200	3321-3325
221 Iron and steel forgings	370300	3462
222 Metal heat treating	370401	3398
223 Primary metal products, n.e.c.	370402	3399
224 Primary copper	380100	3331
225 Primary lead	380200	3332
226 Primary zinc	380300	3333
227 Primary aluminum and alumina	380400	3334
228 Primary nonferrous metals, n.e.c.	380500	3339
229 Secondary nonferrous metals	380600	3341
230 Copper rolling and drawing	380700	3351
231 Aluminum rolling and drawing	380800	3353-3355
232 Nonferrous rolling and drawing, n.e.c.	380900	3356
233 Nonferrous wire drawing and insulating	381000	3357
234 Aluminum castings	381100	3361
235 Brass, bronze, and copper castings	381200	3362
236 Nonferrous castings, n.e.c.	381300	3369
237 Nonferrous forgings	381400	3463
238 Metal cans	390100	3411
239 Metal barrels, drums, and pails	390200	3412
240 Metal sanitary ware	400100	3431
241 Plumbing fixture fittings and trim	400200	3432
242 Heating equipment, except electric	400300	3433
243 Fabricated structural metal	400400	3441
244 Metal doors, sash, and trim	400500	3442
245 Fabricated plate work (boiler shops)	400600	3443
246 Sheet metal work	400700	3444
247 Architectural metal work	400800	3446
248 Prefabricated metal buildings	400901	3448

INDUSTRY CLASSIFICATION OF THE 1982 ILLINOIS INPUT-OUTPUT TABLE (CONTINUED)

	Industry	BEA Codes	SIC Codes
249	Miscellaneous metal work	400902	3449
250	Screw machine products	410100	3451, 3452
251	Automotive stampings	410201	3465
252	Crowns and closures	410202	3466
253	Metal stampings, n.e.c.	410203	3469
254	Cutlery	420100	3421
255	Hand and edge tools, n.e.c.	420201	3423
256	Hand saws and saw blades	420202	3425
257	Hardware, n.e.c.	420300	3429
258	Plating and polishing	420401	3471
259	Metal coating and allied services	420402	3479
260	Miscellaneous fabricated wire products	420500	3495, 3496
261	Steel springs, except wire	420700	3493
262	Pipe, valves, and pipe fittings	420800	3494, 3498
263	Metal foil and leaf	421000	3497
264	Fabricated metal products, n.e.c.	421100	3499
265	Turbines and turbine generator sets	430100	3511
266	Internal combustion engines, n.e.c.	430200	3519
267	Farm machinery and equipment	440001	3523
268	Lawn and garden equipment	440002	3524
269	Construction machinery and equipment	450100	3531
270	Mining machinery, except oil field	450200	3532
271	Oil field machinery	450300	3533
272	Elevators and moving stairways	460100	3534
273	Conveyors and conveying equipment	460200	3535
274	Hoists, cranes, and monorails	460300	3536
275	Industrial trucks and tractors	460400	3537
276	Machine tools, metal cutting types	470100	3541
277	Machine tools, metal forming types	470200	3542
278	Special dies and machine tool accessories	470300	3544, 3545
279	Power driven hand tools	470401	3546
280	Rolling mill machinery	470402	3547
281	Metalworking machinery, n.e.c.	470403	3549
282	Food products machinery	480100	3551
283	Textile machinery	480200	3552
284	Woodworking machinery	480300	3553

INDUSTRY CLASSIFICATION OF THE 1982 ILLINOIS INPUT-OUTPUT TABLE (CONTINUED)

Industry	BEA Codes	SIC Codes
285 Paper industries machinery	480400	3554
286 Printing trades machinery	480500	3555
287 Special industry machinery, n.e.c.	480600	3559
288 Pumps and compressors	490100	3561, 3563
289 Ball and roller bearings	490200	3562
290 Blowers and fans	490300	3564
291 Industrial patterns	490400	3565
292 Power transmission equipment	490500	3566, 3568
293 Industrial furnaces and ovens	490600	3567
294 General industrial machinery, n.e.c.	490700	3569
295 Carburetors, pistons, rings, valves	500001	3592
296 Machinery, except electrical, n.e.c.	500002	3599
297 Electronic computing equipment	510101	3573
298 Calculating and accounting machines	510102	3574
299 Scales and balances	510300	3576
300 Typewriters and office machines, n.e.c.	510400	3572, 3579
301 Automatic merchandising machines	520100	3581
302 Commercial laundry equipment	520200	3582
303 Refrigeration and heating equipment	520300	3585
304 Measuring and dispensing pumps	520400	3586
305 Service industry machines, n.e.c.	520500	3589
306 Instruments to measure electricity	530100	3825
307 Transformers	530200	3612
308 Switchgear and switchboard apparatus	530300	3613
309 Motors and generators	530400	3621
310 Industrial controls	530500	3622
311 Welding apparatus, electric	530600	3623
312 Carbon and graphite products	530700	3624
313 Electrical industrial apparatus, n.e.c.	530800	3629
314 Household cooking equipment	540100	3631
315 Household refrigerators and freezers	540200	3632
316 Household laundry equipment	540300	3633
317 Electric housewares and fans	540400	3634
318 Household vacuum cleaners	540500	3635
319 Sewing machines	540600	3636
320 Household appliances, n.e.c.	540700	3639

INDUSTRY CLASSIFICATION OF THE 1982 ILLINOIS INPUT-OUTPUT TABLE (CONTINUED)

Industry	BEA Codes	SIC Codes
321 Electric lamps	550100	3641
322 Lighting fixtures and equipment	550200	3645-3648
323 Wiring devices	550300	3643, 3644
324 Radio and TV receiving sets	560100	3651
325 Phonograph records and tapes	560200	3652
326 Telephone and telegraph apparatus	560300	3661
327 Radio and TV communication equipment	560400	3662
328 Electron tubes, all types	570100	3671-3673
329 Semiconductors and related devices	570200	3674
330 Other electronic components	570300	3675-3679
331 Storage batteries	580100	3691
332 Primary batteries, dry and wet	580200	3692
333 X-ray apparatus and tubes	580300	3693
334 Engine electrical equipment	580400	3694
335 Electrical equipment and supplies, n.e.c.	580500	3699
336 Truck and bus bodies	590100	3713
337 Truck trailers	590200	3715
338 Motor vehicles and car bodies	590301	3711
339 Motor vehicle parts and accessories	590302	3714
340 Aircraft	600100	3721
341 Aircraft and missile engines and parts	600200	3724, 3764
342 Aircraft and missile equipment, n.e.c.	600400	3728, 3769
343 Ship building and repairing	610100	3731
344 Boat building and repairing	610200	3732
345 Railroad equipment	610300	3743
346 Motorcycles, bicycles, and parts	610500	3751
347 Travel trailers and campers	610601	3792
348 Mobile homes	610602	2451
349 Motor homes (made from purchased materials)	610603	3716
350 Transportation equipment, n.e.c.	610700	3799
351 Engineering and scientific instruments	620100	3811
352 Mechanical measuring devices	620200	3823, 3824, 3829
353 Environmental controls	620300	3822
354 Surgical and medical instruments	620400	3841
355 Surgical appliances and supplies	620500	3842
356 Dental equipment and supplies	620600	3843

INDUSTRY CLASSIFICATION OF THE 1982 ILLINOIS INPUT-OUTPUT TABLE (CONTINUED)

	Industry	BEA Codes	SIC Codes
357	Watches, clocks, and parts	620700	3873
358	Optical instruments and lenses	630100	3832
359	Ophthalmic goods	630200	3851
360	Photographic equipment and supplies	630300	3861
361	Jewelry, precious metal	640101	3911
362	Jewelers' materials and lapidary work	640102	3915
363	Silverware and plated ware	640104	3914
364	Costume jewelry	640105	3961
365	Musical instruments	640200	3931
366	Games, toys, and children's vehicles	640301	3944
367	Dolls	640302	3942
368	Sporting and athletic goods, n.e.c.	640400	3949
369	Pens and mechanical pencils	640501	3951
370	Lead pencils and art goods	640502	3952
371	Marking devices	640503	3953
372	Carbon paper and inked ribbons	640504	3955
373	Artificial trees and flowers	640600	3962
374	Buttons	640701	3963
375	Needles, pins, and fasteners	640702	3964
376	Brooms and brushes	640800	3991
377	Hard surface floor coverings	640900	3996
378	Burial caskets and vaults	641000	3995
379	Signs and advertising displays	641100	3993
380	Manufacturing industries, n.e.c.	641200	3999
381	Transportation and warehousing	65	40-47
382	Communications	66, 67	48
383	Electric, gas, water, and sanitary services	68	49
384	Wholesale and retail trade	69	50-57, 59, 7396, 8042
385	Finance and insurance	70	60-64, 67
386	Real estate and rental	71	65, 66
387	Hotels; personal, legal, and repair services	72, 73	70-73, 811, 891, 893, 899
388	Eating and drinking places	74	58
389	Automotive repair, services, and garages	75	75
390	Amusement and recreation services	76	78-79
391	Health, educational, and nonprofit organizations	77	74, 80, 82-86, 892, 6732
392	Government enterprises	78, 79	N/A

INDUSTRY CLASSIFICATION OF THE 1982 ILLINOIS INPUT-OUTPUT TABLE (CONTINUED)

Industry	BEA Codes	SIC Codes
393 Noncomparable imports	80	N/A
394 Scrap and used goods	81	N/A
395 Government industry	82	N/A
396 Rest of the world industry	83	N/A
397 Household industry	84	N/A
398 Inventory valuation adjustment	85	N/A
399 Compensation of employees	88	N/A

APPENDIX B

2-DIGIT SIC INDUSTRY CLASSIFICATIONS
MANUFACTURING INDUSTRIES

Industry	Description
20	Food and kindred products
21	Tobacco products
22	Textile mill products
23	Apparel and other textile products
24	Lumber and wood products
25	Furniture and fixtures
26	Paper and allied products
27	Printing and publishing
28	Chemicals and allied products
29	Petroleum and coal products
30	Rubber and miscellaneous plastics products
31	Leather and leather products
32	Stone, clay, and glass products
33	Primary metal industries
34	Fabricated metal products
35	Machinery, except electrical
36	Electric and electronic equipment
37	Transportation equipment
38	Instruments and related products
39	Miscellaneous manufacturing industries

APPENDIX C

DESCRITPTION OF LRD VARIABLES USED IN THE CONSTRUCTION OF THE 1982 ILLINOIS INPUT-OUTPUT TABLE[1]

PPN Permanent Plant Number

The permanent plant number (PPN) is a ten digit-number that is assigned to every establishment in the file including nonASM plants.

ET Establishment Type

The Establishment Type distinguishes plants that are part of the ASM sample (Type = 0) from establishments that are non-ASM (Type = 1) in the census years.

AR Administrative Record Impute Flag

The establishment record is an Administrative Record case if this bit is set equal to 1.

Since 1954 the basic mailing lists for the censuses have been obtained from Internal Revenue Service (IRS) and Social Security Administration (SSA) records. After the 1963 census it was decided to make greater use of the data in these records and beginning in 1967 over 100,000 small companies were exempted from the filing requirement in census years. Instead, census-type statistics for this group were developed from IRS-SSA records. In 1972 single-unit establishments with under ten employees were treated as administrative record cases. In 1977 and 1982 the administrative record cutoff varied by industry.

The information obtained from these reports was the name and address, payrolls, and gross business receipts. In addition, an SIC industrial activity code was assigned by use of the permanent SSA records which indicate the industry or kind of business of each employer. Other census statistics for these small firms were imputed, using industry average ratios to payrolls and sales.

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[1]This is an edited version of the information presented by Monahan (1990).

IND Tabulated Industry Code

The general industry coding program used at the Census Bureau assigns each establishment a particular industry code on the basis of its recorded shipment (or production) values for product categories or classes. This code is referred to as the "derived" industry code in ASM years and as the general industry code (I code) in census years. It is derived by summing all non-defective product data to industry totals and assigning the code for the industry with the largest value. (If the establishment has no product with a value greater than zero then the historic (H) code (i.e., the prior year tabulated code for ASM cases; otherwise the stencil code or recorded SSA code) is assigned. If two or more industries tie with the largest value, the tied industry matching the establishment's H code at the four-digit level is assigned. If no match is made at this level, the matching tied industry is assigned as the establishment's industry code. In those cases where there is either no match at any level or there are two tied industries matching the H code at the two or three-digit level, the computer will arbitrarily assign a current industry code based on the last digit of the tied sum being odd or even.)

ST State Code

The State code is a two-digit Census-assigned code. The first digit indicates the geographic division; the second the state or area within the geographic division.

SW Total Salaries and Wages

Gross earnings paid in the calendar year to employees; reported as the sum of production worker wages and non-production worker wages .

Respondents were told to follow the definition of salaries and wages used for calculating the federal withholding tax. They were instructed to report the gross earnings paid in the calendar year to employees at the establishment prior to such deductions as employees' social security contributions, withholding taxes, group insurance premiums, union dues, and savings bonds.

CM Total Cost of Materials

Total cost of materials actually consumed or put into production during the year, whether purchased, withdrawn from inventories or received from other establishments of the same company; reported as the sum of items CP, CR, CF, EE, and CW.

This category refers to the total cost of materials actually consumed or put into production during the year, whether purchased, withdrawn from inventories or transferred from other establishments of the same company. The total excluded the cost of services used, such as advertising, insurance, telephone, etc. and developmental, re-

search, and consulting services of other establishments. It also excluded overhead costs, such as depreciation charges, rent, interest, royalties, etc. and materials, machinery, and equipment used in plant expansion or capitalized repairs which are chargeable to fixed assets accounts.

"Cost" is defined as delivered cost, i.e., as the direct charges actually paid or payable after discounts and including freight charges and other direct charges incurred by the establishment in acquiring the materials. If no record of consumption for a minor item was available, respondents were asked to report purchases. This was also allowed for major items if purchases did not differ significantly from the amounts actually used. Where consumption of major items differed significantly from purchases, an estimate derived by adding beginning inventories of the item to the amount purchased and subtracting end of year inventories was acceptable.

CP Cost of Materials, Parts, Etc.

This item records the total delivered cost of all raw materials, containers, scrap, and supplies, etc., which were: (1) put into production, (2) used as operating supplies, or (3) used in repair and maintenance during the report year.

Costs reported here should include the cost of materials owned by the reporting establishment but consumed by other companies to make products under contract. Costs not reported include expenditures for the following goods and services:

(a) Materials owned by others used in the reporting plant to make products for other establishments under contract or on commission.

(b) Services used or overhead charges, such as advertising, telephone, telegram and cable, insurance, developmental and research; services of engineering, management, marketing and other professional consultants, etc., unless charges for such services were included in the prices paid for materials.

(c) Overhead items such as depreciation charges against plant and equipment, rent and rental allowances, interest payments, royalties, and patent fees.

(d) Materials, supplies, machinery, and equipment were used in the construction of new structures or additions to plant, or new machinery and equipment, and which were chargeable to fixed assets accounts (reported in Capital Expenditures).

(e) Products purchased and resold without further manufacture or processing or assembly. (These costs should be included in Cost of Resales (CR)).

Data on the value of individual materials consumed are collected in census years. The sum of these detailed materials values is balanced with the total Cost of Materials,

Parts, etc. (CP). (i.e., a balancing material record (with negative or positive cost value) is imputed when necessary to force the sum of the detailed values to equal the total recorded in item CP.)

CR Cost of Resales

Cost of all products bought and resold in the same condition as when purchased and not made part of another product manufactured by the reporting establishment.

CF Cost of Fuels

The amount actually paid or payable during the year for all fuels consumed for heat, power or the generation of electricity.

Anthracite and bituminous coal, coke, natural and manufactured gas, fuel oil, liquefied purchased gas, gasoline, and all other fuels including purchased steam are included in this category.

Fuel costs not included are (1) the estimated cost of fuels, such as sawdust or blast furnace gas, produced as a by-product of manufacturing activities, and (2) the cost of such as coal used in making coke (reported in Cost of Materials, Parts, etc. (CP)).

EE Cost of Purchased Electricity

The amount actually paid or payable for electric energy purchased during the year from other companies, or received from other establishments of the same company, excluding reporting establishment.

CW Cost of Contract Work

Total payments made during the year for contract work done by others on materials furnished by reporting establishment, including freight out and in. (Cost of materials worked is reported in Cost of Materials, Parts, etc. (CP))

CPC Cost of Purchased Communications Services

Cost of purchased communication services (telephone, telegraph, etc.).

EE Purchased Electricity

Cost of electric energy purchased from other companies or transferred from other establishments of the same company during the year.

Materials

In addition to the total cost of materials which every establishment was requested to report, quantity and cost information was collected for approximately a thousand specific materials in the census years. About 350 of these were "complete coverage" materials; i.e., every industry that consumed appreciable quantities of the material was canvassed so that the data would represent at least 90 percent of manufacturing consumption was obtained on a more limited basis, generally only in those industries in which the materials were important inputs. (Additional consumption information was collected in the product inquiries for items which were produced and consumed in the same plant.

M Material Code

The six-digit code number relates the commodity to the industry in which it is produced. For example, the code number 024111 refers to whole milk used as a material, and the first four digits of this code number 0241, refer to the agricultural industry, dairy farms, where this product originates.

Special Material Codes:

1. Material detail is not required based on industry.

The detail is dropped and Cost of Materials, Parts, etc. item (CP) is entered in a material record with material "not specified by kind" (n.s.k.) code 979000.

2. Material detail is left blank.

Cost of Materials, Parts, etc. item (CP) is entered in a material record with material code 971000.

3. Materials "Not Elsewhere Classified" (n.e.c.)

A material record with n.e.c. code 970099 records the total cost of materials for which no material items were prelisted on the form and the cost of materials consumed in small amounts. If less than a specified amount ($5,000 in 1972, $10,000 in 1977) of a material for which data are requested is consumed at the establishment, separate figures were not reported.

4. Balancing codes:

(a) Positive balancing code = 972000

The difference between the reported value for Cost of Materials, Parts, etc. (CP) and the sum of detailed material cost from material records is positive. The difference is entered in a material record with balancing code 972000.

(b) Negative balancing code = 973000

The difference between the reported value for Cost of Materials, Parts, etc. (CP) and the sum of detailed material costs from material records is negative. The difference is entered in a material record with balancing code 973000.

MC Material Delivered Cost

The value of materials, etc. consumed should be based on the delivered cost (i.e., the amount paid or payable, including freight and other direct charges incurred by acquiring the materials). This includes purchases, transfers from other establishments of the same company, and withdrawals from inventories.

FIB Inventory Finished Products (beginning of year)

Value of inventories of finished products at beginning of year.

WIB Inventory Work-in-Process (beginning of year)

Value of work-in-process inventories at the beginning of year.

FIE Inventory Finished Products (end of year)

Value of inventories of finished products at end of year.

WIE Inventory Work-in-Process (end of year)

Value of work-in-process inventories at end of year.

NB New Building Expenditures

This category includes all new construction and other land improvements, whether built on contract or by the manufacturer's own labor force. Major alterations, capitalized repairs, and improvement of buildings and site improvements are included.

NM New Machinery Expenditures

Total capital expenditures during the year for new production machinery and equipment and other new machinery and equipment, including replacements as well as additions to capacity. New equipment manufactured by the plant for use in its own production should be included in this category.

UB Used Building Expenditures

The purchase price of all used buildings and other structures purchased during the year.

For any structures transferred to the use of the reporting establishment by the parent company or one of its subsidiaries, the value at which it was transferred to the establishment should be reported.

UM Used Machinery Expenditures

The purchase price of used machinery and equipment acquired from others (including the U.S. Government).

For any equipment transferred to the use of the reporting establishment by the parent company or one of its subsidiaries, the value at which it was transferred to the establishment should be reported.

RCW Receipts for Contract Work

This item records the total receipts for work performed for others on their own materials. (Receipts—not selling value of products—were requested.)

MSC Miscellaneous Receipts

Miscellaneous Receipts include receipts from the sale of scrap and refuse, payments for repair work, installation, etc.

TVS Total Value of Shipments

The total value of Shipments is a collected item; it is reported as the sum of (1) product values (recorded in product classes (PVC) in survey years and in product records (PV) in census years); (2) receipts from contract work performed for others (RCW); (3) sales of products bought and resold without further processing (VR); and (4) miscellaneous receipts for installation and repair work, sales of scrap, etc. (MSC).

The reported TVS figure is considered a more reliable figure than the sum of the individual components. If this sum does not equal the reported total, a product class or product record is imputed to bring them into balance.

Products

In the census years, information is collected on the output of approximately 13,000 individual product items. A "product" as used in the census of manufacturers is the finest level of detail for which output information is requested. It is not necessarily synonymous with the term "product" as used in the marketing sense. In some cases, it may be much more detailed and, in other cases, it is more aggregated. Some 6,000 of the product items were listed separately on the 1977 census report forms. (Data for the remaining products were obtained monthly, quarterly, or annually in commodity surveys of the current industrial reports program of the Bureau of the Census. On the census forms, only an overall control total or "tieline" was obtained.)

Each establishment receives a report form covering one or more industries and containing a product inquiry which lists the primary products of the industries as well as the chief secondary products frequently reported by establishments classified in those industries. Typically, both quantity and value of shipments are collected. However, physical quantity measures are not meaningful for some product lines, and for these, only value of shipments is collected. If a product is used to a large degree in the fabrication of other products within the same establishment in which it was produced, total quantities produced and consumed are collected. Information on production as well as shipments is collected for products for which there are significant differences between the two because of wide fluctuations in finished goods inventories. Alternate measures of output of products, such as value of work done for products with long production cycles, are used as appropriate and feasible. (See Product Classes; 7.1.2) In addition, detailed interplant transfers data are collected for products in certain industries. The type of data collected for a specific product is described in the 1977 Census of Manufactures publication MC77-R-1, Numerical List of Manufactured Products.

It is not considered feasible to estimate the product output of administrative record establishments in terms of specific 7-digit products. This is also true of some reporting companies when product shipments are described too generally. (Frequently these are residuals in the company's records which the company felt it could not break down.) For these cases, therefore, product records are coded only to the 4-digit level. Such "not specified by kind" (n.s.k.) products are published separately in census volumes, except in 4-digit industries where there is only one product category (e.g. Industry 3273, Readymixed concrete). The administrative record estimates for these products are treated as specific information and are not tabulated as n.s.k. products.

PI Product Code

Product coding system based on the Standard Industrial Classification system.

Special Product Codes:

1. Receipts for Contract Work - 930000xxxx

Products made in the reporting establishment on a contract basis from materials owned by others are not entered in the reporting establishment's product records with the specific product codes for those products. Rather, the values of these products (i.e., the receipts for contract work) are recorded with special product codes of the form 930000xxxx. Only the values of f.o.b. plant are entered in these records. The sum of these values is recorded in the Receipts for Contract Work item (RCW). (Products made elsewhere for an establishment on a contract basis from materials supplied by the reporting establishment are included in the reporting plant's product records with the appropriate product codes.)

2. Resales = 999809xxxx

The treatment followed for contract work is also applied to receipts from resales. Resales are defined as products resold as originally purchased and not used in further manufacturing, processing or assembling of products made in the reporting establishment. The receipts from resales are recorded with product codes of the form 999809xxxx. The sum of these values is recorded in the Value of Resales (VR).

3. Miscellaneous Receipts = 999800xxxx

Miscellaneous receipts are entered in product records with product codes of the form 999800xxxx. (Sales of scrap and refuse code = 9998000103; Receipts for repair work code = 9998000601; Other miscellaneous receipts code = 9998000908.) The sum of these values is recorded in the Miscellaneous Receipts item (MSC).

4. Balancing Codes:

A product record is imputed when necessary to balance the sum of the detailed product data (products, miscellaneous receipts, resales and contract work receipts) with the reported total value of shipments (TVS). Balancing product codes are composed of the plant's four digit industry code, followed by four zeros and “20” (for a positive difference) or “10” (for a negative difference).

PV Product Value of Shipments

Net selling value, f.o.b. plant, of shipments, after discounts and allowances and exclusive of freight charges and excise taxes.

Alternate measures of output (e.g. value of work done) for products with long production cycles are used as appropriate and feasible. (The type of data collected for a specific product is described in the 1977 Census of Manufactures publication MC77-R-1, Numerical List of Manufactured Products.)

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