Developing Annual Capital Flow Tables at BEA

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Prepared for the Inforum World Conference XII
Ascea-Velia, Italy, September 6-10, 2004

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1. Introduction. During the last 9 years, the U.S. economy has experienced a rapid expansion, followed by a short recession, and halting recovery. The expansion was driven in large part by investment, particularly in information technology (IT) and telecommunications equipment. The subsequent recession has also in large part been explainable by a sharp decline in those same areas of investment. The expansion and recession were also characterized by high rates of productivity growth. Policy makers and academic researchers have been investigating questions such as:

- What factors were driving the investment boom, and why the subsequent rapid decline?
- How much of the productivity gain during the boom can be explained by IT and related investment?

To address questions such as these, aggregate data is insufficient. Researchers are eager to understand the detailed structure of investment. Which industries are buying what technology from other industries? Detailed information to help study such questions is available from BEAs input-output (I-O) accounts, particularly the capital flow table, which shows the use of each type of investment asset or commodity by each industry. For example, it shows that in 1997 the Financial services industry was one of the largest users of computers, and that the Auto rental industry was the largest user of automobiles.

However, the capital flow table is not currently available as a time-series, but is produced only once every five years just after the benchmark I-O table. [1] Therefore, it is difficult to judge

[1] The benchmark capital flow tables have been published in the following issues of the Survey: August 1971 (1963), September 1975 (1967), July 1980 (1972), November 1985 (1977), December 1998 (1992) and November 2003 (1997). The 1982 table was not published, but is available on the BEA web site. No table was prepared for 1987.

how the use of new capital by industry changes over time, or how the composition of types of equipment used by each industry is changing. We know that such changes are driven by changes in technology, changing prices and cyclical factors, but we don't have a picture of where those changes are. Furthermore, the information is not timely. The most recent capital flow table was released in September 2003. This table was for 1997, so was then six years old. By the time the next table is released in 2008, the 1997 table will be over ten years old, and will describe a very different picture from the world in 2008.

Recognizing the importance of timely and more frequent I-O data, BEA has recently completed a strategic initiative to produce a time-series of annual input-output (I-O) accounts, integrated with the GDP-by-industry accounts.[2] This is the first step to the long-run integration of the Benchmark I-O accounts with the GDP-by-industry and with the National Income and Product Accounts (NIPA).[3] It is also the first time that a complete time-series of annual I-O tables has been generated for a five-year period, from 1998 to 2002.[4]

A natural outgrowth of this initiative would be the addition of an annual capital flow table to the integrated annual I-O accounts. Estimates of total investment by commodity (asset type) have already been made for the integrated industry accounts, which will be a great help in compiling an annual capital flow table. Funding has not yet been approved for the full time-series, but BEA is committed to researching the feasibility of constructing annual capital flow tables, and to use a prototype table for 1998 as a research project. If funds are approved, and the annual capital flow table reaches production, this initial prototype will be followed by a sequence

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[2] This is described and presented in "Improved Annual Industry Accounts for 1998-2003: Integrated Annual Input-Output Accounts and Gross-Domestic-Product-by-Industry Accounts", *Survey of Current Business*, June 2004, 21-57.

[3] This effort was made possible only through the helpful support of the U.S. Census Bureau, which provides most of the data required for both the benchmark and the annual I-O accounts.

[4] This set of integrated accounts will also be of great benefit to builders of econometric I-O models, as this will be the first time that a completely integrated set of I-O and national accounts data will be available.

of tables from 1999 to 2002. Then we anticipate that the subsequent tables will be available with a lag of only two years from its reference year.

The objective of this paper is to present our plans for research on a prototype annual capital flow table, and to present information about source data and methodology necessary to understand those plans. To this end, the paper summarizes the highlights of our planned research project and provides background material to the reader in order to be conversant with this research. The three main problems to address in developing the annual capital flow table are:

1. The compilation of total annual investment data by industry.
2. The derivation of row totals from information in the annual I-O table.
3. Allocating total investment by asset to the industry which uses it.

Section 2 discusses definitional and classification issues that arise in building the capital flow table. In section 3 we discuss briefly the sources of annual investment data. Section 4 describes the process of deriving row totals, and section 5 summarizes the sources of data which may be used to distribute asset totals to industry of use.[5] Section 6 describes the process envisioned for building the annual capital flow table. Finally, section 7 concludes and presents a brief plan for the development of the 1998 prototype table.

2. Definitional and Classification Issues. Four major definitional and classification issues play a role in the creation of the annual capital flow table. These are:

1. Whether data are collected on an enterprise or an establishment basis and whether non-employers are included.
2. The treatment of leased capital and whether it is assigned to the owner or to the user.

[5] More detail on these data sources can be found in Appendix A.

3. The treatment of software (purchased, custom, or own-account) and whether expensed software is reported.

4. The effect of using more timely but less detailed data on the quality of the table.

An establishment is a single physical location where goods are manufactured or services are performed. An enterprise is a firm that consists of one or more establishments. The establishments owned by an enterprise may be involved in different types of activity, producing different goods or services. Some surveys collect data on an establishment basis while others collect it on an enterprise basis. The distinction becomes important when an enterprise consists of many establishments which do not produce the same goods or services. These large multi-establishment enterprises may report investment for only one or a few of the many industries in which their establishments are known to be classified. This problem is called *industry truncation*.[6] A secondary issue related to the survey coverage is the survey's choice of sample.

The allocation of investment in the capital flow table is on a use basis, not an ownership basis. This distinction is most important in the case of operating leases.[7] The capital flow table assigns capital acquired under an operating lease (such as airplanes, automobiles, computers, rail cars, and structures) to the industry of the lessor. Most of the survey data for investment report capital leases as purchases of capital by the using (lessor) industry already.

Another problematic area for compiling investment data is capitalized versus expensed software. Though software has been treated as investment in the U.S. National Income Accounts

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[6] This problem is investigated and an adjustment is proposed in Becker, et al. (2004) for the Annual Capital Expenditures Survey (ACES).

[7] An operating lease is a lease for which the lessee acquires the property for only a small portion of its useful life. An operating lease is commonly used to acquire equipment on a short-term basis. A capital lease, on the other hand, is a lease that meets one or more of the following criteria, meaning it is classified as a purchase by the lessee: the lease term is greater than 75% of the property's estimated economic life; the lease contains an option to purchase the property for less than fair market value; ownership of the property is transferred to the lessee at the end of the lease term; or the present value of the lease payments exceeds 90% of the fair market value of the property.

and I-O tables since 1999, many firms do not actually capitalize all software and instead treat it as a current expense. For example, the Annual Survey of Manufacturers asks for capital expenditures on "computers and peripheral data processing equipment" which leaves it unclear whether software is to be included. Own-account software and construction are investment spending performed by a firm's own employees.

Finally, BEA is interested in how reliance on more frequent but less comprehensive data will affect the quality of the annual capital flow table. BEA will compare the annual data with more detailed, but less timely data, for unusual trend lines and data inconsistencies which might indicate errors. BEA will use the detailed establishment-based data collected by the Economic Census to provide best levels, and data from the enterprise-based Annual Capital Expenditures Survey and other annual surveys to provide best changes. BEA will also use Census data to disaggregate values in the annual survey data. For example, annual data on capital purchases may be broken down into purchases of new and used structures and equipment based on the results of the more detailed Census.

3. Data Sources for Industry Investment in Equipment, Software and Structures. The construction of an annual capital flow table will rely heavily on industry investment data from a variety of surveys, mostly from the U.S. Census Bureau. The surveys discussed in this paper, taken together, can provide investment data on the entire set of private sector industries. While no single survey serves as the best source of data for every industry, information from the various surveys can be combined and reconciled to provide a comprehensive estimate of equipment, software and structures investment by industry.

Among the most prominent surveys to be used are the Annual Capital Expenditure Survey (ACES), the new Information and Communication Technology Survey (ICT), the Annual Survey of Manufactures (ASM), the Economic Census, including the Business Expenditure

Survey (BES), and the Value Put in Place (VPIP). Other industry specific surveys will provide valuable source data in their individual industries of focus. The Economic Census (EC), conducted every five years will provide benchmark best levels for many industries.

Each survey has its own particular instructions, methods of estimation, definitions and system of industry classification. Therefore, each survey comes with its own set of strengths and weaknesses for the purpose of compiling annual time series of industry investment. The following sections will describe briefly the individual surveys we plan to use. There is also information in Appendix A which will summarize relevant facts about each survey.

3.1 The Annual Capital Expenditures Survey. The Annual Capital Expenditures Survey (ACES) is an annual survey which measures capital spending by private enterprises. Every five years, the Census conducts a more detailed version of the ACES.[8] The survey has broad coverage and includes: capital leases, capitalized software (including own-account software, custom software and purchased software), own-account construction, and data for non-employers. The ACES identifies capital expenditures for new and used structures and equipment separately.[9] The major drawback of the ACES is that it collects information on an enterprise basis instead of on an establishment basis. This leads to the problem where a company may be producing goods and services in a dozen or more industries, but only report investment in four or five industries. Since the capital flow table is published on an establishment level, it would be desirable to convert the ACES data from an enterprise to an establishment basis. Despite its drawbacks, the

[8] The more detailed version of ACES collects data from a larger sample, and also collects information on the types of assets purchased, by fairly broad categories. The most current detailed year for the ACES is 2003.

[9] By definition, the capital flow table is an account of new purchases of equipment, software and structures. Flows of used goods are represented in the broader I-O framework, but the capital flow table does not show sales of used goods between industries, or between private industries, consumers and government.

ACES is the only survey that covers investment expenditures for all private industries on an annual basis.

Comment [DSM1]: Need discussion of how expensed software and computer equipment are treated. Also, could use more discussion of what kind of detail is available for non-employers.

3.2 Information and Communication Technology (ICT) Survey. This new survey complements the Annual Capital Expenditure Survey (ACES) with data on expensed purchases of information and communication technology equipment and software that are excluded from ACES. It will become an important annual source for the capital flow tables in identifying and allocating software, ICT equipment, and certain medical instrumentation across industries. As with the ACES, the data are collected at the enterprise level.

3.3 The Annual Survey of Manufactures (ASM). The Annual Survey of Manufactures (ASM) will play a major role in the derivation of industry investment totals for manufacturing. It is establishment based, and provides information on total capital expenditures, total expenditures on buildings and other structures, and total expenditures on machinery and equipment. The ASM publishes estimates at a fairly detailed industrial level.

It should be noted that the ASM no longer breaks building and machinery estimates out to new and used capital expenditures, as they did in 1996 and earlier years. Though not published, the ASM on its long form requires respondents to break down their capital expenditures by automobiles, computers and peripheral data processing equipment, and all other expenditures for machinery and equipment.[10] These unpublished data may be obtained from the Census and used to further allocate assets to industries.

3.4 The Service Annual Survey (SAS). The Census Bureau's Service Annual Survey is an annual survey of firms operating in the service sector. The primary data presented in the survey are revenue and expense estimates. Census reports the data at a very detailed industrial level.

[10] Beginning in the 2003 ASM, Census will report these estimates, according to Mendel Gayle of the Census Bureau.

The data are gathered using a sample from the Business Register[11] and so Census determines the classification of individual establishments. Since each company must report data for all their establishment locations, the survey can be considered establishment based.

Comment [DSM2]: Is this really true?

Data on investment are not currently collected in this survey, though BEA would treat certain expense line items in the survey as capital purchases. Thus, the best use of SAS data may be as column controls for capital expenses for certain commodities.

3.5 The Economic Census and Business Expenses Survey. While the Economic Census (EC) covers all employer establishments in years ending in 2 and 7, total capital expenditures are collected for mining, manufacturing, and construction only. While these data are collected only for broad categories, since they are collected on an establishment basis they can play a useful role in cross-checking the more detailed ACES asset expenditure data.

The Business Expenses Survey (BES) is a supplement to the Economic Census that is collected in Census years to provide operating expense estimates for most service sector industries. BES also collects information on expensed purchases of custom software and expensed purchases of computer hardware and prepackaged software. The survey also provides separate rental payment totals for buildings and for equipment and machinery.

3.6 Census Value of Construction Put in Place. The value of construction put in place (VPIP) data produced by the Census Bureau are classified by type of project based on the end usage of the project. Projects are classified as privately owned or government owned. The distinction is made on the basis of ownership during the construction period. The total value-in-place for a given period is the sum of the value of work done on all projects underway during the period, regardless of when work on each individual project was started or when payment was made to the contractors. Estimates are provided for private and public construction, monthly and annually,

[11] The Business Register is a complete list of firms and their establishments, formerly known as the Standard Statistical Establishment List (SSEL).

seasonally adjusted and not seasonally adjusted. The VPIP is the primary source for the National Income and Product Accounts (NIPA) structures estimates.

3.7 Adjustments to the Source Data. This section lists several adjustments to the source data which must be taken to bring the investment controls into consistency with the BEA definition of total investment.

Employee-owned autos. Certain individuals use their autos either wholly or partly for business purposes. We will follow the same procedure used for the benchmark capital flow table to estimate the proportion of expenditures attributable to business use, and add these estimates to the industry investment controls.

Employee-owned trucks. The source data also do not include investment in trucks owned by individuals but used wholly or partly for business purposes. The portion of expenditures attributable to business use are estimated using data from the Census of Transportation Truck Inventory and Use Survey.

Software. Although the ACES has included capitalized expenditures for software since 1995, most software is not explicitly capitalized. Furthermore, neither the ASM nor the Economic Census explicitly include software in capital investment. We plan to investigate the use of the Information and Communication Technology (ICT) survey as a source for data on software expenditures. However, we will need to compare these data to the estimates of software distribution that were made for the benchmark capital flow table, which were made using distributions of employment for specified occupations.

Treatment of Leases. While the ICT is consistent with ACES in its treatment of operating and capital leases, it differs in its treatment of rented equipment in a way that may involve double counting with other data sources, and thus may be a concern for the capital flow table. Rented assets are included with assets leased under operating leases in the ICT. The capital flow tables

separates rented assets from leased assets, attributing rented assets to the rental industry and leased assets to the using industry. The following table outlines the differences in treatment of rentals, operating leases and capital leases between the capital flow table, the Fixed Assets data, and the ACES and ICT.

3.8 Summary of Investment Data Sources for Investment. The previous sections provide some brief information on the various surveys that can be used to estimate annual control totals for investment in equipment, software and structures by industry. Table 1 at the back of this paper summarizes relevant characteristics of each survey, such as the survey frequency, level of industry detail, asset type detail, publication lag, whether the survey is on an enterprise or establishment basis, the treatment of leases and software, whether or not construction is included, and whether or not the survey includes government or government enterprises.

For the purpose of setting best levels of investment, the Economic Census (EC) is probably the best source, although we must still make the adjustments discussed in section 3.7. The only establishment-based source that is available annually, and can be used as a best change measure is the ASM, which is only available for manufacturing. For industries not covered by the EC, and for annual updates for non-manufacturing industries, the ACES must be used. The ACES would be much more useful if the data could be converted to an establishment basis, or corrected for industry truncation. The ICT, BES and the SAS can be used to estimate certain items which are expensed, yet should be counted as investment, such as software, computers and telecommunications equipment. VPIP data can be used for certain structures estimates, but the EC and ACES are closer to the definitions of new structures investment used in the capital flow table.

4. Derivation of Row Totals from the Annual I-O. The annual capital flow table can be viewed as an expansion or elaboration of the private fixed investment column of the annual input-

Comment [DSM3]: Describe here any known weaknesses in the annual I-O database that may raise difficulties.

output use table.[12] The rows of the use table show commodities, and the columns show either the purchasing industries or final demand categories. Total commodity output (the row total) consists of the sum of purchases by commodities by all industries and final demand. Total industry output (the column total) consists of the sum of purchases of other commodities and value added for a given industry. Equipment, software and structures used by industries are combined in this table and shown as sales to the final demand category called private fixed investment.

However, the definitions of private fixed investment in the use table and in the capital flow table are slightly different. The capital flow table shows only new equipment, software and structures; it does not show purchases of used assets. The structures portion of the table includes real estate commissions on the sales of new residential structures only, not on the sale of used residential or nonresidential structures. Finally, the capital flow table does not include purchases of scrap or net purchases of used goods. In contrast, the private fixed investment column of final demand in the use table includes scrap, net purchases of used goods, and real estate brokers' commissions on the sales of used structures.

Table 2 shows the relationship between private fixed investment in the use table and in the capital flow table for 1997. The first column shows the value of private fixed investment in the use table for each category of equipment, software and structures. The third column shows the corresponding value in the capital flow table. The middle column shows the value of transactions in scrap, net purchases of used goods, and brokers' commissions on the sales of nonresidential or used residential structures. For example, the row total for Autos in the capital flow table is $75,148.9 million. This represents the purchases of new autos. Sales of used autos from the business sector amounted to $44,502.5 million in 1997, mostly sales to personal consumption from Automotive equipment rental and leasing (5321). This amount enters the fixed investment column of the use table as a negative number, and so reduces the total value of net purchases of

Comment [DSM4]: Get the table from the benchmark article.

[12] This relationship is illustrated in Chart 1, at the back of this paper.

autos in that column to a value of $30,646.4. Since net sales of used autos are not included in the capital flow table, the total value of autos is larger than in the use table.

5. Data Available for Allocating to Purchasing Industry. This section summarizes the three main sources of information which may be of use for allocating total investment purchases of each commodity to the appropriate using industry. These are: the BLS occupational employment matrix; the detailed ACES; and the Statistics Canada investment data. The BLS occupational matrix is the oldest set of data of the three, and the best understood by BEA personnel. The ACES began in the early 1990s, and there have now been three detailed distributions of asset by industry information published. BEA has not has much experience in working with the Statistics Canada data, but plans to begin a collaborative research project in the fall of 2004.

5.1 The BLS Occupation by Industry Matrix. The Occupational Employment Matrices (OEM) are generated using data from BLS's Occupational Employment Statistics (OES) survey. The OES survey gathers employment and wage data on an establishment basis for all full- and part-time wage and salary workers, excluding the self-employed, owners and partners in unincorporated firms, household workers and unpaid family workers.

The OEM poses several problems for use with allocating investment by asset to using industry. First, there are many disclosure restrictions in the publicly available data. Second, self-employed workers are not allocated to specific industries, but rather are kept in a separate column of the matrix. BLS does provide estimates of self-employed and family workers at either the total industry or total occupation level, but the self-employed must be distributed to industries by assumption (for example, self-employed lawyers are assumed to work in the legal industry). Third, the industry classification system used by BLS is not exactly consistent with NAICS. Fourth, the OEM includes some public employment, in the education and hospitals industries. Finally, for the purposes of compiling an annual capital flow table, the OEM suffers from a lack

of comparability over time. In each release, the industry and occupational categories are revised, sometimes quite significantly. Although BLS periodically estimates a time-series of occupational matrices, these are generally not at the same level of detail as the matrices released every two years, and they are published with a significant lag.

5.2 ACES Distributions. The quinquennial ACES surveys provide detailed information at the enterprise level on the types of structures and equipment purchased by all private nonfarm businesses. Thus, it is probably the best source of comprehensive data for determining the distributions of assets purchases to industries in the U.S.

However, several issues must be addressed in order to use ACES for allocating capital expenditures to using industries. Since the ACES did not switch to NAICS until 1999, the first detailed survey data on a NAICS basis will not be available until 2005 for investments made in 2003. BEA's production of a prototype annual capital flow table for 1998 based on ACES distributions would therefore rely on a concordance between the SIC classification of that year's ACES and the NAICS classification of the annual capital flow table. This short-term problem would eventually be resolved as the NAICS-based ACES data becomes available.

An additional challenge to using ACES to allocate assets to industries is the treatment of expensed software and equipment. Given the importance attributed to this type of investment as an important determinant of industry productivity, accurate measurement of these investments is particularly critical. A capital asset has an expected life of more than one year, and ACES collects information on capital expenditures for new and used structures and equipment that are chargeable to asset accounts for which depreciation or amortization accounts are ordinarily maintained. Equipment and software that are expected to last more than a year but are purchased out of operating expenses are thus out of the scope of ACES. This omission will be largely addressed in the 2003 survey with the inclusion of data on expensed communication equipment

and software on the new ICT survey described in Section 3. For a 1998 prototype table, expensed equipment and software purchases must be estimated using other methods.

The enterprise-based structure of the ACES survey program leads to a substantial area of imprecision in using ACES to allocate assets to industries. In contrast to the ASM, which surveys manufacturing establishments about their capital investments, ACES surveys enterprises, and requires the enterprise to report for all of its establishments in a consolidated form. This may result in firms reporting information for only a few industries. Thus, for example, an automobile manufacturer would attribute investment in its distribution, sales, or transportation branches to the manufacturing industry instead of reporting activity in all of these industries.

Becker et al. also propose a correction for this industry truncation problem that is of potential use for constructing the annual capital flow tables. Working with ACES data at the level of 63 industries and 40 asset types, the authors start by assuming that the Business Register is correct with respect to the industries in which a firm produces output. They then divide the sample of ACES reporters into those that completely match the Business Register (complete reporters) and those that do not. For complete reporters, they calculate a ratio of investment to payroll for each combination of asset and industry. These ratios are then applied to the incomplete reporters in the following way. Each firm's reported capital spending is reallocated across industries using the implied distribution of investment-to-payroll records from the complete reporters. Where the ratio of investment to employment is zero for all industries for a particular firm, they substitute an investment distribution based on the distribution of payroll. The authors do not apply this procedure to investment in cars and light trucks; the challenges associated with their allocation are more likely resolved with a good approach to leased assets. While this matrix developed by Becker, et al. for 1998 can be used by the BEA to adjust ACES data for industry truncation, the underlying issue remains, that investment data collected at an enterprise level are not on the right basis for constructing a capital flow table which is on an establishment definition.

5.3 Statistics Canada's Annual Business Investment Data. Statistics Canada collects finely detailed annual industry and asset data from a broad establishment-based survey program. The published data provide expenditure totals for construction and for machinery and equipment at the level of 200. This survey program separately provides expenditure totals for 161 types of capital assets at the level of 21 broad industries.

Comment [DSM5]: Is it really establishment-based, or is it company-based?

Comment [DSM6]: Is this the actual data publication, or does that have another title?

The published data on the allocation of capital assets by 21 broad industries[13] may be useful directly in allocating equipment to using industries. Further, a comparison can be made between these broad industry distributions and those derived from ACES in order to evaluate industry truncation. A special tabulation of the investment data would be more valuable still, providing a matrix of approximately 161 capital asset types by two- and three-digit NAICS industries. Assuming similarity in industry structure between the US and Canada, this information could be useful as an alternative to the occupational matrix in allocating assets to industry, and as a guide in evaluating inconsistencies between the Census' Annual Survey of Manufactures and the Census' Annual Capital Expenditure Survey.

To this end, a joint research project is planned for Fall 2004 to obtain a detailed Statistics Canada asset-by-industry matrix and work with Statistics Canada economists to evaluate the comparability of these data to those available for the U.S. This involves evaluating the asset classifications as well as the similarity of industry structure between the U.S. and Canadian economies. Particular areas of concern are treatment of leases, expensed equipment and software, and classification of computer-enhanced equipment. If the classification systems and industry

[13] Agriculture, Forestry, Fishing and Hunting, Mining and Oil and Gas Extraction, Utilities, Construction, Manufacturing, Wholesale Trade, Retail Trade, Transportation and Warehousing, Information and Cultural Industries, Finance and Insurance, Real Estate and Rental and Leasing, Professional, Scientific, and Technical Services, Management of Companies and Enterprises, Administrative and Support, Waste Management and Remediation Services, Educational Services, Health Care and Social Assistance, Arts, Entertainment, and Recreation, Accommodation and Food Services, Other Services (Except Public Administration), Housing, and Public Administration

structure are sufficiently similar, a version of the annual capital flow table based on the Canadian allocation of assets to industry could be created. This version could be compared with one based on the modified ACES distributions and one based on the occupational matrix. Alternatively, the Canadian distribution could be used to supplement ACES data for industries that are suspected to have poor asset allocations, such as Wholesale Trade and the transportation industries. Finally, the annual frequency of the Canadian data provides an opportunity to examine shifting patterns in each industry's use of capital assets.

5.4 Summary of Allocation Issues. The published benchmark capital flow tables have up to now used either the occupational matrix or direct allocation. When using occupational distributions, a set of occupations is chosen that is considered to be correlated with the distribution of a certain type of equipment. Certain occupations or sets of occupations are assumed to be good indicators of which industries use a specific type of capital good.[14] For example, machine tools are allocated to industries according to the employment of machine tool operators. This method works best when the occupations chosen are highly relevant to the use of a particular capital good, and the ratios of investment in that type of good to occupational employment in those categories is roughly constant. Of the total value of equipment expenditures in the 1997 capital flow table, 85 percent were distributed using occupational employment. Direct allocation is possible when a certain commodity is so highly specific that it may possibly be used by only one or a small number of industries. Where it may be used by a small number of industries, it is generally distributed using total industry output from the I-O table. As mentioned above, the occupational matrix suffers from lack of consistency of industry and occupational definitions over time. It is available only every two years, but occupational distributions for interim years could be obtained by interpolation.

[14] This is a maintained hypothesis, and has not been tested. This method of allocation has been questioned by several users of the capital flow tables.

In compiling the 1997 benchmark capital flow table, BEA also made use of unpublished industry distributions of assets from the 1998 ACES. This survey was published on the SIC basis, and the conversion to NAICS was not exact. Furthermore, the asset types available from the ACES were less detailed than the commodity level of detail in the 1997 capital flow table. However, these converted ACES distributions were able to serve as a rough check on the distributions derived from the occupational data. In some cases, the ACES and occupational distributions were quite close. In other cases, BEA revised the original occupational distributions to obtain totals by broad asset category more consistent with the ACES.

The Statistics Canada data hold the potential of providing indicators of annual changes in the distribution of assets. The maintained assumptions in this case are: the technology in the U.S. and Canada are similar, leading to a similar pattern of investment; and business cycle and technology changes in the two countries are similar, so that changes in the U.S. can be understood by using the Canadian data. We plan to test these assumptions by comparing the ACES and Statistics Canada distributions for both 1998 and 2003. If time permits, we will also compare these distributions with the biennial occupational distributions, which will provide an independent assessment of the accuracy of the occupational distributions BEA has been using for the historical benchmark capital flow tables.

6. Estimating the Annual Capital Flow Table. The annual capital flow table for each year must ultimately satisfy two constraints. It must sum across the row to the adjusted private fixed investment by commodity from the annual use table. It must sum down the column to the investment totals by industry, which will be derived as a time-series. The process of deriving an annual capital flow table will consist of the following steps:

1. Obtain an initial distribution of asset by type (commodity) to using industry. This may be based on a legacy estimate (1997 capital flow table), the occupation by industry matrix, the ACES, Statistics Canada data, or some hybrid of the above.

2. Derive a set of industry (column) controls, adjusting the raw data source data as described in 3.7.

3. Perform an initial row scaling, and compare the column totals with the column controls. For industries where the two are extremely different, hand adjustments may need to be made to the initial distribution or to the industry controls.

4. Perform a biproportional row and column scaling to bring the matrix into consistency. This is a modified rAs procedure, where higher quality cells are not scaled as much as lower quality cells.

All the above steps except the first follow the procedures used for building previous benchmark capital flow tables. As background work for the 1998 prototype annual capital flow table, we intend to explore the distribution method more thoroughly by making methodical comparisons of the distributions in the occupational matrix, the ACES and the Statistics Canada data, and report on these results.[15]

In step 4, the quality of the distribution of each asset may be assigned based on how similar the asset distributions are between the occupational matrix, the ACES and the Statistics Canada distribution. The normal linear rAs scaling procedure can be modified to adjust cells nonlinearly, based on assigned data quality.

One such method, uses the following scaling formula:

$$T_i = \sum_{j=1}^{m} b_{ij} z_i^{\alpha_{ij}}$$

[15] We also plan to compare our findings with those of Becker, et al. (2004)

where: T is the control total for a row of the matrix

b_{ij} is a typical element of the matrix

z_i is the scaling factor for row i

α_{ij} is the "quality indicator" for b_{ij}, $0 <= \alpha_{ij} <= 1$, where 0 means highest confidence (little scaling), and 1 means minimal confidence (more scaling)

The scaling factor is solved using an iterative technique similar to the simpler form of rAs.[16]

7. Summary, and Plan for a 1998 Prototype Table. In the introduction to this paper we stressed the importance and feasibility of developing an annual version of the capital flow table. In addition to serving as a natural extension to the recently developed integrated time-series of annual I-O tables and GDP-by-Industry, such tables would address many needs and goals for researchers in the field of investment and productivity. Several definitional and classification issues were described in section 2, as a prelude to presenting the data foundation for the three main parts of compiling a capital flow table: the development of time-series of annual industry investment control totals; the linking with the annual I-O tables by adjusting the investment final demand in the use table to include only purchases of new equipment and structures; and the development of distributions of assets to each industry. Finally, we discussed in brief format the methodology for assembling these pieces into a completed table.

In conclusion we discuss some points pertinent to the compilation of a prototype table for 1998. As a prototype, such a table may take many shapes. The easiest and cheapest method would be to approach the 1997 benchmark capital flow table as a set of "legacy" coefficients, and scale it to updated row and column controls. Such a version would not of course be our first

[16] This technique is presented in Almon, et al. (1974), p. 155 in their description of updating an input-output matrix.

choice, but would represent a "naive" update of the 1997 table. A further step would be to use the 1998 ACES asset distributions as hard control totals on groups of commodities in the table. This would impose on the table as much structure as we are capable of deriving from ACES, while maintaining the "legacy" distribution of 1997 capital flows within those more aggregate totals. The two problems we see with this approach are the lack of exactness in SIC to NAICS conversion, and the enterprise definition of the ACES. Becker, et al. were able to obtain access to the microdata underlying the ACES and correct somewhat for the industry truncation problem that arises from using enterprise data, and it would be desirable for BEA to obtain access to that same data, and use the results in a capital flow table. Given that the next detailed ACES will be released for 2003, there remains the question of how to develop annual capital flow tables for the intervening years. One solution would be to use the changing structure of the BLS occupation by industry matrix over time to interpolate between the 1998 and 2002 ACES distributions. However, perhaps a better solution would be to explore the use of Statistics Canada investment data for this same purpose. Our preliminary investigation would explore similarities and differences between ACES, Statistics Canada and distributions that would be obtained from our traditional approach using the occupational data. We envision that that outcome of this study would be a proposed hybrid approach, where the U.S. distribution could be fixed using converted ACES data, and the Statistics Canada data could be used as an interpolator or measure of best change in the industry distributions.

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