Equipment Investment Data and Capital Flow Tables

In LIFT and *Iliad*, Inforum's Models of the U.S. Economy

Douglas S. Meade

Introduction

This paper describes how data on equipment investment is derived for LIFT and *Iliad*, Inforum's models of the U.S. economy. Because these models are used for policy simulation and forecasting, our goal is to relate the demand for Producers' Durable Equipment (PDE)[1] to the growth of industries. Therefore, in these models, the data used is more detailed than the PDE by 25 types of capital goods available from the NIPA. The detail for each type of capital good is expanded by product, 320 for *Iliad*, and 85 for LIFT. Investment by buyer is available in the Inforum models at the level of 55 purchasing industries. Equipment investment by buyer is related to each type of capital good or PDE through a capital flow table. The following sections describe how each of these series are derived in current prices. Then the derivation of constant price investment and PDE is explained. This method is somewhat different from that used currently in the NIPA. The next section summarizes investment in the context of the NIPA and shows some recent behavior and trends in the aggregate data.

Equipment Investment in the National Income and Product Accounts

Equipment investment is an important part of the aggregate economy, probably more than its relative size would indicate. In addition to upgrading and expanding the existing capital stock of the various industries, equipment investment contributes to aggregate final demand. In fact, it is perhaps the most dynamic component of the U.S. economy. Throughout the postwar period, equipment investment has contributed a large proportion of volatility to the economy. Figure 1 shows the percentage change in total equipment investment compared with overall GDP. Equipment investment is extremely procyclical, accentuating the changes in other categories of GDP.

The relative share of equipment investment in GDP has ranged from 5.3% to 8.1 % in current prices, and has lately approached this high point again, reached in the late 1970s. As seen in Figure 3, although there were short periods of strong growth in the mid 1980s and in the early 1970s, the growth in equipment investment has been particularly strong from 1976 to 1979, and from 1991 to 1996.

[1] In this paper, we use the term PDE when discussing equipment investment by type of asset, or by supplying industry. We use the term investment more often when discussing the classification by purchasing industry. In the aggregate, of course, there is no distinction.

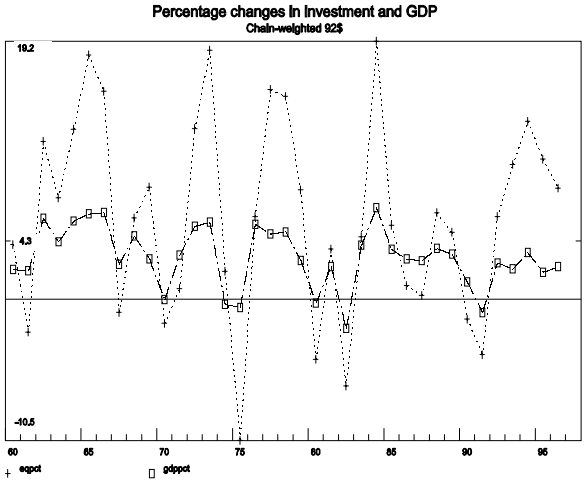


Figure 1

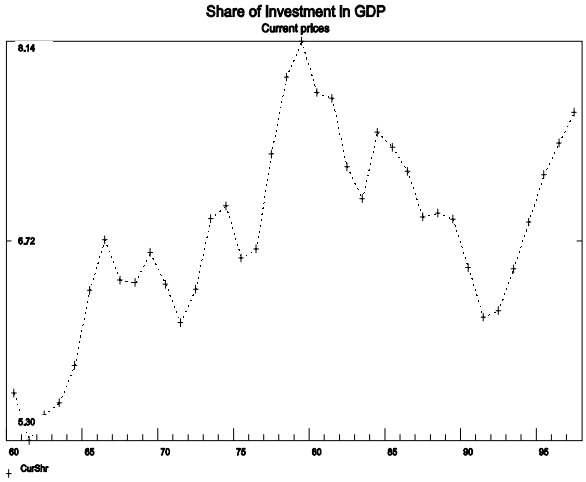


Figure 2

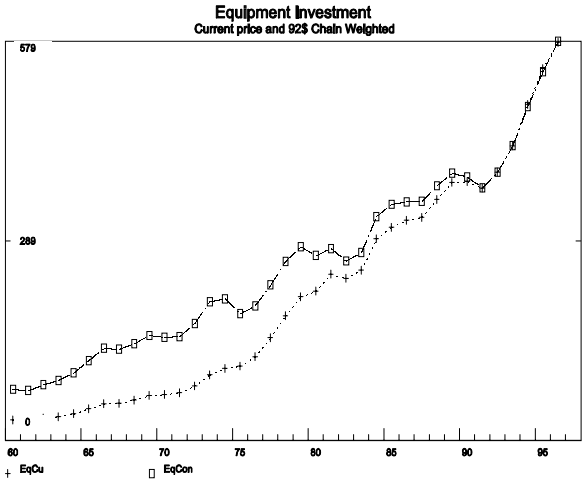


Figure 3

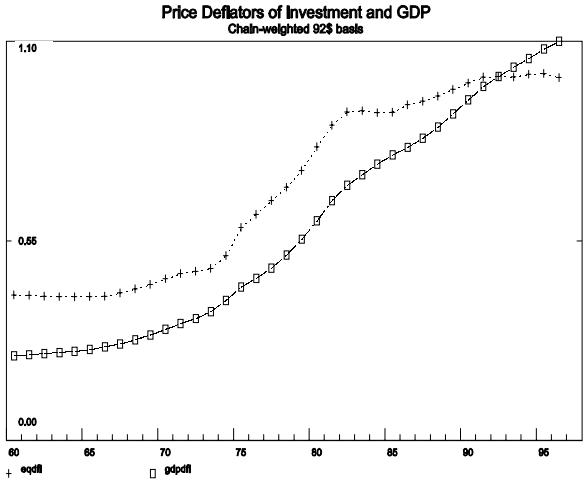


Figure 4

The latter period is interesting because it looks the same in the national accounts data whether it is measured in current or constant prices. During this period, an increasing proportion of investment goods have been in the computers, communication equipment and electronics industries, which have experienced falling prices, according to BEA. Figure 4 compares the growth of the overall equipment investment deflator with the GDP deflator.

Table 1 shows a summary of NIPA tables 5.8 and 5.9, for selected years. The full detail in these tables shows equipment investment in current prices and in chain-weighted 92 dollars for about 25 categories of investment goods by type, in purchasers' prices. The first block of the table shows that by far the fastest

Table 1. Summary of Producers' Durable Equipment in the National Accounts

PDE in Current Dollars	1960	1970	1980	1990	1992	1995	Avg. Growth
Total producers' durable equipment	30208	67525	219762	381165	394735	546085	8.27%
Information processing & related eq	4739	14340	58932	124150	134175	183205	10.44%
Industrial equipment	9313	20181	60402	89759	89317	124494	7.41%
Transportation & related equipment	8509	16242	48385	75536	86168	124891	7.68%
Other equipment	7257	16260	52567	88954	81829	112470	7.83%
PDE in Constant 92 Dollars	1960	1970	1980	1990	1992	1995	Avg. Growth
Total producers' durable equipment	75252	151562	272434	387989	394735	541407	5.64%
Information processing & related eq	2979	10731	45433	116226	134175	201146	12.04%
Industrial equipment	41937	73678	95497	94958	89317	116163	2.91%
Transportation & related equipment	28818	49683	74177	81193	86168	118109	4.03%
Other equipment	31295	57251	82618	93244	81829	105409	3.47%
Implicit PDE Deflator	1960	1970	1980	1990	1992	1995	
Total producers' durable equipment	0.401	0.446	0.807	0.982	1.000	1.009	2.64%
Information processing & related eq	1.591	1.336	1.297	1.068	1.000	0.911	-1.59%
Industrial equipment	0.222	0.274	0.633	0.945	1.000	1.072	4.50%
Transportation & related equipment	0.295	0.327	0.652	0.930	1.000	1.057	3.65%
Other equipment	0.232	0.284	0.636	0.954	1.000	1.067	4.36%

growing category is Information processing and related equipment, which has grown at an average rate of 10.4% over the 1960 to 1995 period, and by 1995 comprised roughly one third of total equipment investment. The period of fastest growth of this Information processing equipment category was actually 1970-1980 (14%, not shown). In 1990 to 1995, the fastest growing category in current prices has been the Transportation category (10%), whereas the Information processing category has grown at about 8%. The deflator for Information processing equipment has been falling throughout the period, at an average of -1.6%, but from 1990 to 1995, it has been falling at -3.2%. This is the result of the use by BEA of an hedonic deflator for many categories of capital goods, which is an attempt to define quantity in terms of the characteristics of the capital goods. From 1980 to 1995, this deflator indicates that the prices of Information processing equipment fell by 40%.

Inforum has long taken the position that the computer deflator should be kept at a value of 1.0, not necessarily because we really think it should be constant, but because we think the BEA deflator declines too quickly. Before chain-weighting was adopted as the preferred means of presenting constant price aggregates, the extra growth in real GDP contributed by the falling computer deflator was significant, and

when the current year was very far from the base year of the deflator, computers seemed to comprise too large a proportion of total GDP and of total investment. We shall see at the end of this paper what the constant computer deflator implies for the constant dollar investment series developed by Inforum, compared to the numbers we have just seen from the NIPA.

As described below, Inforum uses the NIPA tables in current prices as a control on the estimates of PDE by detailed industry. Note that each type of PDE in the NIPA is "net purchases of new and used PDE", and this needs to be reconciled with PDE derived from shipments data, which are for new goods. Also, the NIPA table includes both residential and non-residential PDE, but the equipment investment data derived by Inforum includes only non-residential investment. BEA derives their PDE data in non-benchmark years by an abbreviated commodity-flow method, whereby shipments data are obtained for each type of capital good, and then adjusted by Census data on exports and imports to estimate domestic supply. The commodity-flow technique uses ratios for each good to determine what share should be allocated as PDE. BEA deflates the domestic components with the PPI, with a few exceptions, and deflates the imported components with the BLS import price indexes, except for computers and transportation equipment.

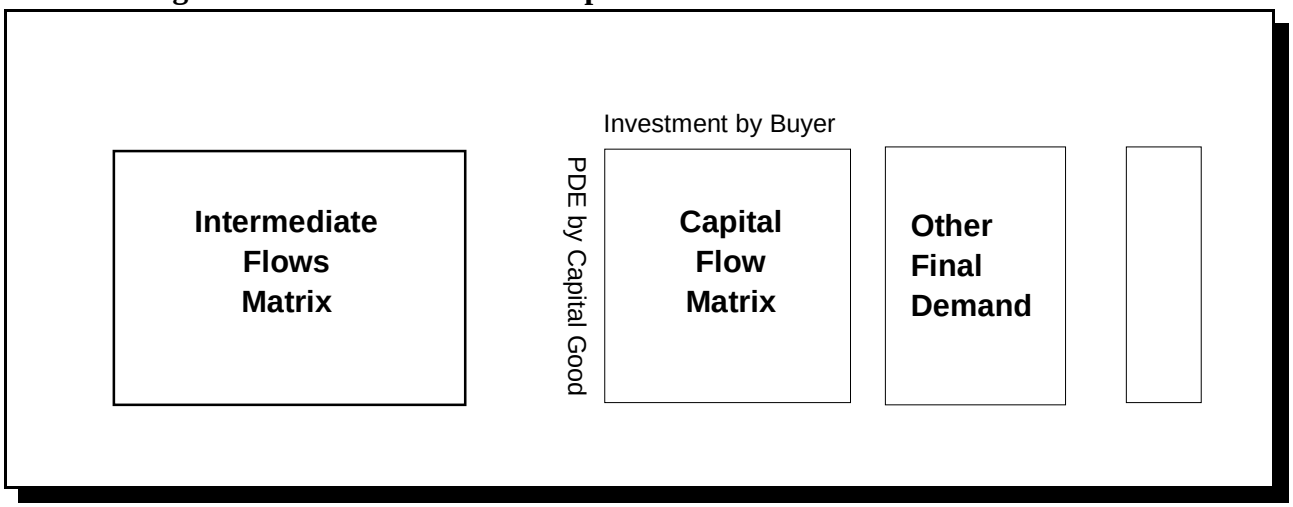
The Framework of Equipment Investment in an Inforum Model

Before discussing the development of the equipment investment data, it is useful to know how equipment investment works in a standard Inforum model, such as LIFT or *Iliad*. Figure 5 contains a schematic diagram of the capital flow table, within the context of the standard input-output tableau. This tableau shows output on the right as the sum of intermediate demands for each product as shown in the intermediate flows matrix, equipment investment demands, as shown in the capital flow matrix, and other final demand. Note that equipment investment is part of final demand, *not* intermediate demand. Even though equipment is used as an input to production, it is not used up within the current year, and so is not counted as an intermediate input. The rows of the capital flow matrix indicate producers' durable equipment (PDE) by commodity or asset type, in producers' prices.[2] The columns of this matrix indicate users or purchasers of equipment investment goods. Therefore, for any given year, the capital flow matrix shows the amount of a certain type of capital good purchased by a given industry. When the capital flow matrix is normalized, so that its columns sum to 1.0, then it is called a "B-matrix".[3] In LIFT, this matrix is currently 85 rows by 55 columns.

[2] Producers' prices do not include wholesale, retail and transportation margins, which are the extra costs necessary to bring the good to the final user. Therefore, the capital flow table also includes values in these rows for the margins incurred in the purchases of equipment investment goods.

[3] This name, like the "A-matrix" for the direct requirements matrix, has no special meaning, but has taken hold solidly in the input-output literature.

Figure 5. The Context of the Capital Flow Matrix within the I-O Tableau



In *Iliad* it has 320 rows and 55 columns. Of course, the matrix is rather sparse, having entries mostly in those rows which sell equipment investment goods, or trade and transportation margins on those goods. In a simulation of the LIFT or *Iliad* model, investment by the 55 purchasing industries is first forecast using the equipment investment equations. These purchases are then passed through the B-matrix to obtain an estimate of PDE by product. This PDE is the equipment investment component of final demand, which is then used in the input-output solution to obtain an estimate of output.

The last capital flow matrix published by BEA was for 1977. We have obtained an unpublished matrix for 1982, but no matrix is available for 1987. The following sections describe how the row totals (PDE) and the column totals (investment by industry) are derived, and then how a time series of capital flow matrices is obtained by balancing. Finally, the method of obtaining constant price PDE and investment is described.

Obtaining Estimates of Producers' Durable Equipment by Product in Current Prices

This section describes how Inforum derives a time-series of PDE by product that is consistent with the NIPA data on PDE by type, although Inforum develops the PDE data at a much greater level of detail. Manufacturing PDE is derived from adjusted product shipments, while the few non-manufacturing PDE sectors are estimated from other sources. Margins, which account for the costs of distribution and transportation, are added to these initial estimates, to obtain a value of investment by purchaser in purchasers' prices, the same valuation which is used in the NIPA.

The basis for most of the PDE series is the manufacturing product shipments data compiled in the Census Bureau's *Census of Manufactures* (CM) and *Annual Survey of Manufactures* (ASM). Inforum has combined

these data sources to produce a time series of product shipments data by 5-digit SIC, that currently exists for the period 1958 to 1995[4].

This time series of shipments is adjusted to estimate a time series on domestic supply of each commodity, by adding imports, and subtracting exports and excise taxes. From the benchmark I-O table for 1987 are available two files which show the domestic final demand by PDE and by Personal Consumption Expenditures (PCE) by specially defined BEA SIC codes. A process of matching these "SIC" codes to the 5-digit SIC codes used by Inforum is performed, so we can develop ratios at this detailed level of the share of PDE to domestic supply. After this, both the product shipments and the I-O data are aggregated, and a table of ratios is constructed which shows the percentage of total domestic use that goes to either PCE or PDE, for 320 *Iliad* commodities. Within these 320 commodities, there are quite a few which are either mostly PDE, or mostly PCE. Others, such as Motor vehicles, are split between these two and other categories, such as government purchases or inventory change.

A first estimate of PDE (and PCE) in current and constant prices is obtained by using these ratios to split out a constant share of domestic use, derived from product shipments as described above. This is similar to the BEA commodity flow approach. In the 1987 benchmark table, there are also four non-manufacturing

Table 2. PDE Producers' Value, Margins, and Purchasers' Value for Selected Commodities

		Producers' value	Rail	Truck	Water	Air	Wholesale	Retail	Purchasers' value
169	Construction machinery and equipment	7991.5	11.2	187.7	60.3	45.3	1455.2	245.1	9996.3
191	Packaging machinery	6082.8	0.4	18.3	2.2	16.5	289.7	0	6409.9
198	Electronic computers	16014.3	0.3	4.1	0.5	9.1	2526.7	329.8	18884.8
199	Computer peripherals	13124.6	0.2	5.2	0.6	53.9	2721.6	167.3	16073.4
219	Telephones, switchboards, modems, faxes, etc.	13488.8	0.8	22.7	0.3	70.4	806.9	0	14389.9
220	Radio & TV and communication equipment	7753.6	0.2	4.4	0	30.2	391.4	0	8179.8
233	Motor vehicles and passenger car bodies	62227.6	679.1	912.3	12.3	0	2535.4	2288.1	68654.8
235	Aircraft	8556.8	0	1.5	0	2.3	127.4	0	8688.0
246	Search and navigation equipment	10414.9	0	6.3	0.7	6.6	66.2	0	10494.7

[4] The Inforum time series of 5-digit product shipments data is not the same list of 5-digit industries available in the current ASM. It is instead a list of 5-digit categories so defined as to enable a continuous time series during this period, but still based in the 1987 SIC classification.

sectors that supply PDE demand. These are Other non-ferrous ores (13), Crude oil extraction (16)[5], Computer and data processing services (289) and Engineering and architectural services (295). For these industries, esimates of output are adjusted by exports and imports, and a series of PDE is estimated in the same manner as for the manufacturing industries.

The initial estimates are for new PDE by product, valued in producers' prices (the value from the factory). In order to relate these estimates to NIPA PDE by type, we need to account for the following:

1. The costs of transportation and distribution, called the trade and transportation margins.
2. Purchases of used equipment as well as sales of used equipment and scrap. Purchases of new equipment is the initial estimate, while *net* purchases of new and used equipment is the NIPA concept.
3. The estimates by 320 products must be related to the 25 categories of PDE by type in the NIPA.

Also, a weakness of the ratio approach for commodities such as motor vehicles, is that this is a large item in both personal consumption and equipment investment and the share of consumption and investment will be changing from year to year. Information from the NIPA can be used to help determine the amount of production going to PDE of motor vehicles.

So, the main task in this next step is two use two sources of information from the benchmark I-O table to adjust the detailed PDE series to be consistent with the NIPA. The first source is the summary of the PDE workfile, which shows the PDE from each industry in producers' prices and in purchasers' prices, with each of the transportation and trade margins also identified. A sample of a few rows of this file are shown in Table 2. For example, this file shows that the difference between the total producers' value and purchasers' value for construction equipment in 1987 was $2004.8 million (9996.3 - 7991.5), and that the two largest components of this were the wholesale and retail trade margins.

Another file, called the PDE-NIPA bridge, shows the relationship between purchasers' value PDE in the workfile to the 25-category purchasers' value PDE in the NIPA. A sample of this file is shown in Table 3. This indicates, for example, that in 1987 from the *Iliad* industry Farm machinery and equipment (167), $2011.9 million was in the Tractors category, $4155.8 million in Agricultural machinery, and $865.4 million in Other nonresidential equipment. The ratios at the right indicate the share of the respective industry of the respective NIPA category.

Margin flows for each PDE category are estimated for each year by using the 1987 ratios of margins as a share of producers' value, but adjusting for changes in relative prices, so that the margin ratios are roughly constant in real terms. The PDE in producers' values and associated margins are scaled to be consistent with

[5] It is not the commodity crude oil which is counted as equipment investment, but rather the capitalized exploration activities.

Table 3. Sample of PDE-NIPA Bridge for 1987

166	Internal combust engines, n.e.c.		
7	Engines and turbines	876.6	0.349395
	TOTAL IO	876.6	
167	Farm machinery and equipment		
18	Tractors	2011.9	0.313815
19	Agricultural machinery, except tractors	4155.8	0.812946
24	Other nonresidential equipment	865.4	0.071815
	TOTAL IO	7033.0	
168	Garden tractors and lawn & garden equip		
18	Tractors	2694.6	0.420312
19	Agricultural machinery, except tractors	36.4	0.007128
24	Other nonresidential equipment	3140.9	0.260652
	TOTAL IO	5871.9	
169	Construction machinery and equipment		
10	General industrial, including materials handling, e	43.9	0.002410
18	Tractors	1647.0	0.256895
20	Construction machinery, except tractors	8305.4	0.942301
	TOTAL IO	9996.3	
170	Mining machinery and equipment		
21	Mining and oilfield machinery	668.7	0.543180
	TOTAL IO	668.7	

NIPA PDE in purchasers' values by scaling to the NIPA PDE for that year, estimating a new PDE-NIPA bridge for that year (at the *Iliad* level) so that the column totals equal the published PDE from the NIPA. The row totals of this bridge are then the estimated PDE in purchasers' values for that year. Margins are split out by the estimated margin ratios, and accumulated into the trade and transportation industries. When this process is complete, a current price series of PDE at the *Iliad* level is available which is consistent with the PDE categories published in the NIPA.

Obtaining Real PDE by Product

As described above, the estimate of PDE by commodity is derived by estimating total domestic supply by commodity, and then allocating a certain proportion of this total supply to PDE. The deflation of PDE depends on the sources of supply. Deflators for domestic supply are derived from 5-digit SIC product deflators that are also used by BEA in its work on Gross Product Originating (GPO). Imports deflators are derived largely from BEA end-use deflators, supplemented with BLS import price indexes, and with foreign price indexes from the Inforum International System.

To obtain 1987 dollar PDE, product shipments, imports and exports in 1987 dollars are first used to obtain domestic use in 1987 dollars, and a series of 1987 dollar PDE is obtained using the PDE ratios described above. The ratio of current over constant price PDE is then used as a PDE deflator, to deflate the PDE which has been brought into consistency with the NIPA. Margin sectors are deflated with separate output deflators for those industries.

The Development of Equipment Investment Data by Purchaser

Parallel to the process of developing PDE data is the task of developing the equipment investment data by purchaser. These data are first collected in current prices, and then the total for all industries is adjusted to sum to the NIPA non-residential equipment investment control total.

The list of Inforum equipment investment purchasing industries is shown at the back of this paper as Appendix A. Of these 55 industries, 32 of them are manufacturing industries. As shown in table 4, manufacturing investment now comprises on 18% of total equipment investment, down from about 27% in 1967. However, it is also the sector of the economy with the best data available.

For the manufacturing industries, Inforum has compiled a time series from 1958 to 1995 of equipment investment by detailed industry. In Census years, this data is from the *Census of Manufactures* (CM)[6], and from the *Annual Survey of Manufactures* (ASM)[7] for intervening years. However, the level of detail available for different periods is not the same, and moreover, some changes in the SIC code have necessitated concordance changes at even the 3-digit level. For this reason, the data for each subperiod is aggregated to the 55-sector level using a different concordance[8].

For the nonmanufacturing industries, Inforum starts with the investment series that are compiled by BEA as

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[6] *Industry Series*, Table 3b: "Gross Book Value of Depreciable Assets, Capital Expenditures, Retirements, Depreciation and Rental Payments".

[7] *Statistics for Industry Groups and Industries*, Table 5, "Capital Expenditures for Plant and Equipment for Industry Groups and Industries".

[8] The subperiods are: 1958-62, 1963-66, 1967-76, 1977-86 and 1987-95.

Table 4. Summary of Current Price Investment by Purchaser

	1958	*1967*	*1977*	*1982*	*1987*	*1992*	*1994*
Total for all industries	**25400.0**	**54404.0**	**151061.0**	**238549.0**	**329106.0**	**394735.0**	**494012.1**
Agriculture, mining, construction	6400.6	11699.3	36945.6	41835.5	48361.7	48738.6	65407.1
Non-durable manufacturing	2458.4	6380.3	16866.5	23891.3	25826.4	40324.4	41925.6
Durable manufacturing	3338.8	8551.2	19460.6	28978.7	34251.1	38347.9	48650.1
Transportation	2003.3	6861.9	15343.3	23095.4	30310.0	40568.2	39878.8
Utilities	4086.0	6795.7	20109.8	35903.1	56863.9	60159.0	79769.5
Wholesale & retail trade	3496.6	6399.9	19248.5	36711.1	48014.0	89300.3	117197.3
Finance,insurance,real estate	1152.5	2050.5	9501.2	19910.0	36443.8	34464.3	49874.3
Services	3263.8	7961.2	20224.3	37575.0	66529.1	70797.3	93397.4
Sales of used equip	-800.0	-2296.0	-6639.0	-9351.0	-17494.0	-27965.0	-42088.0

part of the capital stock study, published periodically in the *Survey of Current Business.* There is also a large book describing the collection and compilation of this data entitled *Fixed Reproducible Tangible Wealth in the United States.* This study has especially good detail in the transportation and service sectors of the economy. These time-series on investment in the nonmanufacturing industries is forced to pass through benchmark capital flow tables for specified years, as described below.

The Inforum equipment investment series by purchaser must be consistent with the NIPA, and at the same time be as consistent as possible with the column totals of the published capital flow tables. These published column totals are available for 1958, 1963, 1967, 1972, 1977 and 1982. These have been aggregated or disaggregated where necessary to conform to the industry definitions of the 55 Inforum sectors. Although the capital flow tables are compiled with a considerable lag (we were only able to obtain the 1982 table in 1994!), they are still sometimes subject to revisions of equipment investment in the NIPA. Therefore, the total equipment investment benchmarks from the capital flow tables must be scaled slightly to bring them into consistency with the NIPA. When this is finished, the six historical capital flow table totals serve as benchmark points, through which the current price investment series must pass.

The next step is then to benchmark the raw data series through the benchmark points. Figures 6 to 9 below may help to illustrate this procedure. In these graphs, the solid line indicates the raw data series, or "mover" series, from the BEA capital stock study. The "+" signs indicate the benchmark data points. The final benchmarked data series is shown with the dotted line. The algorithm used in benchmarking is to preserve the growth rate of the "mover" series as closely as possible, while constraining the final series to pass through the benchmark points[9].

Now, for the non-benchmark years, investment by industry is made consistent with the NIPA First we defeine *net* purchases for the sector Scrap, secondhand and used (55) to be equal to the difference between total

[9] This is handled using the @bmk() function in G.

investment and new investment in the NIPA table 5.8. Note that this value will be negative because sales are greater than purchases, mostly sales of autos by the auto leasing industry to Personal Consumption. The rest of the sectors are then scaled equally so that they sum to the total investment figure in the NIPA. A summary of the resulting data is shown in table 4.

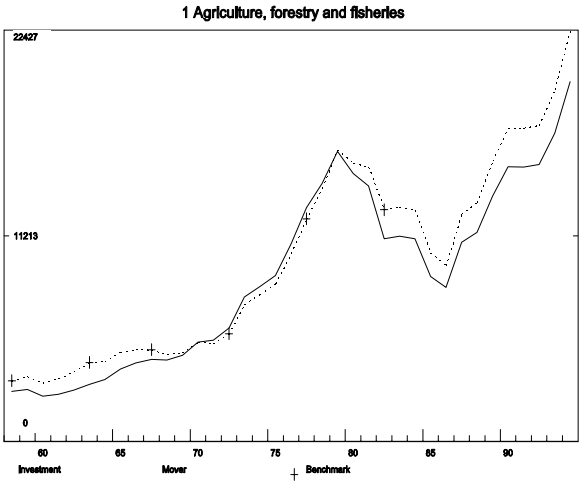
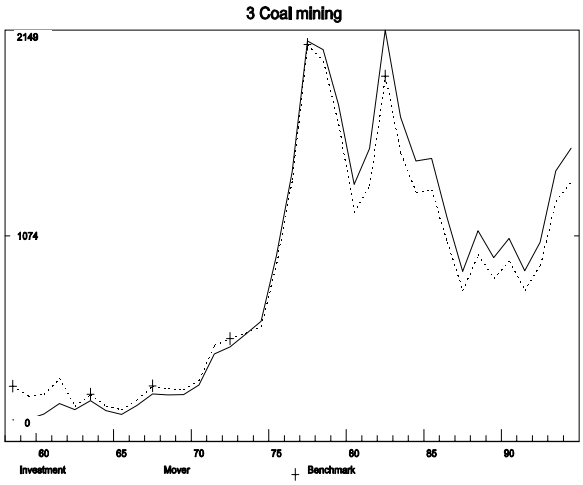


Figure 6



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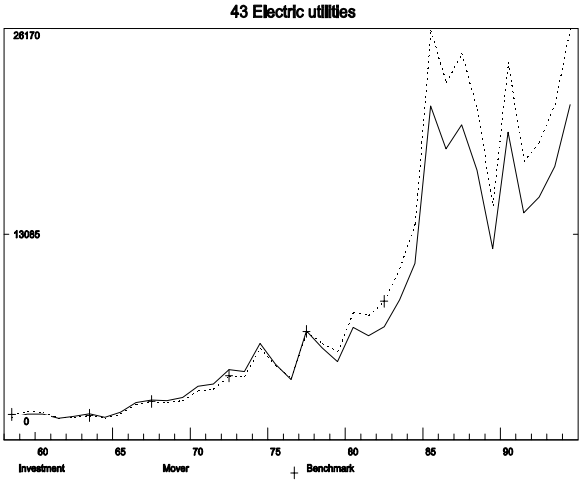


Figure 8

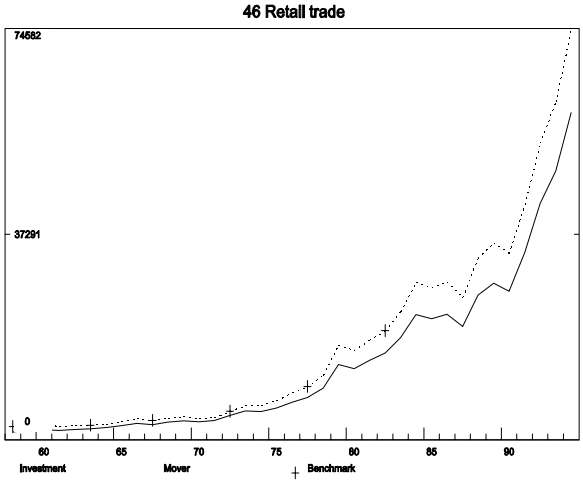


Figure 9

Table 5. Top 10 Flows in Capital Flow Matrix in 1982 and 1994

Listing of flows in the 1982 capital flow table, sorted by size:

Flow	Selling industry		Buying industry
9470.3	233 Motor vehicles and passenger car	45	Wholesale trade
8861.7	219 Telephones, switchboards, modems	42	Communications services
6727.5	167 Farm machinery and equipment	1	Agriculture, forestry and fisheries
4681.7	235 Aircraft	40	Air transportation
4194.4	233 Motor vehicles and passenger car	46	Retail trade, restaurants & bars
3923.1	169 Construction machinery and equip	6	Construction
3854.4	270 Telephone and telegraph	42	Communications services
3849.0	275 Wholesale trade	54	Educational and social services and n
3363.1	233 Motor vehicles and passenger car	41	Trucking and other transport
2906.3	276 Retail trade	48	Real estate and rental

Listing of flows in the 1994 capital flow table, sorted by size:

Flow	Selling industry		Buying industry
28994.5	233 Motor vehicles and passenger car	45	Wholesale trade
22382.0	233 Motor vehicles and passenger car	46	Retail trade, restaurants & bars
14870.3	219 Telephones, switchboards, modems	42	Communications services
11515.5	275 Wholesale trade	54	Educational and social services and n
9914.0	167 Farm machinery and equipment	1	Agriculture, forestry and fisheries
9170.0	169 Construction machinery and equip	6	Construction
8484.6	249 Surgical and medical instruments	53	Health services
8474.2	275 Wholesale trade	46	Retail trade, restaurants & bars
7771.6	276 Retail trade	48	Real estate and rental
7717.3	233 Motor vehicles and passenger car	6	Construction

The Balancing of Capital Flow Matrices

So far, we have explained the derivation of controls for PDE by product, in current and constant dollars, and the derivation of controls for investment by purchasing industry in current dollars. This section discusses the derivation of a time-series of capital flow tables, which describe the product composition of investment by industry. This product composition of each industry will be used to derive the constant price equipment investment data by purchaser.

It is unfortunate, but the most recently available capital flow matrix from BEA is for 1982. This matrix is

Table 6. Summary of 1987$ Investment by Purchaser

	1958	*1967*	*1977*	*1982*	*1987*	*1992*	*1994*
Total for all industries	**77356.0**	**150015.8**	**235744.1**	**263526.9**	**329105.8**	**359036.1**	**447495.9**
Agriculture, mining, construction	20588.6	33777.3	58581.8	45463.3	48361.4	41843.1	53787.3
Non-durable manufacturing	8899.7	18825.8	26786.7	26595.2	25826.1	37064.7	38177.1
Durable manufacturing	11574.7	25670.7	30900.0	31392.4	34250.6	35167.8	44449.2
Transportation	6416.4	21003.0	25315.6	26009.7	30310.3	33974.0	33003.0
Utilities	11701.5	17619.7	30590.6	39883.9	56865.2	54965.0	71049.0
Wholesale & retail trade	9226.1	15640.2	29761.5	41346.7	48013.9	83417.2	107886.6
Finance,insurance,real estate	3036.3	4633.6	14309.5	21749.2	36443.8	35099.5	50860.6
Services	8989.9	19960.3	31292.1	41681.2	66528.9	63722.5	82214.8
Sales of used equip	-3077.2	-7114.8	-11793.7	-10594.7	-17494.3	-26217.7	-33931.7

rather sparse, and a few large flows constitute the bulk of the equipment investment[10]. Therefore, it is advantageous to use the information in the benchmark table as a starting point, and then perform a row and column balancing procedure in each year to conform with the time series of PDE on the row totals, and equipment investment by buyer on the column totals. The procedure used to do this is the well-known *rAs* balancing technique. The method is so called, because given a starting matrix **A**, the method is equivalent to finding diagonal matices *r* and *s* such that the matrix *r***A***s* has the required row and column sums (PDE and investment controls in this case). In practice, this is implemented by scaling the rows and columns iteratively to the controls until convergence within a certain tolerance is achieved. Problems can arise in certain large cells, where the PDE data is not consistent with the investment data by purchasing industry. For example, most of the aircraft are sold to the airline industry. Likewise, most of the airline industry's investment is comprised of purchases of aircraft. If the data on purchases of investment are significantly larger than aircraft PDE, we would need to review these data estimates.

The balancing was done for each year in a stairstep fashion. First the 1982 benchmark table was scaled to equal the controls consistent with the latest NIPA. Then the balanced 1982 table was taken as the starting point for the 1983 balancing, the 1983 table for the 1984 balancing, and so on. This procedure has been carried forwards to 1994, and backwards to 1958. To obtain an idea of how much the relative sizes of the cells change with the annual scaling, see table 5, which contains a comparison of the ten top-ranked cells in 1982 and in 1994. Although relative positions have changed slightly, 8 of the top 10 flows in 1982 are still in the top ten in 1994.

[10] In 1982, for example, the total equipment investment was $238.5 billion. The *Iliad* capital flow matrix has 17600 (320*55) cells. The top 50 cells contained $110.9 billion, or 46% of total investment.

The 87$ Investment Series

Once these tasks are complete, obtaining the 87$ investment series is comparatively simple. The capital flow matrices obtained in the previous step are deflated across the row using PDE deflators, and the column sums of the resulting constant price matrices are the constant price investment series. This is the series that is used in the estimation of the LIFT investment equations. The constant price matrices are normalized to sum to 1.0 down the column and these serve as a time series of B-matrices for the LIFT model. In the model the B-matrices are used both to calculate PDE from investment, as well as to calculate equipment investment prices by buyer given a vector of output prices. Table 6 shows a summary of the 1987$ investment series, at the same level of detail as table 4.

As described above, there are several differences between Inforum's deflation methodology and that of BEA. BEA adheres to the use of the rapidly falling computer deflator, whereas Inforum assumes a constant deflator for computers. Inforum uses domestic output deflators to deflate the domestic component of PDE, and imports deflators to deflate the import component. The constant price aggregate is formed by simple addition of deflated PDE by industry, whereas BEA is using a chain-weighting approach, presumably using the 25 detailed categories presented in NIPA table 5.8. It is natural to wonder with all the various differences in method between Inforum and BEA in the calculation of constant price investment, how different are the actual constant price investment series?

Figure 10 shows a comparison of the Inforum total investment converted to 1992$ with that published by BEA in the NIPA. Figure 11 shows the implicit deflator of total equipment investment in both the Inforum data and the NIPA. It appears that the historical path of the two deflators is very similar, until about 1982, when the Inforum deflator starts to grow much faster. This is also the period when the BEA computer deflator started to decline drastically, and computers were by this time taking a fairly large share of total

Figure 10

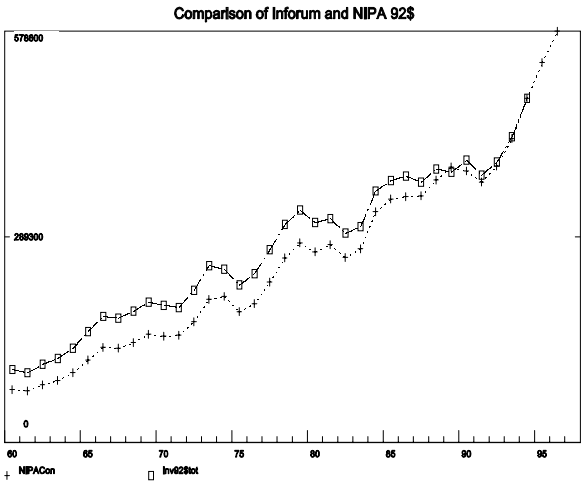
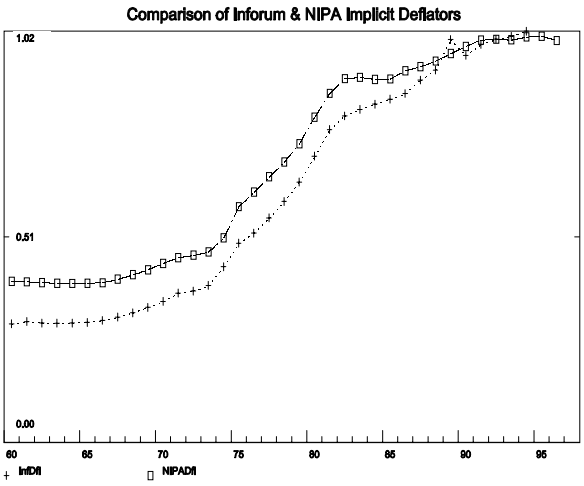


Figure 11



PDE. To put these two figures in perspective, it is helpful to study table 7, which shows the growth rates of the Inforum implicit deflator for total equipment investment, the growth rate of the NIPA deflator, and the growth rate of the NIPA computer deflator. From this table, one comes away with the conclusion that not all of the difference between the Inforum and NIPA implicit investment deflator is computers, although computers seem to be particularly important after 1982. From 1960 to 1974, the Inforum deflator is growing almost 1% faster than the NIPA, when computers comprised less than 3% of total equipment investment, in current prices. From 1974 to 1982, the Inforum deflator is only about .5% higher. However, after 1982, the share of computers is over 10%, the deflator is falling at an average of 13% per year, and the Inforum and NIPA deflators growth rates diverge by roughly 1%. This behavior seems to be well-explained by the difference in the treatment of computers. The period from 1960 to 1974 is more of a mystery, but it may have something to do with the effects of chain weighting.

Table 7. Comparison of Inforum and NIPA Implicit Equipment Investment Deflators

	60-74	*74-82*	*82-90*	*90-94*
Inforum Implicit Investment Deflator	2.81	7.75	2.12	1.52
NIPA Implicit Investment Deflator	1.71	7.19	1.06	0.6
	69-74	*74-82*	*82-90*	*90-94*
BEA Computer Deflator	-4.15	-19.74	-13.89	-13.01
	60-74	*74-82*	*82-90*	*90-94*
Average Share of Computers	0.028	0.049	0.103	0.108

Appendix A. Inforum Equipment Investment Sectors

	Inforum Investment Sector	*SIC*
1	Agriculture, forestry and fisheries	01 to 09
2	Metal mining	10, 14
3	Coal mining	12
4	Crude petroleum and natural gas	13
5	Non-metallic mining	14
6	Construction	15,16
7	Food and tobacco products	20,21
8	Textile mill products	22
9	Apparel and other textile products	23
10	Paper and allied products	26
11	Printing and publishing	27
12	Chemicals and selected chemical products	28 exc. 282
13	Plastics and synthetic materials	282
14	Petroleum refining and related products	29
15	Rubber and miscellaneous plastics products	30
16	Footwear and leather products	31
17	Lumber and wood products	24
18	Furniture	25
19	Stone, clay and glass products	32
20	Primary iron and steel	331,332,339,3462
21	Primary nonferrous metals manufacturing	333,334,335,336,3463
22	Metal products	34, exc. 3462,3463
23	Engines and turbines	351
24	Agricultural, construction & mining machinery	352, 353
25	Metalworking machinery	354
26	Special industry machinery	355
27	General and miscellaneous industrial machinery	356,359
28	Computers and office equipment	357
29	Service industry machinery	358
30	Electrical industrial equipment and apparatus	361,362
31	Household appliances, elec lighting & wiring	363,364,369
32	Audio, video and communication equipment	365,366
33	Electronic components	367
34	Motor vehicles and equipment	371
35	Aircraft and parts	372
36	Ships and other transportation equipment	373,374,375,376,379
37	Instruments	38
38	Miscellaneous manufacturing	39
39	Railroad transportation	40,474,pt. 4789
40	Air transportation	45
41	Trucking and other transport	41,42,44,46,47
42	Communications services	48
43	Electric utilities	491, pt. 493
44	Gas, water and sanitary services	492, pt. 493,494,495,496,497
45	Wholesale trade	50,51
46	Retail trade, restaurants & bars	52-59
47	Finance and insurance	61,62,63,64,67
48	Real estate and rental	65,66
49	Hotels, repairs except auto	72,76
50	Business and professional services	73,81,89
51	Automotive repair and services	75
52	Movies and amusements	78,79
53	Health services	80
54	Educational and social services and nonprofit organizations	82 to 88
55	Used, scrap and secondhand	