(7) $$L = f_L(L_1, L_2, \ldots, L_p)$$

(8) $$M = f_M(M_1, M_2, \ldots, M_m)$$

where $L_i$ is the level of labor services provided by persons in the $i^{\underline{th}}$ skill class, $K_i$ is the level of capital services provided by the capital stock of the $i^{\underline{th}}$ asset class, and $M_i$ is the level of materials services provided by raw materials of the $i^{\underline{th}}$ type.

Homogeneous translog forms of (5), (6), (7), (8) can be expressed by Tornqvist indexes

(9) $$\Delta \ln Q_t = \bar{w}_{Kt} \Delta \ln K_t + \bar{w}_{Lt} \Delta \ln L_t + \bar{w}_{Mt} \Delta \ln M_t,$$

(10) $$\Delta \ln K_t = \sum_{i=1}^{n} \bar{w}_{Kit} \Delta \ln K_{it},$$

(11) $$\Delta \ln L_t = \sum_{i=1}^{p} \bar{w}_{Lit} \Delta \ln L_{it},$$

(12) $$\Delta \ln M_t = \sum_{i=1}^{m} \bar{w}_{Mit} \Delta \ln M_{it}$$

where $\bar{w}_K$, $\bar{w}_L$ and $\bar{w}_M$ are the mean shares of capital, labor and materials services in the value of total input, $\bar{w}_{Ki}$ is the mean share of the $i^{\underline{th}}$ type of capital service in the value of total capital input, $\bar{w}_{Li}$ is the mean value share of the $i^{\underline{th}}$ type of labor service in the value of total labor input, $\bar{w}_{Mi}$ is the mean value share of the $i^{\underline{th}}$ type of raw material in the value of total materials input.

There are special considerations which have to be made in measuring capital input. If all capital items were rented or leased, then the value of rent and lease payments would equal the value of capital input. However, for most business enterprises the vast bulk of capital goods are owned rather than leased. Therefore, the value of capital input must be inferred by constructing the annualized cost of

owning the various types of capital. We follow the methodology developed by Christensen and Jorgenson (1969) in constructing our capital accounts.

We assume that the flow of capital services from each type of asset is proportional to the stock of the asset at the end of the previous period (the beginning of the current period). We denote the factors of proportionality by $q_{Ki}$ and write

$$K_{it} = q_{Ki} K^A_{i,t-1} , \tag{13}$$

where $K^A_{i,t-1}$ is the stock of the $i^{\underline{th}}$ asset type. Substituting (13) into (10) we have

$$\Delta \ln K_t = \sum_{i=1}^{n} \bar{w}_{Kit} \Delta \ln K^A_{i,t-1} \tag{14}$$

since the $q_{Ki}$'s are constants. This shows that the rate of growth of aggregate capital services is a weighted average of the rates of growth of the various types of capital stock. It is incorrect, however, to interpret this as the rate of growth of aggregate capital stock because the weights are relative value shares in the total service flow rather than relative shares in the value of capital stock. This aggregate capital stock can be expressed as a Tornqvist index of its components

$$\Delta \ln K^A_t = \sum_{i=1}^{n} \bar{w}_{Ait} \ln K^A_{it} \tag{15}$$

where $\bar{w}_{Ai}$ is the relative asset share of the $i^{\underline{th}}$ asset class.

The capital service flow from each type of asset is proportional to the corresponding stock. Relations (14) and (15) reveal that the analogous relationship is not true for aggregate capital services. The ratio of aggregate capital services to aggregate capital stock is not constant. It depends on the composition of the aggregate stock. Therefore, it is incorrect to use the aggregate capital stock to

represent aggregate capital services. Let us denote the ratio of capital services to capital stock by $q_{Kt}$ which is potentially different for each time period. Thus $q_{Kt}$ is variable even though each $q_{Ki}$ is a constant. We can write

$$K_t = q_{Kt} K^A_{t-1} \tag{16}$$

The index $q_{Kt}$ can be interpreted as the capacity of the aggregate capital stock to produce capital services. Since $q_{Kt}$ can be written as $K_t/K^A_{t-1}$, we see that it indicates the flow of capital services per unit of aggregate capital stock. Henceforth, when we use the term "composition index of capital," we will be referring to $q_{Kt}$.

Just as it is erroneous to use aggregate capital stock to represent aggregate capital services, it is also erroneous to use aggregate hours worked to represent aggregate labor services. Aggregate hours are computed simply by summing the number of manhours of each type. This means that each hour is given the same weight regardless of skill class. Thus we can write aggregate hours as

$$\Delta \ln L^H_t = \Delta \ln \sum_{i=1}^{p} L^H_{it} . \tag{17}$$

We assume that the flow of capital services per hour is constant for each skill class

$$L_{it} = q_{Li} L^H_{it} , \tag{18}$$

where $q_{Li}$ is the flow of labor services per hour worked by someone in the $i^{\underline{th}}$ skill class.

The Tornqvist index of labor services can be written

$$\Delta \ln L_t = \sum_{i=1}^{p} \bar{w}_{Lit} \Delta \ln L^H_{it} \tag{19}$$

where $\bar{w}_{Lit}$ is the mean share in labor compensation of the $i^{\underline{th}}$ skill class of hours worked. We define the "composition index of labor" ($q_{Lt}$) as the flow of aggregate labor services per manhour $L_t/L_t^H$. Thus we can write

$$L_t = q_{Lt} L_t^H \tag{20}$$

where

$$\Delta \ln q_{Lt} = \sum_{i=1}^{p} \bar{w}_{Lit} \Delta \ln L_{it}^H - \Delta \ln \sum_{i=1}^{p} L_{it}^H . \tag{21}$$

The possible interpretations of $q_{Lt}$ are exactly analogous to those of $q_{Kt}$. It represents the error involved in using aggregate hours as the measure of total labor input.

2.4. Productivity. Substituting (16) and (20) into (9) we have

$$\begin{aligned} \Delta \ln Q_t = {} & \bar{w}_{Kt} \Delta \ln K_{t-1}^A + \bar{w}_{Kt} \Delta \ln q_{Kt} + \bar{w}_{Lt} \Delta \ln L_t^H \\ & + \bar{w}_{Lt} \Delta \ln q_{Lt} + \bar{w}_{Mt} \Delta \ln M_t \end{aligned} \tag{22}$$

Thus the rate of growth of total factor input is composed of five appropriately weighted components: (a) the rate of growth of capital stock; (b) the rate of growth of the composition index of capital; (c) the rate of growth of total hours; (d) the rate of growth of the composition index of labor, and (e) the rate of growth of materials. Combining (22) with the definition of total factor productivity ($A = Y/Q$) we can write

$$\begin{aligned} \Delta \ln A_t = {} & \Delta \ln Y_t - (\bar{w}_{Kt} \Delta \ln K_{t-1}^A + \bar{w}_{Kt} \Delta \ln q_{Kt} \\ & + \bar{w}_{Lt} \Delta \ln L_t^H + \bar{w}_{Lt} \Delta \ln q_{Lt} + \bar{w}_{Mt} \Delta \ln M_t) \end{aligned} \tag{23}$$

## 3. MEASUREMENT OF OUTPUT

The starting point for the construction of an index of real product is the measurement of the value of total product in current prices. Our concept of output is intermediate between gross output at market prices and gross output at factor cost, as these terms are usually employed. We exclude indirect business taxes unrelated to factor outlay, such as retail sales taxes and excise taxes. However, indirect business taxes which are part of the outlay on factor services, such as property taxes, are retained in our gross product measure.[3]

To construct our output measure we start with the value of operating revenues broken down into various categories. The categories used are:

1) Local revenues
2) Toll - interstate revenues
3) Toll - intrastate revenues
4) Directory advertising revenues
5) Miscellaneous revenues

Data for these five revenue categories are presented in Table 1. They are net of sales and excise taxes. However, they include gross receipts taxes, which are indirect business taxes not related to factor input. Furthermore, uncollectible revenues are included in the five categories. It is necessary to subtract gross receipts taxes and uncollectible revenues to arrive at revenues from the producer point of view. Data on uncollectible revenues by output type are not available. We believe the most reasonable assumption is that uncollectible revenues occur proportionately in the five revenue categories. Therefore, we subtract

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[3]These classifications were proposed by Christensen and Jorgenson (1970)

uncollectible revenues and gross receipts taxes proportionately from the five revenue categories. Data for uncollectible revenues and gross receipts taxes are presented in Table 1. Total revenue net of gross receipts taxes and uncollectible revenues is also presented.

The next task is to separate the revenue categories into price and quantity components. We deflate each adjusted revenue category to arrive at real output. The deflators used are rate indexes which are described in detail in the Bell System Productivity Study, 1947-1971.[4] These are based to 1.0 in 1967 and hence outputs are expressed in 1967 dollars. Table 2 gives these five real outputs and their prices. These five outputs are then aggregated using the Tornqvist index procedure assuming the relative rate indexes are equal to the relative marginal costs of producing the outputs. Aggregate output and its deflator are presented in Table 3.

In Table 4 we present the shares of total revenue accounted for by each output in each year. In Table 5 we present the rate of growth of each output type and aggregate output in each year. Tables 4 and 5 also contain the average shares and growth rates over the full sample period 1947-1979 and the subperiods before and after 1961.

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[4]This document was prepared by the Economic Analysis Section of the Comptroller's Office, AT&T. Hereafter it is referred to as BSPS.

Table 1

Revenues, Gross Receipts Taxes and Uncollectible Revenues

(millions of dollars)

| Year | Local | Toll: Interstate | Toll: Intrastate | Directory Advertising | Miscel-laneous | Uncollectible Revenues | Gross Receipts Taxes | Total |
|---|---|---|---|---|---|---|---|---|
| 1947 | 1272.9 | 525.0 | 387.6 | 82.1 | 13.6 | 6.6 | 42.6 | 2232.0 |
| 1948 | 1506.3 | 579.7 | 430.1 | 101.1 | 16.1 | 8.4 | 46.6 | 2578.2 |
| 1949 | 1697.3 | 584.1 | 487.7 | 116.6 | 17.8 | 10.2 | 53.5 | 2839.7 |
| 1950 | 1941.4 | 663.5 | 521.2 | 125.7 | 19.3 | 9.5 | 61.3 | 3200.3 |
| 1951 | 2146.4 | 784.9 | 558.0 | 138.4 | 21.2 | 9.5 | 69.8 | 3569.7 |
| 1952 | 2397.6 | 874.5 | 595.8 | 159.9 | 23.0 | 11.1 | 76.5 | 3963.2 |
| 1953 | 2642.9 | 951.6 | 619.5 | 190.0 | 25.0 | 12.2 | 87.4 | 4329.3 |
| 1954 | 2837.0 | 1050.3 | 670.5 | 215.1 | 26.6 | 14.9 | 93.3 | 4691.2 |
| 1955 | 3086.5 | 1200.4 | 759.3 | 234.7 | 30.3 | 14.0 | 100.7 | 5196.3 |
| 1956 | 3368.6 | 1344.7 | 831.6 | 264.1 | 33.1 | 16.8 | 114.4 | 5710.9 |
| 1957 | 3647.6 | 1466.5 | 891.1 | 294.7 | 36.7 | 22.8 | 122.8 | 6191.0 |
| 1958 | 3944.4 | 1540.6 | 950.0 | 322.3 | 38.3 | 24.3 | 132.4 | 6639.0 |
| 1959 | 4250.8 | 1738.5 | 1047.6 | 340.4 | 40.6 | 25.0 | 142.7 | 7250.3 |
| 1960 | 4547.4 | 1880.0 | 1116.4 | 370.4 | 43.9 | 37.7 | 156.1 | 7764.3 |
| 1961 | 4797.5 | 2046.7 | 1170.6 | 393.0 | 47.1 | 40.5 | 164.5 | 8249.9 |
| 1962 | 5088.5 | 2250.4 | 1221.4 | 408.4 | 50.2 | 38.7 | 167.4 | 8812.8 |
| 1963 | 5389.7 | 2442.3 | 1294.8 | 430.3 | 55.4 | 43.6 | 178.0 | 9390.9 |
| 1964 | 5633.7 | 2709.3 | 1496.2 | 455.5 | 56.0 | 44.7 | 194.8 | 10111.1 |
| 1965 | 5961.3 | 2988.2 | 1625.5 | 478.3 | 59.6 | 51.1 | 208.4 | 10853.4 |
| 1966 | 6354.7 | 3471.2 | 1803.2 | 504.1 | 68.4 | 63.4 | 230.1 | 11908.2 |
| 1967 | 6737.7 | 3815.3 | 1922.6 | 533.5 | 75.4 | 75.4 | 248.5 | 12760.6 |
| 1968 | 7184.1 | 4201.4 | 2139.7 | 567.7 | 81.1 | 74.0 | 290.0 | 13810.1 |
| 1969 | 7774.4 | 4884.6 | 2413.3 | 615.6 | 90.2 | 94.3 | 330.5 | 15353.2 |
| 1970 | 8456.0 | 5179.6 | 2694.5 | 677.9 | 86.9 | 140.0 | 385.5 | 16569.4 |
| 1971 | 9187.0 | 5716.9 | 2933.1 | 713.9 | 114.2 | 154.3 | 430.1 | 18080.7 |
| 1972 | 10362.0 | 6323.5 | 3447.2 | 766.4 | 127.3 | 138.9 | 489.9 | 20397.6 |
| 1973 | 11417.6 | 7269.8 | 4007.8 | 831.2 | 136.0 | 152.4 | 548.5 | 22961.5 |
| 1974 | 12811.8 | 7923.5 | 4536.3 | 912.8 | 158.8 | 191.2 | 609.5 | 25542.5 |
| 1975 | 14026.8 | 8849.4 | 5074.6 | 1008.2 | 182.3 | 214.6 | 673.4 | 28253.2 |
| 1976 | 15607.8 | 10049.1 | 6014.9 | 1141.8 | 200.6 | 226.6 | 763.2 | 32024.4 |
| 1977 | 17069.6 | 11206.7 | 6885.5 | 1314.8 | 229.6 | 262.0 | 844.9 | 35599.3 |
| 1978 | 18743.7 | 12820.3 | 7948.3 | 1531.2 | 300.1 | 342.2 | 945.7 | 40055.6 |
| 1979 | 20271.8 | 14506.6 | 8849.1 | 1810.0 | 409.3 | 459.7 | 965.9 | 44421.2 |

Table 2

Output Price and Quantity Indexes

(millions of 1967 dollars)

| | Local Revenues | | Toll: Interstate Revenues | | Toll: Intrastate Revenues | | Directory Advertising | | Miscellaneous Revenues | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | Quantity Index | Price Index | Quantity Index | Price Index | Quantity Index | Price Index | Quantity Index | Price Index | Quantity Index | Price Index |
| 1947 | 1822.7 | .683 | 516.1 | .995 | 457.1 | .830 | 206.6 | .389 | 21.1 | .631 |
| 1948 | 2046.0 | .721 | 570.1 | .995 | 475.5 | .886 | 236.2 | .419 | 23.4 | .675 |
| 1949 | 2179.0 | .762 | 574.5 | .994 | 503.3 | .948 | 254.2 | .449 | 26.0 | .667 |
| 1950 | 2338.8 | .812 | 652.6 | .995 | 521.2 | .978 | 256.9 | .479 | 27.7 | .681 |
| 1951 | 2503.9 | .839 | 772.1 | .994 | 550.0 | .992 | 277.5 | .488 | 28.6 | .727 |
| 1952 | 2662.1 | .881 | 848.9 | 1.000 | 578.4 | 1.008 | 314.3 | .498 | 30.5 | .736 |
| 1953 | 2817.6 | .917 | 901.9 | 1.031 | 588.1 | 1.030 | 326.7 | .568 | 32.7 | .747 |
| 1954 | 2962.4 | .936 | 943.4 | 1.088 | 626.6 | 1.046 | 351.2 | .598 | 34.4 | .757 |
| 1955 | 3184.6 | .948 | 1078.5 | 1.089 | 702.4 | 1.058 | 364.7 | .630 | 38.3 | .774 |
| 1956 | 3440.7 | .957 | 1208.3 | 1.088 | 767.8 | 1.059 | 388.3 | .665 | 40.6 | .798 |
| 1957 | 3671.4 | .971 | 1318.2 | 1.087 | 826.7 | 1.053 | 399.0 | .722 | 43.4 | .824 |
| 1958 | 3855.2 | 1.000 | 1387.1 | 1.085 | 866.4 | 1.071 | 416.0 | .757 | 44.6 | .837 |
| 1959 | 4125.2 | 1.007 | 1571.7 | 1.081 | 945.9 | 1.083 | 427.9 | .778 | 46.3 | .856 |
| 1960 | 4403.7 | 1.007 | 1735.5 | 1.057 | 1002.8 | 1.086 | 443.4 | .815 | 49.2 | .869 |
| 1961 | 4636.7 | 1.010 | 1889.8 | 1.057 | 1046.1 | 1.092 | 451.5 | .849 | 52.4 | .877 |
| 1962 | 4913.7 | 1.012 | 2077.9 | 1.058 | 1110.5 | 1.075 | 454.6 | .878 | 54.9 | .895 |
| 1963 | 5200.8 | 1.012 | 2276.4 | 1.048 | 1195.7 | 1.058 | 459.6 | .915 | 59.7 | .908 |
| 1964 | 5439.8 | 1.012 | 2534.0 | 1.044 | 1386.1 | 1.054 | 475.1 | .936 | 59.3 | .922 |
| 1965 | 5791.2 | 1.005 | 2876.1 | 1.015 | 1541.2 | 1.030 | 487.2 | .959 | 61.8 | .942 |
| 1966 | 6184.0 | 1.003 | 3356.7 | 1.009 | 1737.1 | 1.013 | 502.0 | .980 | 68.7 | .972 |
| 1967 | 6570.9 | 1.000 | 3720.9 | 1.000 | 1875.0 | 1.000 | 520.3 | 1.000 | 73.6 | 1.000 |
| 1968 | 6990.8 | 1.001 | 4185.1 | .978 | 2094.5 | .995 | 539.1 | 1.026 | 75.7 | 1.044 |
| 1969 | 7481.5 | 1.011 | 4834.8 | .983 | 2358.6 | .996 | 543.9 | 1.101 | 80.1 | 1.095 |
| 1970 | 7896.6 | 1.038 | 5291.4 | .949 | 2554.5 | 1.022 | 566.1 | 1.161 | 73.3 | 1.149 |
| 1971 | 8241.2 | 1.080 | 5679.5 | .975 | 2683.3 | 1.059 | 578.2 | 1.196 | 91.7 | 1.207 |
| 1972 | 8715.2 | 1.153 | 6250.3 | .981 | 2995.0 | 1.117 | 607.4 | 1.224 | 98.1 | 1.259 |
| 1973 | 9258.6 | 1.197 | 7064.5 | .999 | 3332.2 | 1.167 | 643.3 | 1.254 | 99.1 | 1.332 |
| 1974 | 9752.1 | 1.274 | 7698.9 | .998 | 3642.3 | 1.208 | 661.3 | 1.338 | 105.1 | 1.465 |
| 1975 | 10105.1 | 1.346 | 8288.1 | 1.035 | 3901.2 | 1.261 | 667.8 | 1.464 | 110.4 | 1.601 |
| 1976 | 10604.0 | 1.428 | 9196.8 | 1.060 | 4263.3 | 1.369 | 692.5 | 1.599 | 115.6 | 1.684 |
| 1977 | 11208.5 | 1.477 | 10208.7 | 1.065 | 4723.6 | 1.414 | 721.7 | 1.767 | 125.4 | 1.776 |
| 1978 | 11877.7 | 1.529 | 11630.6 | 1.068 | 5316.6 | 1.448 | 761.9 | 1.947 | 152.1 | 1.912 |
| 1979 | 12536.4 | 1.567 | 13221.9 | 1.063 | 5882.8 | 1.457 | 820.3 | 2.138 | 190.6 | 2.080 |

Table 3

Aggregate
Output
(millions of 1967 dollars)

| Year | Quantity Index | Price Index |
|---|---|---|
| 1947 | 2995.2 | .745 |
| 1948 | 3309.7 | .779 |
| 1949 | 3483.0 | .815 |
| 1950 | 3750.1 | .853 |
| 1951 | 4091.0 | .873 |
| 1952 | 4384.6 | .904 |
| 1953 | 4614.8 | .938 |
| 1954 | 4860.3 | .965 |
| 1955 | 5321.1 | .977 |
| 1956 | 5802.0 | .984 |
| 1957 | 6220.0 | .995 |
| 1958 | 6529.8 | 1.017 |
| 1959 | 7085.6 | 1.023 |
| 1960 | 7606.3 | 1.021 |
| 1961 | 8050.9 | 1.025 |
| 1962 | 8590.9 | 1.026 |
| 1963 | 9175.8 | 1.023 |
| 1964 | 9885.9 | 1.023 |
| 1965 | 10754.0 | 1.009 |
| 1966 | 11847.9 | 1.005 |
| 1967 | 12760.6 | 1.000 |
| 1968 | 13882.9 | .995 |
| 1969 | 15287.1 | 1.004 |
| 1970 | 16359.3 | 1.013 |
| 1971 | 17240.2 | 1.049 |
| 1972 | 18611.0 | 1.096 |
| 1973 | 20294.9 | 1.131 |
| 1974 | 21718.9 | 1.176 |
| 1975 | 22878.6 | 1.235 |
| 1976 | 24585.8 | 1.303 |
| 1977 | 26599.6 | 1.338 |
| 1978 | 29177.2 | 1.373 |
| 1979 | 31876.7 | 1.394 |

Table 4

Revenue Shares by Type of Output

| Year | Local | Toll: Interstate | Toll: Intrastate | Directory Advertising | Miscellaneous Revenue |
|---|---|---|---|---|---|
| 1947 | .558 | .230 | .170 | .036 | .006 |
| 1948 | .572 | .220 | .163 | .038 | .006 |
| 1949 | .585 | .201 | .168 | .040 | .006 |
| 1950 | .594 | .203 | .159 | .038 | .006 |
| 1951 | .588 | .215 | .153 | .038 | .006 |
| 1952 | .592 | .216 | .147 | .039 | .006 |
| 1953 | .597 | .215 | .140 | .043 | .006 |
| 1954 | .591 | .219 | .140 | .045 | .006 |
| 1955 | .581 | .226 | .143 | .044 | .006 |
| 1956 | .577 | .230 | .142 | .045 | .006 |
| 1957 | .576 | .231 | .141 | .047 | .006 |
| 1958 | .580 | .227 | .140 | .047 | .006 |
| 1959 | .573 | .234 | .141 | .046 | .005 |
| 1960 | .571 | .236 | .140 | .047 | .006 |
| 1961 | .567 | .242 | .138 | .046 | .006 |
| 1962 | .564 | .250 | .135 | .045 | .006 |
| 1963 | .561 | .254 | .135 | .045 | .006 |
| 1964 | .544 | .262 | .145 | .044 | .005 |
| 1965 | .536 | .269 | .146 | .043 | .005 |
| 1966 | .521 | .284 | .148 | .041 | .006 |
| 1967 | .515 | .292 | .147 | .041 | .006 |
| 1968 | .507 | .296 | .151 | .040 | .006 |
| 1969 | .493 | .310 | .153 | .039 | .006 |
| 1970 | .495 | .303 | .158 | .040 | .005 |
| 1971 | .492 | .306 | .157 | .038 | .006 |
| 1972 | .493 | .301 | .164 | .036 | .006 |
| 1973 | .483 | .307 | .169 | .035 | .006 |
| 1974 | .486 | .301 | .172 | .035 | .006 |
| 1975 | .481 | .304 | .174 | .035 | .006 |
| 1976 | .473 | .304 | .182 | .035 | .006 |
| 1977 | .465 | .305 | .188 | .036 | .006 |
| 1978 | .453 | .310 | .192 | .037 | .007 |
| 1979 | .442 | .316 | .193 | .039 | .009 |

Average Shares

| | Local | Toll: Interstate | Toll: Intrastate | Directory Advertising | Miscellaneous |
|---|---|---|---|---|---|
| 1947-61 | .580 | .223 | .148 | .043 | .006 |
| 1961-79 | .504 | .290 | .160 | .039 | .006 |
| 1947-79 | .537 | .261 | .156 | .041 | .006 |

Table 5

Rates of Growth of Output

| Year | Local | Toll: Interstate | Toll: Intrastate | Directory Advertising | Miscellaneous Revenues | Aggregate Output |
|---|---|---|---|---|---|---|
| 1948 | .116 | .100 | .040 | .133 | .102 | .100 |
| 1949 | .063 | .008 | .057 | .074 | .107 | .051 |
| 1950 | .071 | .127 | .035 | .010 | .063 | .074 |
| 1951 | .068 | .168 | .054 | .077 | .031 | .087 |
| 1952 | .061 | .095 | .050 | .125 | .065 | .069 |
| 1953 | .057 | .061 | .017 | .039 | .069 | .051 |
| 1954 | .050 | .045 | .063 | .072 | .050 | .052 |
| 1955 | .072 | .134 | .114 | .037 | .108 | .091 |
| 1956 | .077 | .114 | .089 | .063 | .058 | .087 |
| 1957 | .065 | .087 | .074 | .027 | .068 | .070 |
| 1958 | .049 | .051 | .047 | .042 | .027 | .049 |
| 1959 | .068 | .125 | .088 | .028 | .037 | .082 |
| 1960 | .065 | .099 | .058 | .035 | .061 | .071 |
| 1961 | .052 | .085 | .042 | .018 | .062 | .057 |
| 1962 | .058 | .095 | .060 | .007 | .047 | .065 |
| 1963 | .057 | .091 | .074 | .011 | .084 | .066 |
| 1964 | .045 | .107 | .148 | .033 | -.006 | .075 |
| 1965 | .063 | .127 | .106 | .025 | .041 | .084 |
| 1966 | .066 | .155 | .120 | .030 | .106 | .097 |
| 1967 | .061 | .103 | .076 | .036 | .068 | .074 |
| 1968 | .062 | .118 | .111 | .035 | .029 | .084 |
| 1969 | .068 | .144 | .119 | .009 | .057 | .096 |
| 1970 | .054 | .090 | .080 | .040 | -.089 | .068 |
| 1971 | .043 | .071 | .049 | .021 | .224 | .052 |
| 1972 | .056 | .096 | .110 | .049 | .068 | .077 |
| 1973 | .060 | .122 | .107 | .057 | .010 | .087 |
| 1974 | .052 | .086 | .089 | .028 | .059 | .068 |
| 1975 | .036 | .074 | .069 | .010 | .049 | .052 |
| 1976 | .048 | .104 | .089 | .036 | .046 | .072 |
| 1977 | .055 | .104 | .103 | .041 | .081 | .079 |
| 1978 | .058 | .130 | .118 | .054 | .193 | .092 |
| 1979 | .054 | .128 | .101 | .074 | .226 | .088 |

| | Local | Toll: Interstate | Toll: Intrastate | Directory Advertising | Miscellaneous | Total Output |
|---|---|---|---|---|---|---|
| 1947-61 | .067 | .093 | .059 | .056 | .065 | .071 |
| 1961-79 | .058 | .108 | .096 | .033 | .072 | .076 |
| 1947-79 | .060 | .101 | .080 | .043 | .069 | .074 |

## 4. MEASUREMENT OF LABOR INPUT

The value of labor input encompasses all labor related payments including wages, fringe benefits, employer social security payments, and unemployment insurance. The resulting value of labor input, which we refer to as total compensation, is given in the first column of Table 6.

To construct a quantity index for labor input we start with data on hours worked by non-construction employees in the Bell System. Construction employees are excluded since their input is included in the capital input they produce. As will be discussed in Section 5, capital input includes not only that purchased from outside sources but also that produced within the Bell System.

The data on hours of non-construction employees are broken down by occupation and years of service. For 1973 to 1979, the data are also classified by age. Table 7a indicates the breakdown by occupation and years of service, showing the number of hours worked by each group in specified years. Table 7b shows the breakdown by occupation, years of service, and age and the number of hours worked by each group in 1979.

We aggregate hours worked in the various labor groups using the Tornqvist index procedure. Denoting the index of hours worked by L and the wage index by $P_L$, we represent the value of labor input as the sum of the values of labor input from the various categories:

$$P_L L = \Sigma\, P_{Lj}\, L_j,$$

where $P_{Lj}$ is the price of the $j^{\underline{th}}$ type of labor, and $L_j$ is the number of hours worked by employees of this type. The Tornqvist index of hours worked L is related to the $L_j$ as follows:

Table 6

Labor Input

| Year | Total Compensation (millions of dollars) | Hours Worked (millions) | Compensation Index | Quantity Index (millions of 1967 dollars) | Price Index |
|---|---|---|---|---|---|
| 1947 | 1266.6 | 825.7 | .859 | 3065.5 | .413 |
| 1948 | 1445.7 | 859.3 | .867 | 3220.8 | .449 |
| 1949 | 1551.0 | 856.0 | .891 | 3299.0 | .470 |
| 1950 | 1615.2 | 834.7 | .919 | 3318.3 | .487 |
| 1951 | 1789.8 | 877.6 | .914 | 3469.1 | .516 |
| 1952 | 1993.1 | 918.1 | .918 | 3642.3 | .547 |
| 1953 | 2152.6 | 947.2 | .929 | 3802.9 | .566 |
| 1954 | 2252.7 | 941.9 | .943 | 3840.3 | .587 |
| 1955 | 2388.4 | 937.0 | .948 | 3842.1 | .622 |
| 1956 | 2587.4 | 1015.0 | .944 | 4141.0 | .625 |
| 1957 | 2628.8 | 983.3 | .945 | 4017.1 | .654 |
| 1958 | 2635.6 | 957.0 | .972 | 4020.2 | .656 |
| 1959 | 2739.3 | 900.1 | .992 | 3861.0 | .709 |
| 1960 | 2855.1 | 893.6 | .999 | 3858.2 | .740 |
| 1961 | 2948.6 | 877.0 | 1.008 | 3822.5 | .771 |
| 1962 | 3064.7 | 876.6 | 1.011 | 3833.9 | .799 |
| 1963 | 3169.6 | 871.4 | 1.016 | 3830.0 | .828 |
| 1964 | 3439.3 | 899.9 | 1.015 | 3950.3 | .871 |
| 1965 | 3689.9 | 936.4 | 1.009 | 4086.3 | .903 |
| 1966 | 4027.8 | 983.0 | 1.001 | 4253.8 | .947 |
| 1967 | 4329.1 | 1001.2 | 1.000 | 4329.1 | 1.000 |
| 1968 | 4613.9 | 1019.4 | .998 | 4399.3 | 1.049 |
| 1969 | 5351.1 | 1087.4 | .988 | 4643.3 | 1.152 |
| 1970 | 6123.2 | 1147.2 | .986 | 4889.6 | 1.252 |
| 1971 | 6877.1 | 1143.2 | 1.000 | 4943.5 | 1.391 |
| 1972 | 7876.3 | 1123.4 | 1.020 | 4953.0 | 1.590 |
| 1973 | 8787.0 | 1133.3 | 1.019 | 5035.7 | 1.745 |
| 1974 | 9844.5 | 1144.0 | 1.026 | 5073.8 | 1.940 |
| 1975 | 11114.7 | 1114.8 | 1.048 | 5050.7 | 2.201 |
| 1976 | 12369.3 | 1084.6 | 1.063 | 4983.1 | 2.482 |
| 1977 | 13641.1 | 1106.4 | 1.085 | 5192.5 | 2.627 |
| 1978 | 15347.8 | 1154.2 | 1.086 | 5419.7 | 2.832 |
| 1979 | 17587.4 | 1207.7 | 1.079 | 5636.3 | 3.120 |

Table 7a

Hours Worked by Occupation and Years of Service
(millions of hours)

Telephone Operators

| | -1 yr. | 1-2 yrs. | 3-5 yrs. | 6+ yrs. | |
|---|---|---|---|---|---|
| 1950 | 46.3 | 85.8 | 106.4 | 117.0 | 1950 |
| 1960 | 39.3 | 38.0 | 48.6 | 163.9 | 1960 |
| 1970 | 88.1 | 73.3 | 37.5 | 103.8 | 1979 |
| 1979 | 35.4 | 28.1 | 16.6 | 82.3 | 1979 |

Plant Craftsman

| | -1 yr. | 1-2 yrs. | 3-5 yrs. | 6+ yrs. | |
|---|---|---|---|---|---|
| 1950 | 7.3 | 31.9 | 43.7 | 69.3 | 1950 |
| 1960 | 4.3 | 8.8 | 47.4 | 129.8 | 1960 |
| 1970 | 42.6 | 46.0 | 45.2 | 149.2 | 1970 |
| 1979 | 14.1 | 13.4 | 18.4 | 228.3 | 1979 |

Clerical

| | -1 yr. | 1-2 yrs. | 3-5 yrs. | 6+ yrs. | |
|---|---|---|---|---|---|
| 1950 | 17.7 | 37.8 | 38.2 | 50.5 | 1950 |
| 1960 | 25.6 | 25.8 | 35.7 | 83.8 | 1960 |
| 1970 | 47.7 | 47.4 | 32.0 | 83.1 | 1970 |
| 1979 | 28.1 | 28.5 | 24.8 | 121.0 | 1979 |

Other Non-Supervisory

| | -1 yr. | 1-2 yrs. | 3-5 yrs. | 6+ yrs. | |
|---|---|---|---|---|---|
| 1950 | 6.4 | 16.2 | 19.6 | 25.0 | 1950 |
| 1960 | 8.8 | 11.0 | 19.8 | 48.5 | 1960 |
| 1970 | 27.1 | 25.9 | 18.0 | 47.9 | 1970 |
| 1979 | 28.4 | 30.3 | 29.1 | 145.8 | 1979 |

Table 7a (continued)

*Foreman and Supervisors

| | -5 yrs. | 5-9 yrs. | 10+ yrs. | |
|---|---|---|---|---|
| 1950 | 3.9 | 7.7 | 60.6 | 1950 |
| 1960 | 2.0 | 6.5 | 79.1 | 1960 |
| 1970 | 8.9 | 11.4 | 88.5 | 1970 |
| 1979 | 8.4 | 22.6 | 109.7 | 1979 |

*Executive and Staff

| | -5 yrs. | 5-9 yrs. | 10+ yrs. | |
|---|---|---|---|---|
| 1950 | 5.5 | 3.3 | 34.6 | 1950 |
| 1960 | 4.6 | 7.1 | 55.2 | 1960 |
| 1970 | 19.3 | 12.0 | 92.3 | 1970 |
| 1979 | 27.2 | 36.4 | 130.8 | 1979 |

*Prior to 1965, hours worked by each of these occupation and years of service classes are available, but wage rates are not. "Foremen and Supervisors" and "Executive and Staff" are combined into "All Management." Wage rates for "All Management" are available prior to 1965 for the years of service classes 0-5 years, 5-9 years, and 10+ years.

Table 7b

1979 Hours Worked by Occupation, Years of Service, and Age

(millions of hours)

| | Age | | | | |
|---|---|---|---|---|---|
| | 0-24 | 25-34 | 35-44 | 45-54 | 55 + |
| Telephone Operators | | | | | |
| -1 yr. | 21.5 | 9.8 | 2.6 | 1.2 | .2 |
| 1-2 yrs. | 13.2 | 9.5 | 3.2 | 1.8 | .3 |
| 3-5 yrs. | 5.5 | 7.7 | 1.8 | 1.3 | .3 |
| 6+ yrs. | 1.0 | 26.0 | 16.5 | 25.3 | 13.5 |
| Plant Craftsman | | | | | |
| -1 yr. | 6.5 | 6.0 | 1.1 | .4 | .1 |
| 1-2 yrs. | 5.3 | 6.5 | 1.2 | .4 | .1 |
| 3-5 yrs. | 4.5 | 12.2 | 1.3 | .4 | .1 |
| 6+ yrs. | 1.2 | 93.6 | 56.8 | 53.5 | 23.2 |
| Clerical | | | | | |
| -1 yr. | 13.6 | 9.2 | 3.3 | 1.6 | .3 |
| 1-2 yrs. | 11.6 | 10.9 | 3.7 | 1.8 | .4 |
| 3-5 yrs. | 8.0 | 12.3 | 2.7 | 1.4 | .4 |
| 6+ yrs. | 2.3 | 53.5 | 25.3 | 27.1 | 12.8 |
| Other Non-Supervisory | | | | | |
| -1 yr. | 12.6 | 12.2 | 2.5 | .9 | .2 |
| 1-2 yrs. | 10.7 | 14.6 | 3.3 | 1.4 | .3 |
| 3-5 yrs. | 8.1 | 16.2 | 3.0 | 1.4 | .4 |
| 6+ yrs. | 2.3 | 63.5 | 29.7 | 32.5 | 17.8 |
| Foremen & Supervisors | | | | | |
| -5 yrs. | 1.8 | 5.0 | 1.1 | .4 | .1 |
| 5-9 yrs. | .7 | 17.8 | 3.2 | .8 | .2 |
| 10+ yrs. | .0 | 17.6 | 33.5 | 41.7 | 16.9 |
| Executive & Staff | | | | | |
| -5 yrs. | 6.2 | 16.3 | 3.6 | .9 | .2 |
| 5-9 yrs. | 1.2 | 27.3 | 6.0 | 1.5 | .4 |
| 10+ yrs. | .0 | 20.2 | 39.8 | 46.8 | 23.9 |

$$\ln L(T) - \ln L(T-1) = \sum_j \bar{v}_{jt} \{\ln L_j (T) - \ln L_j (T-1)\}$$

where the weights ($\bar{v}_j$) are the average shares of each type of labor in the value of total labor input. Therefore, in addition to hours worked we need data on the weights to construct the labor quantity index. Although we have data on wage payments to each type of labor, we do not have information on payments of fringe benefits, social security, etc., to each type of labor. We believe it is a reasonable approximation of reality to assume that non-wage compensation is proportional to wage compensation. Thus we have used the wage payment shares as estimates of the total compensation shares in the aggregation procedure.

Average hourly wages used to create the wage shares were available for the categories specified in Tables 7a and 7b. As Table 7a indicates, we could not obtain a breakdown of "management" wages into "foremen and supervisors" and "executive and staff" wages before 1965. We therefore used the "all management" wage rate to aggregate hours worked by "foremen and supervisors" and "executive and staff" in the early period.

The resulting aggregate labor quantity index is scaled to equal labor compensation in our base year, 1967. The ratio between this index and total hours worked provides an index of labor input per hour work, which reflects changes over time in the composition of the Bell System work force.

The price and quantity indexes of labor input are presented in Table 6, along with total compensation, hours worked, and the index of labor input per hour worked. From 1947 to 1956 the quantity index grew at a rate of 3.3% per year. This is due to an increase in both hours worked and composition of the work force. The increase in the composition index results from changes in both the occupational mix and the experience level of the Bell employees. Between 1956 and 1963 there

is a decline in labor input at a rate of 1.1% per year. This is caused by the substantial decline in hours worked, which is partially offset by an increase in the composition index. Both the occupational mix and the experience level of the labor force contribute to this increase. From 1963 to 1970 the labor input index grows at 3.5% per year. This is due to the 3.9% per year growth in hours worked, which is partially offset by a decrease in the composition index. During this period there is a decrease in the experience level of the Bell labor force which causes the negative growth of the composition index. Between 1970 and 1977 hours worked declined slightly and the experience level and occupational mix improved, causing a growth of 0.9% per year in labor input. Between 1977 and 1979 labor input grows at 4.1% per year. This results from a 4.4% per year growth in hours worked, partially offset by a decrease in the composition index. This decrease is due to a change in the occupational mix of the labor force.

## 5. MEASUREMENT OF CAPITAL INPUT

We follow the methodology developed by Christensen and Jorgenson (1969) in constructing our capital accounts. This involves estimating the cost of capital, depreciation, revaluation, and taxation of several classes of capital goods.

There are some capital items which are rented by the Bell System. The rental payments must be separated into price and quantity components in order to combine owned and rented capital into an index of total capital input.

5.1. Owned Capital Stocks. We begin by computing perpetual inventory estimates of the stock of each type of capital used in the Bell System. In each year the stock of each type of capital is the sum of stocks remaining from past investments of each vintage. Under the assumption that efficiency of capital goods declines geometrically, the replacement rate, $\delta$, is a constant. Capital stock at the end of every year can be estimated from investment during the year and capital stock at the end of the previous year:

$$K_t^A = I_t + (1-\delta)\, K_{t-1}^A,$$

where $K_t^A$ is end of year capital stock and $I_t$ is the quantity of investment. To estimate these stocks we therefore need a benchmark estimate of capital stock, investment in constant prices, and a rate of replacement. We estimate capital stocks for each of the 20 capital types given in Table 8.

All investment data are taken from the Quarterly Report No. 2A, Analysis of Changes in Telephone Plant Accounts. This report gives the book value of investments placed in service each year from 1947 to the present. Over this period there have been redefinitions of various accounts which need special treatment.

Table 8

| Capital Type | Book Value of Investment | Book Value of Investment Deflator | Capital Stock Deflator | Capital Stock Benchmark | Replacement Rate |
|---|---|---|---|---|---|
| Data Source | All investment data are from Quarterly Report No. 2A, Analysis of Changes in Telephone Plant Accounts. | All deflators are from Telephone Plant Indexes. June refers to the year average price and Dec. to the end of year spot price. | | All net plant figures are taken from Current Cost of Bell System Plant. All figures are in 1967 dollars. | CC refers to Current Cost of Bell System Plant. |
| Buildings | Account 212 | June lagged one year i.e. June (-1) | Dec. | Net plant 12/31/58 deflated by capital stock deflator: $2937.615 million | 1947-1979: Rate implicit in CC stock, 1958-1978; .0270 |
| Central Office Equipment: Manual | Account 221-Manual minus adjustment for 1/1/59 redefinition of sub-accounts in 221 | June lagged 6 months i.e. 1/2(June + June (-1)) | Dec. | Net plant 12/31/58 deflated by capital stock deflator: $537.771 million | 1947-1979: Rate implicit in CC stock 1970-1978; .16211 |
| Central Office Equipment: Panel | Account 221-Panel minus adjustment for 1/1/59 redefinition of sub-accounts in 221 | June lagged 9 months i.e. 1/4(3*June(-1) + June) | Dec. | Net plant 12/31/58 deflated by capital stock deflator: $209.230 million | 1947-1965: Rate implicit in CC stock, 1958-1965; .0816. 1965-1979: Rate implicit in CC stock, 1965-1980; .185 |
| Central Office Equipment: Step by Step | Account 221-S×S minus adjustment for 1/1/59 redefinition of sub-accounts in 221 | June lagged 6 months i.e. 1/2(June + June(-1)) | Dec. | Net plant 12/31/58 deflated by capital stock deflator: $1554.293 million | 1947-1970: Rate implicit in CC stock, 1958-1970; .0642; 1970-1979: Rate implicit in CC stock 1970-1978; .1042 |

Table 8 (continued)

| Capital Type | Book Value of Investment | Book Value of Investment Deflator | Capital Stock Deflator | Capital Stock Benchmark | Replacement Rate |
|---|---|---|---|---|---|
| Central Office Equipment: Crossbar | Account 221-Crossbar minus adjustment for 1/1/59 redefinition of sub-accounts in 221 | June lagged 9 months i.e. 1/4(3*June(-1) + June) | Dec. | Net plant 12/31/58 deflated by capital stock deflator: $1559.250 million | 1947-1979: Rate implicit in CC stock, 1958-1978; .0539 |
| Central Office Equipment: Circuit | Account 221-Toll plus Account 221-Circuit plus adjustment sub-tracted from all other COE accounts due to 1/1/59 redefinition | June lagged 6 months i.e. 1/2(June + June(-1)) | Dec. | Net plant 12/31/58 deflated by capital stock deflator: $1228.398 million | 1947-1979: Rate implicit in CC stock, 1958-1978; .0735 |
| Central Office Equipment: Radio | Account 221-Radio minus adjustment for 1/1/59 redefinition of sub-accounts in 221 | June lagged 6 months i.e. 1/2(June + June(-1)) | Dec. | Assume zero initial stock in 1948 | 1949-1979: Rate implicit in CC stock, 1958-1978; .0833 |
| Central Office Equipment: Electronic | Account 221-Elec-tronic | June lagged 9 months i.e. 1/4(3*June(-1) + June) | Dec. | Assume zero initial stock in 1963 | 1964-1979: Rate implicit in CC stock, 1965-1978; .031 |
| Station Equipment: Station Apparatus | 1947-1956: Account 231, a portion of accounts 234 and 235, all adjusted for redefinition of investment occuring 1/1/57. 1957-1976: Account 231 | June | Dec. | Net plant 12/31/58 deflated by capital stock deflator: $1123.524 million | 1947-1956: .317 1956-1979: Rate implicit in CC stock, 1958-1978; .1144 |

Table 8 (continued)

| Capital Type | Book Value of Investment | Book Value of Investment Deflator | Capital Stock Deflator | Capital Stock Benchmark | Replacement Rate |
|---|---|---|---|---|---|
| Station Equipment: Station Connections | 1947-1956: Accounts 232 and 233 plus a portion of accounts 234 and 235, all adjusted for redefinition of investment occuring 1/1/57. 1957-1976: Account 232. | June | Dec. | Net plant 12/31/58 deflated by capital stock deflator: $2598.114 million | 1947-1958: .11 1958-1979: Rate implicit in CC stock, 1958-1978; .1337 |
| Station Equipment: Large PBX | 1947-1956: A portion of Account 234. 1957-1976: Account 234 | June lagged 4 months i.e. 1/3(June(-1) + 2*June) | Dec. | Net plant 12/31/58 deflated by capital stock deflator: $439.9891 million | 1947-1970: Rate implicit in CC stock, 1958-1970; .0950; 1970-1979: Rate implicit in CC stock 1970-1978, .140 |
| Pole Lines | Account 241 | June | Dec. | Net plant 12/31/58 deflated by capital stock deflator: $1543.178 million | 1947-1979: Rate implicit in CC stock, 1958-1978; .0657 |
| Cable: Aerial | Account 242.1 | June | Dec. | Net plant 12/31/58 deflated by capital stock deflator: $2893.361 million | 1947-1979 Rate implicit in CC stock, 1958-1978; .0463 |
| Cable: Underground | Account 242.2 | June | Dec. | Net plant 12/31/58 deflated by capital stock deflator: $1875.849 million | 1947-1979 Rate implicit in CC stock, 1958-1978 .0284 |

Table 8 (continued)

| Capital Type | Book Value of Investment | Book Value of Investment Deflator | Capital Stock Deflator | Capital Stock Benchmark | Replacement Rate |
|---|---|---|---|---|---|
| able: Buried | Account 242.3 | June | Dec. | Net plant 12/31/58 deflated by capital stock deflator: $666.440 million | 1947-1979: Rate implicit in CC stock, 1958-1978 .0383 |
| able: Submarine | Account 242.4 | June | Dec. | Net plant 12/31/58 deflated by capital stock deflator: $74.81371 million | 1947-1979: Rate implicit in CC stock, 1958-1978; .0657 |
| erial Wire | Account 243 | June | Dec. | Net plant 12/31/58 deflated by capital stock deflator: $468.569 million | 1947-1965: Rate implicit in CC stock, 1958-1965; .1168. 1966-1979: Rate implicit in CC stock, 1965-1978 .1645 |
| Underground Conduit | Account 244 | June | Dec. | Net plant 12/31/58 deflated by capital stock deflator: $1401.958 million | 1947-1979: Rate implicit in CC stock, 1958-1978; .0256 |
| Furniture and Office Equipment | Account 261 | June | Dec. | Net plant 12/31/58 deflated by capital stock deflator: $220.746 million | 1947-1979: Rate implicit in CC stock, 1958-1978; .0822 |

Table 8 (continued)

| Capital Type | Book Value of Investment | Book Value of Investment Deflator | Capital Stock Deflator | Capital Stock Benchmark | Replacement Rate |
|---|---|---|---|---|---|
| Vehicles and Other Work Equipment | Account 264 | June | Dec. | Net plant 12/31/58 deflated by capital stock deflator: $228.516 million | Vintage Stock. 1947-1958: .21 1958-1976: Rate implicit in CC stock, 1958-1970 given above vintage; .1802 |

In 1959 the "Toll" category of Central Office Equipment (COE) was dropped and "Circuit" started. The new Circuit category includes all the former Toll category plus portions of four COE categories: Manual, Panel, Step-by-Step, Crossbar, and Radio. We therefore combine the Toll and Circuit investment and add small portions of the above COE investments from 1947 to 1959 to obtain a consistent "Toll and Circuit" investment series. The gross book value of the stock transferred from each of these COE categories to Circuit in 1959 is available in the Quarterly Report No. 2A. For each COE category, we computed the ratio of the gross book value of the stock transferred out to the total gross book value of the stock. This ratio was applied to total investment in each year prior to 1959 to estimate the value of investment transferred to Toll and Circuit.

Station Equipment was the second group requiring adjustment. After 1957 this category has three capital types, Station Apparatus, Station Connections, and Large Private Branch Exchanges (PBX). Before 1959 there were two additional categories, and the PBX category included Small PBX. An additional complication is that investment prior to 1957 did not include some investment "waiting for installation" but after 1957 it did. We decided to use the three categories of investment after 1957 and consequently had to allocate the five categories of investment from 1947 to 1956 to the three more aggregated categories. This was done on the basis of a memo from the Economic Studies Department of AT&T estimating the gross book value of these three stocks, had the 1957 definition been in effect. The result is consistent series for the three investment categories over the entire 1947-79 period.

The next step was to deflate the book value of investment by an appropriate price deflator to estimate real investment. Price indexes for each capital type were taken from Bell System Telephone Plant Indexes. As the book value deflator should