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2 Productivity Measurement in Service Industries

Edwin R. Dean and Kent Kunze

The U.S. Bureau of Labor Statistics (BLS) presently publishes productivity measures for 173 industry titles, of which 39 are for the broad service, or nongoods, sector. In 1975 the bureau published a total of 53 industry titles, of which 10 were in the service sector. At present, the published industries cover 42 percent of all workers in service industries in the private business sector.

After placing the service industry productivity measures in the context of the larger BLS program of productivity measurement, we will provide in sections 2.1–2.3 basic information about the industry productivity measures, including the measurement model used by the bureau. Section 2.4 describes the methods used for specific industries; the discussion groups the industries into broad sectors, such as transportation, trade, and communications. Figures 2.1–2.7, should be examined in conjunction with section 2.4 because they illustrate the construction of several of the measures. Section 2.5 examines trends in the measures themselves, and section 2.6 discusses some comparisons of the BLS measures and the industry output measures developed by the U.S. Bureau of Economic Analysis (BEA).

These industry measures form one part of a broad BLS program of productivity measurement. The methods used for these measures differ from the methods used for the other components of the program. Industry productivity measures are available for mining and manufacturing industries as well as for service industries. They are annual measures, employing gross output and hours of labor input, mostly at the three- and four-digit (but occasionally at

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the two-digit) levels. These measures are prepared and published in an autumn press release and then in a bulletin several months later.

Other major components of the bureau's productivity measurement program are (1) quarterly measures of output per hour for major sectors of the economy, which are prepared using gross product originating (value added) and are published in press releases eight times a year; (2) annual measures of multifactor productivity for major sectors, which use value-added output and are published annually; (3) annual measures of multifactor productivity for two-digit manufacturing industries, which use gross output and are updated and published when resources permit; (4) annual measures of multifactor productivity for selected three-digit industries, which are published annually; (5) international comparisons of labor productivity in manufacturing, which are published annually for 12 countries; (6) measures of labor productivity for selected federal government functions, which are published annually; and (7) labor productivity measures for selected state and local government activities, which are published annually.

The methods used for the various measures differ. For example, the industry measures of labor productivity use gross output, base-year weighted; the major sector multifactor productivity measures use value-added output, base-year weighted, and the two- and three-digit industry multifactor measures use Törnqvist indexes of gross output.

2.1 The Model

The industry labor productivity measures are computed as indexes of output per hour by dividing an index of output by an index of aggregate employee hours. For industries in trade and services (the service industry within the broad nongoods sector), measures are prepared relating output to the hours of all persons involved in producing that output, including self-employed and unpaid family workers.

The index of output per hour is expressed as the quotient of an index of weighted output and an index of employee hours, as follows:

$$\text{Output index} \div \text{Employee hours index} = \text{Output per hour}$$

$$\frac{\sum l_{i,0}\, q_{i,t}}{\sum l_{i,0} q_{i,0}} \div \frac{\sum l_{i,t} q_{i,t}}{\sum l_{i,0} q_{i,0}} = \frac{\sum l_{i,0}\, q_{i,t}}{\sum l_{i,t} q_{i,t}},$$

where $l_{i,t}$ is unit labor requirements of product i in year t, where unit labor requirements are aggregate hours spent in producing product i divided by gross output of product i; $q_{i,t}$ is gross output of product i in year t, and "product" is understood to be either a good or a service. The output index compares the quantities of the various products in the current year with the quantities in the base period, each weighted by the employee hours expended per unit produced in the base period. The employee hours index compares the aggregate

employee hours in the base and current periods. The employee hours data are the total hours expended by employees in establishments classified in the industry to produce the base-period and current-period composites.

The productivity index, as described above, eliminates the effects of shifts in product mix on productivity. That is, because of the fixed, current-year output weights, labor productivity changes resulting from changes in the relative quantities of the various outputs will not affect the productivity indexes. These productivity indexes are affected only by changes in unit labor requirements of the individual products.

The measurement procedures described above were developed a number of years ago and are intended to show the changes in total labor requirements of the industry that result from changing production processes for the various industry products (Seigel 1961).

2.2 General Description of Measures

2.2.1 Output

The industry output indexes are based on measured quantities of products or services provided by the industry. The unit of measurement of the quantity can be either a physical quantity such as passenger-miles, ton-miles, or kilowatt hours or a constant-dollar value of production. One of the primary objectives for output measures is to start with as much detail or disaggregation of the measured outputs as possible. For example, the output index of the electrical utility industry (SIC 491) is not simply the number of kilowatt hours produced. Instead, it is derived from indexes of the number of kilowatt hours sold to each of seven types of customers. The amounts sold to each type of customer are aggregated with specific weights for each type of service. Similarly, the output index of hardware stores (SIC 5251) is obtained by aggregating the deflated revenues of 23 different merchandise lines from all stores. The intent is to develop output indexes that correctly reflect the differing trends in the output of various products produced within the industry.

As a general rule, weights are derived every five years from the economic censuses because only the economic censuses provide the detailed data needed for the disaggregation of the output and the development of the weights. For most industries that do not rely on census data, weights are still changed every five years for consistency within the measurement program. Although the above model states that the desired weights are unit labor requirements, this is not the case for many industries and, as a matter of fact, for most of the service industries.

Industry output information is obtained from a wide variety of sources, both public and as private. Output indexes for trade, services, and manufacturing make extensive use of Census Bureau data. Other important federal government sources include the Department of Transportation, the Internal

Revenue Service (IRS), the Department of Energy, and the Department of the Interior. For deflated value series, industry price indexes are derived from the BLS producer price indexes and consumer price indexes (CPIs).

2.2.2 Employee Hours

Indexes of employee hours are computed by dividing aggregate employee hours for each year by the base-period aggregate. Employee hours are treated as homogeneous and additive with no distinction made between hours of different groups of employees. For industries in which the self-employed are important, indexes are constructed for the hours of all persons, including paid employees, partners, proprietors, and unpaid family workers.

Industry employment and employee hours indexes are developed from basic data compiled by BLS, the Census Bureau, and other sources. For most private nonagricultural industries, BLS publishes employment and average weekly hours data for production or nonsupervisory workers and employment data for all employees. The Bureau of the Census publishes employment and aggregate hours data for production workers and employment data for all employees. Average annual hours of nonproduction and supervisory workers are estimated from all available data. For trade and service industries, all-persons hours estimates are derived by summing the aggregate hours for paid employees and the estimated aggregate hours for the self-employed and unpaid family workers. In a few industries, labor input measures are simply total employee counts.

2.3 Characteristics of the Measures

The above model of productivity measurement is very straightforward. However, when put to use, it can become complicated. When the bureau begins to study the possibility of developing a new industry productivity measure, the first task is to examine the available data. It is common to find that the data suffer from various deficiences. If the deficiencies are important and not correctable, the study is ended and no measure is developed. In other instances, special efforts are made to correct the data problems.

There are a number of conditions considered during the examination of the data. It is important to find out whether, for the industry in question, there have been significant changes in the standard industrial classification (SIC) code over the time period considered, and, if so, whether adjustments can be made for the changes. Changes in the SIC codes indicate major changes in the type of products or services being produced or changes in product mix. If these new products or the changing mix of products cannot be introduced with acceptable weights, then the output and productivity indexes will not capture the correct output changes over time.

A second important condition that is examined is whether the industry has become more or less vertically integrated over time. This condition is a partic-

ularly important consideration when output indexes, based on a gross output concept, are constructed from deflated value data. Gross output (the output concept generally employed by the bureau) may not change as an industry becomes more or less integrated. However, labor hours could change with a change in vertical integration. Therefore measured productivity can change even though there are no changes in the production process. Changes in vertical integration are generally examined by studying changes in the ratio of value-added output to gross output.

Two other important considerations are (1) what percentages of primary products are made within the industry, and what changes in the percentages have occurred over time; and (2) what percentage of output for the industry is composed of primary products. The first of these conditions is referred to as product coverage and the second as specialization. The reasons these percentages are important have to do with how the data are reported—a problem mostly in noncensus years. The amounts (values) of primary products produced for the year are reported on a "wherever made" basis; the amount of industry output is reported for primary and secondary products combined. The amount of industry primary products output is not known. In order to develop weights and match prices for each product group, it is necessary that both the coverage and specialization ratios be high. Historically, an industry measure has not been developed unless both percentages have been over 90 percent.

Some of the industries for which the bureau publishes measures are regulated—most notably in the transportation, communications, and electric, gas, and sanitary service industries. Regulated prices of outputs may not reflect competitive market conditions, a fact that can have adverse effects on the output measures. When value weights are being used, the regulated prices are part of the weights used to compute the output indexes. In this case the weights may reflect neither unit labor requirements nor marginal costs of production, and the output indexes are not weighted correctly.

It is difficult to determine how much effect the use of revenue weights, which contain regulated prices, has had on the output trends. The trend in the output index for the railroad industry was revised slightly downward when a change from revenue weights to labor cost weights was introduced in 1974. Certainly there has been some distortion in the changes of the output index for telephone communications during the regulated years because long distance rates were set artificially high to offset low local rates.

For labor input there are also a number of potential data problems. Presently, establishment surveys do not collect hours data on supervisory and nonproduction workers. The hours for supervisory and nonproduction workers are estimated for each industry. In addition, household data on hours of work of self-employed and unpaid family workers are generally very thin at the industry level—a particularly acute problem for measuring labor input in the service sector, where most nonfarm self-employed and unpaid family workers

are working. As a result changes in annual hours of these workers are often erratic.

The hours collected by the bureau's establishment survey are based on hours paid and not hours worked, which is the more appropriate measure for labor input. However, results from the bureau's hours at work survey show that for the private business sector the ratio of hours at work to hours paid has been reasonably stable since 1981 (Jablonski, Kunze, and Otto 1990). Indeed, even for many of the nongoods industries this seems to be the case. For the transportation sector, however, the ratio increased nearly 5 percentage points from 1981 to 1989.[1] Hence, actual hours of work have increased faster than hours paid. This would suggest that labor input increased 5 percentage points more than reported for this period and that labor productivity growth for industries in this sector was about 5 percentage points less, on average, than reported for this time period.

2.4 Description of Service Industry Measures

As noted earlier, the bureau presently publishes productivity measures for 173 industry titles, of which 39 are for the broad service or nongoods sector. In 1975 the bureau published a total of 53 industry titles, of which 10 were in the service sector. Of the present 39 industry titles in the service sector, a total of 32 are for mutually exclusive service industries. The difference between the number of titles and industries arises from the overlap of measures for both a two-digit SIC code and a three- or four-digit SIC code within the two-digit group. There is at least one published measure for every major industry division in the service sector.[2] As of 1987, the published industries covered 42 percent of all workers in service industries in the private business sector (table 2.1). (The private business sector excludes government and nonprofit institutions.)

The reader should note that figures 2.1–2.7 provide diagrams intended to clarify how the various industry output measures are developed and to supplement the following verbal descriptions of the construction of the productivity measures for each sector.

Transportation. The bureau publishes productivity measures for five industries in the transportation sector.[3] The employment coverage of these mea-

1. Unpublished data provided by the Office of Productivity and Technology, Bureau of Labor Statistics.

2. The bureau does produce productivity measures for the Federal Government including the Postal Service. However, these measures are not included in this study. Technical notes describing detailed characteristics of all industry measures are available on request.

3. For the intercity trucking industry, SIC 4213 (part), two measures are produced; one is for freight trucking alone and one is for all intercity trucking. For railroad transport (SIC 401), two measures are produced using different output concepts, car miles and revenue ton miles. Thus, seven measures are produced for the five industries covered.

Table 2.1 **Service Industries Covered by BLS Productivity Measures and Employment Coverage for Major Service Sectors**

	1987 Employment (thousands)	Employment Coverage (%)
Services producing sector	59,860	
Transportation	3,478	
Railroad transport, revenue traffic (SIC 401)	*271*	
Railroad transport, car miles (SIC 401)	*271**	
Bus carriers, class I (SIC 4111, 413, 414) (part)	*20*	
Intercity trucking (SIC 4213) (part)	*448*	
Intercity trucking, freight (SIC 4213) (part)	*293**	
Air transportation (SIC 4511, 4521) (part)	*457*	
Petroleum pipelines (SIC 4612, 13)	*18*	
Transportation employment covered	*1,214*	*34.9*
Communications	1,300	
Telephone communications (SIC 4811)	*905*	
Communications employment covered	*905*	*69.6*
Electric, gas, & sanitary services	930	
Gas & electric utilities (SIC 491, 492, 493)	*817*	
Electric utilities (SIC 491, 493) (part)	*605**	
Gas utilities (SIC 492, 493) (part)	*212**	
Utilities employment covered	*817*	*87.8*
Trade	26,287	
Scrap & waste materials (SIC 5093)	*117*	
Hardware stores (SIC 5251)	*176*	
Department stores (SIC 5311)	*2,033*	
Variety stores (SIC 5331)	*248*	
Retail food stores (SIC 54)	*3,191*	
Grocery stores (SIC 5411)	*2,749**	
Retail bakeries (SIC 546)	*190**	
Franchised new car dealers (SIC 5511)	*922*	
Auto & home supply stores (SIC 5531)	*346*	
Gasoline service stations (SIC 5541)	*681*	
Apparel & accessory stores (SIC 56)	*1,242*	
Men's & boy's clothing stores (SIC 5611)	*116**	
Women's ready-to-wear stores (SIC 5621)	*419**	
Family clothing stores (SIC 5651)	*281**	
Shoe stores (SIC 5661)	*233**	
Furniture, home furnishings, & equipment stores (SIC 57)	*938*	
Furniture & home furnishings stores (SIC 571)	*558**	
Appliance, radio, TV, & music stores (SIC 572, 73)	*379**	
Household appliance stores (SIC 5722)	*105**	
Radio, TV, & music stores (SIC 573)	*274**	
Eating & drinking places (SIC 58)	*6,460*	
Drug- & proprietary stores (SIC 5912)	*595*	
Liquor stores	*178*	
Trade employment covered	*17,127*	*65.2*
Finance, insurance, & real estate	7,131	

(*continued*)

Table 2.1 (continued)

	1987 Employment (thousands)	Employment Coverage (%)
Commercial banking (SIC 602)	*1,562*	
FIRE employment covered	*1,562*	*21.9*
Services	20,734	
Hotels, motels, & tourist courts (SIC 7011)	*1,558*	
Laundry & cleaning services (SIC 721)	*468*	
Beauty & barber shops (SIC 7231, 41)	*770*	
Beauty shops (SIC 7231)	*687**	
Automotive repair shops (SIC 753)	*803*	
Services employment covered	*3,599*	*17.4*
Services-producing sector employment covered	*25,224*	*42.1*

Source: Bureau of Labor Statistics.

Note: Employment coverage of BLS measures is in italics. *Designates employment is aggregated at a higher level.

sured industries is 35 percent of the transportation sector, based on 1987 employment. Interestingly, the same industries represented over 50 percent of transportation employment in 1980. The decrease in coverage is attributable to declining employment in some measured industries and increasing employment in the yet-unmeasured industries within the sector. For example, employment in railroads (a measured industry) has dropped from 671,000 in 1967 to 271,000 in 1987; employment in transportation services (an unmeasured industry) has risen from 100,000 in 1967 to 296,000 in 1987.

Conceptually, the output measures for transportation industries are relatively easy to define: output is the movement of goods or passengers over distance. This is a quantifiable definition. Industry output for this sector is based on physical quantities of ton-miles, passenger-miles, or barrel-miles. In both trucking and railroads, the index of ton-miles is adjusted for changes in commodity mix being transported. The adjustment factor is the difference between the price weighted growth rate of tons of commodities and the unweighted aggregate growth rate of tons of commodities. There are over 170 commodity lines for railroads and trucking. For the air transportation industry four separate measures of output are aggregated using revenue weights (fig. 2.1).

Input measures are indexes of total hours for the railroad and petroleum pipeline industries. For trucking, air transportation, and bus carriers, labor input measures are indexes of annual employment only.

A potential problem specific to trucking and railroads is the lack of data on average length of haul. To the extent that unit requirements are different for long-distance hauls versus short hauls, a bias occurs if average length of haul changes during the period studied. The adjustment for commodity mix changes, referred to above, may partially correct for this bias. Another pos-

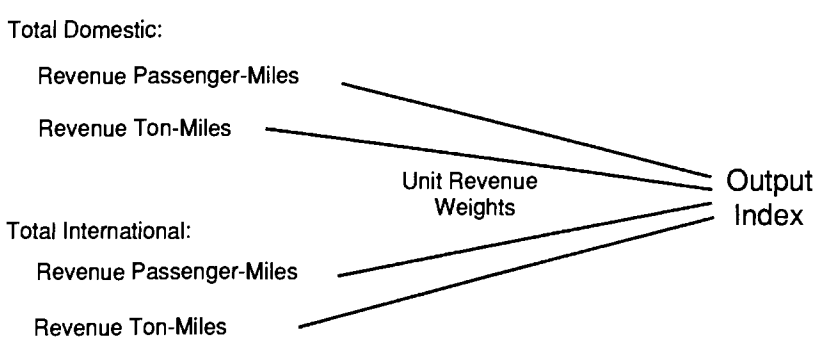

Fig. 2.1 Transportation: Air transportation (SIC 4511, 4521 part)
Note: Physical quantities are combined using unit revenue weights to create an industry output index.
Source: Bureau of Labor Statistics

sible problem, mentioned above, is the use of regulated output prices for deflating revenues or developing weights. If output prices, because of regulation, do not accurately reflect competitive market equilibrium conditions, then output measures can be biased. This problem is greater for the historical data than for recent data.

Communications. There is only one industry measure within the communications sector—telephone communications (SIC 4813), which covered 70 percent of total employment in the sector in 1987. Again, coverage has actually decreased over the past ten years as a result of rapid growth in the unmeasured industries (television, radio, and cable television broadcasting).

Output indexes are generated as weighted aggregates of deflated revenues collected by four different categories of telephone services: local calls, measured toll service (MTS), wide-area toll service (WATS), and all other (this includes private line service). The revenue data are collected and published by the Federal Communications Commission. Deflators are derived from price indexes compiled and published by the BLS under its producer price index program. Revenues by type of service are used as weights. Labor input is an index of total hours derived from the bureau's establishment survey data.

Besides the possible problem of regulated prices, a measurement problem may exist because of flat-rate charges for WATS or local service. The price indexes for flat-rate services reflect changes in the service rate only and do not reflect changes in the volume of traffic or other additional services being provided with the local or WATS service. Hence changes in deflated revenues may not reflect total changes in outputs.

Electric, gas, and sanitary services. The bureau publishes three productivity measures for industries in this group. The industries are electric utilities (SIC 491 plus part of SIC 493), gas utilities (SIC 492 plus part of SIC 493), and

the combination of the two. These measures do not include any government-owned establishments. In 1987 the measures covered approximately 88 percent of total employment in this sector.

Output indexes in the electric utilities industry are weighted aggregates of seven types of electric services measured in kilowatt hours (fig. 2.2). Services are differentiated by type of customer: residential, commercial, industrial, and so on. Weights are unit revenues for each service. For the gas utilities industry the output index is a weighted aggregate of four types of services; again the weights are unit revenues by type of service. The two industries' outputs are aggregated using employee weights. Output data are collected by the Department of Energy, the Rural Electrification Administration, and the American Gas Association. Input indexes are derived from employment and average hours data collected by the bureau's establishment survey.

Trade. The trade sector is the largest of the service producing sectors. In 1987 over 26 million people worked in this area. The bureau publishes measures for 23 different industries of which 19 are mutually exclusive. These published industries cover 17 million workers or 65 percent of the trade sector. Only one of these measures—scrap and waste materials (SIC 5093)—is in wholesale trade. The remainder of the measures are for retail trade industries.

With the exception of scrap and waster materials, output indexes for the trade industries are weighted aggregates of deflated sales of merchandise lines. Sales data, available from the census of retail trade and annually from *Current Business Reports,* are deflated by price indexes derived from CPIs. For census years the sales data are reported by merchandise lines. For noncensus years more aggregated sales data are reported. For the later, deflators are calculated by combining the prices with the base year weights. The number of merchandise lines varies by industry (table 2.2).

Several types of weights are used in the BLS measures (figs. 2.3 and 2.4). The most commonly used weights are product group gross margins derived from the input-output tables produced by the BEA. Unfortunately gross margin data are not available for all merchandise lines reported. Labor cost weights are used for some years in the retail food store measure. Employment weights are used in the franchised new car dealer measure. Detailed all employee hours weights are used for department stores. Industry all person hour weights are sometimes used to weight four-digit measures into two-digit measures, as in retail food stores and total apparel stores. In some industry measures, gasoline service stations, for example, gross margin weights were not available for most of the services and products sold, other than gasoline. In these cases sales data are used for weighting products sold.

The labor input indexes for most of the measures in retail trade are all-persons hours. The bureau includes measures of self-employed and unpaid family workers derived from either IRS data or current population survey data. Some measures, for example, department stores and franchised new car

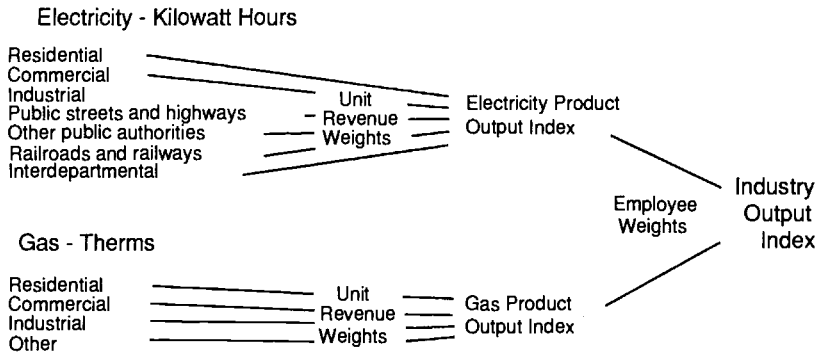

Fig. 2.2 Utilities: Gas and electric utilities (SIC 491, 492, 493)
Note: Physical quantities are combined to form output indexes using unit revenue weights. Indexes are aggregated to an industry output index using employee weights.
Source: Bureau of Labor Statistics

Table 2.2 Number of Merchandise Lines for Retail Industries

Covered Retail Trade Industries	Merchandise Lines Used
Hardware stores (SIC 5251)	23
Department stores (SIC 5311)	41
Variety stores (SIC 5331)	33
Grocery stores (SIC 5411)	26
Retail bakeries (SIC 546)	15
Franchised new car dealers (SIC 5511)	7
Auto & home supply stores (SIC 553)	17
Gasoline service stations (SIC 5541)	11
Men's & boy's clothing stores (SIC 5611)	20
Women's ready-to-wear stores (SIC 5621)	19
Family clothing stores (SIC 5651)	22
Shoe stores (SIC 5661)	7
Furniture & home furnishings stores (SIC 571)	56
Appliance, radio, TV, & music stores (SIC 572, 573)	36
Household appliance stores (SIC 572)	17
Radio, TV, & music stores (SIC 573)	19
Eating & drinking places (SIC 58)	5
Drug- & proprietary stores (SIC 5912)	30
Liquor stores (SIC 5921)	6

Source: Bureau of Labor Statistics.

dealers, are all employee hours measures because of the lack of suitable self-employed and unpaid-family-worker information from these sources.

Hardware stores (SIC 525) provide a good example of productivity measurement methods in retail sales. For a benchmark year (economic census year) annual sales are reported by merchandise line for the industry in the

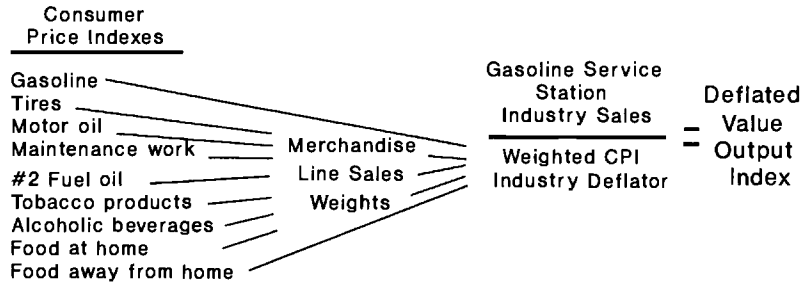

Fig. 2.3 Retail trade: Gasoline service station (SIC 5541)
Source: Bureau of Labor Statistics

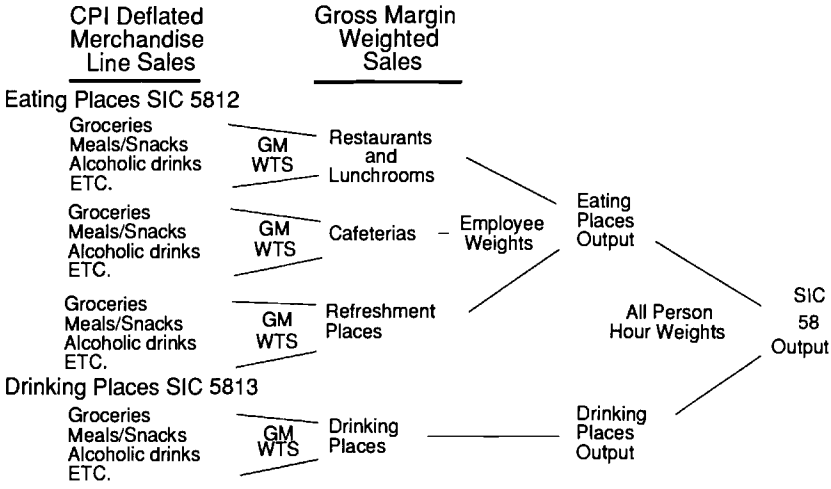

Fig. 2.4 Retail trade: Eating and drinking places (SIC 58)
Note: Merchandise line sales are deflated by CPIs or combined CPI deflators and then aggregated to industry segments using gross margin weights. Segments are further aggregated with employment and hours weights.
Source: Bureau of Labor Statistics

census of retail trade. To provide output indexes between pairs of benchmark years, these detailed sales data are separately deflated by the appropriate CPIs and aggregated using base-year gross margin weights. The gross margin weights are introduced as a proxy for labor weights in the aggregation of quantities. The gross margin data are developed from BEAs input-output tables.

Annual measures of output for hardware stores are developed from total industry sales as reported in current business reports; CPIs for all items sold in hardware stores; and from merchandise line sales reported in the most recent economic census. Annual industry sales, reported for the total industry,

are deflated using an aggregation of CPIs. The price indexes are weighted according to the reported merchandise line sales from the most recent census. Table 2.3 lists the merchandise lines and CPIs used for hardware stores. The annual output indexes are bench marked to the benchmark year indexes derived, as described above, from the more detailed sales data published in each census of retail trade.

Labor input for the hardware stores measure is an index of hours of all persons working in the industry. The number of employees and the average weekly hours of nonsupervisory workers are derived directly from the bureau's establishment survey. The number of self-employed and unpaid family workers and their respective average weekly hours are derived from current population survey data. The average hours of supervisory workers are constructed from the census of population. These average hours are held constant between decennial census years. Average hours and employment by class of worker are simply multiplied and summed over all classes of workers in the industry.

Finance, insurance, and real estate. Commercial banking (SIC 602) is the only industry in this sector for which the bureau publishes a productivity measure. In 1987 commercial banks employed 1.56 million people, or 22 percent of all workers in the finance, insurance, and real estate sector.

The output measure for this industry is based on the number of transactions for three major banking activities: time and demand deposits, loans, and trusts (fiduciaries). (See fig. 2.5.) Each major activity is an aggregate of more refined measures. The indexes for these three activities are aggregated with fixed-year employment weights to obtain the output index for commercial banking. The employment weights were derived for 1967, 1972, 1977, and 1982 from data published in the Federal Reserve's functional cost analysis (FCA).

The components of time deposits consist of (1) demand deposits, and (2) time and savings deposits. Output indexes for both of these categories are constructed and aggregated on the basis of employment weights derived from the FCA. Time and savings deposits at commercial banks include all regular savings accounts, club accounts, certificates of deposit, and other time deposits.

The output measure for demand deposits consists of two components—the number of checks written by the public and transacted through the banks, plus the number of electronic funds transfers (EFTs) to the banks' customer accounts. The two sets of numbers are added for each year, yielding the number of demand deposit transactions from 1967 forward.

The output series for the number of checks is based on three surveys conducted in 1970, 1974, and 1979 in addition to annual data published by the Federal Reserve System. The three surveys are used as benchmarks to which the Federal Reserve's annual data are adjusted by linear interpolation.

Table 2.3 Merchandise Lines, Sales, and CPIs Used for Hardware Stores, 1982

Merchandise Lines	1982 Sales ($1,000)	Percent	CPIs
Groceries & other foods	13,266	0.0016	Food at home
Cigars, cigarettes, & tobacco	10,025	0.0012	Tobacco products
Health & beauty aids	11,478	0.0014	Toilet goods & personal care appliances
Men's & boys' clothing, except footwear	11,827	0.0015	Men's & boys' apparel
Women's & girls' wear, except footwear	6,454	0.0008	Women's & girls' apparel
Footwear, except infants'	8,256	0.0010	Footwear
Curtains, draperies, & dry goods	6,977	0.0009	Textile house furnishings
Major household appliances	203,986	0.0252	Household appliances
Small electric appliances	184,128	0.0228	Office machines, small electric appliances, etc.
TVs	44,624	0.0055	Television
Audio equipment, musical instruments, supplies	32,843	0.0041	Sound equipment
Furniture & sleeping equipment	42,112	0.0052	Furniture & bedding
Floor coverings	23,680	0.0029	Floor & window coverings, infants, laundry, etc.
Kitchenware & home furnishings	434,429	0.0537	Tableware, serving pieces, etc.
Jewelry	6,183	0.0008	Jewelry & luggage
Sporting goods	271,409	0.0335	Sporting goods & equipment
Hardware & tools	3,047,705	0.3766	Weighted CPIs*
Plumbing & electrical supplies	1,640,569	0.2027	Plumbing, heating, elec. & cool. supplies
Lawn & garden equipment & supplies	784,706	0.0970	Weighted CPIs†
Lumber & building materials	1,106,017	0.1367	Maintenance & repair commodities
Cars, trucks, & power vehicles	7,401	0.0009	New vehicles
Automotive fuels & lubricants	84,774	0.0105	Motor fuel, motor oil, coolant
Auto tires, batteries & accessories	94,733	0.0117	Automobile parts & equipment
Household fuels	14,740	0.0018	Fuel oil, coal & bottled gas
Total MLS used	8,092,322	1.0000	
Total MLS reported in census	8,335,088		
MLS used as a percentage of MLS reported in census	0.9709		

*Weighted CPIs: lawn equipment, power tools, & other hardware; miscellaneous supplies & equipment (maintenance & repair commodities).

†Weighted CPIs: lawn equipment, power tools & other hardware; lawn & garden supplies.

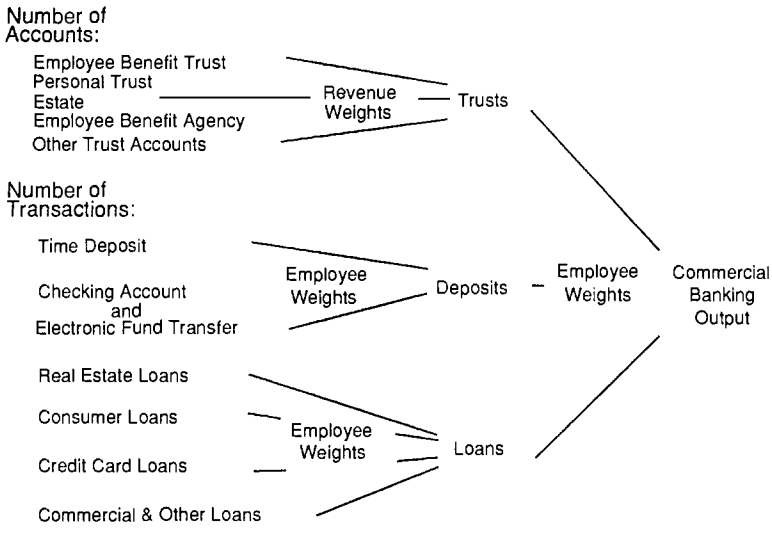

Fig. 2.5 Finance: Commercial banking (SIC 602)
Source: Bureau of Labor Statistics

Loans are measured in terms of the number of new loans extended. The loan output measure is an aggregate of four types of loans: real estate, consumer, credit card, and, commercial and other loans. These loan outputs are aggregated by employment weights, derived from the FCA, for 1967, 1972, 1977, and 1982.

The output measure for real estate loans represents the number of residential mortgage loans, the number of construction loans, and the number of commercial mortgage loans. Data used to derive real estate loans are obtained from the Federal Housing Association (FHA) and the U.S. Department of Housing and Urban Development (HUD).

The index for consumer loans is a composite of the number of automobile loans, home improvement loans, personal loans, mobile home loans, and other installment loans. The weights used to aggregate the consumer loans output components are derived from American Bankers Association (ABA) data on the expense per average loan. The number of credit card loans is represented by the physical volume of bank credit card transactions. The output measure is based on the number of bank credit card transactions occurring within the United States as reported by the VISA card network and the Mastercard Association.

The measure of trust department output is the number of accounts. The total number of accounts, by type, is combined on the basis of net income, as reported by the FCA.

The output measure for commercial and other loans, for 1977 forward, is based on the number of loans as reported in the Federal Reserve's survey of

terms of bank lending. Prior to 1977 no information on commercial loans is included in the banking output index.

Labor input in commercial banking is measured by an index of all-employees hours from 1967 forward. The number of employees and hours are derived from BLS establishment data. Average weekly hours are available only for nonsupervisory workers. They are inputed to all employees. This procedure assumes that supervisory workers work the same number of average weekly hours as nonsupervisory workers.

Services. The bureau publishes only five measures in the services division of the SIC system, which includes, for example, hotels (SIC 7011) and automotive repair shops (SIC 753). The employment coverage for these five industries is the lowest of all the sectors in the overall service sector at just 17 percent. Furthermore, this number is somewhat inflated because this sector has the largest percentage of nonprofit establishments, and these are not included in the denominator of the coverage ratio.

Outputs are aggregated indexes of deflated revenues. In general, deflators are constructed from appropriate CPIs and revenue weights. Labor input indexes are derived from the bureau's establishment survey of employment and hours, the current population survey, and IRS data. The CPS and IRS data are used to estimate the number of self-employed and unpaid family workers.

An example of productivity measurement in the service division is the automotive repair shop industry (SIC 753). Annual measures of output are constructed by deflating total industry receipts, as reported in current business reports, service annual survey, by the CPI expenditure category "automative maintenance and repair."

The annual output indexes are bench marked every five years to the receipts data published in the census of service industries. Figure 2.6 diagrams the construction of the output index for benchmark years. For a benchmark year, annual receipts are reported for 12 kind-of-operation groupings. The annual receipts are deflated by appropriate CPIs to the previous benchmark year, indexed, and combined to the three-digit level using base-year paid-employee data as weights.

The receipts data available by kind of operation are for those establishments with payroll. To arrive at an all-establishment index, a coverage adjustment ratio is derived by dividing industry receipts of all establishments by receipts of establishments with payroll. The index of weighted receipts is multiplied by this coverage adjustment ratio to arrive at the final benchmark output index for each census period.

Labor input for automotive repair shops is an index of hours of all persons working in the industry. The number of employees and the average weekly hours of nonsupervisory workers are derived directly from the bureau's establishment survey. The number of self-employed workers is derived from IRS data. The number of unpaid family workers and the average weekly hours for

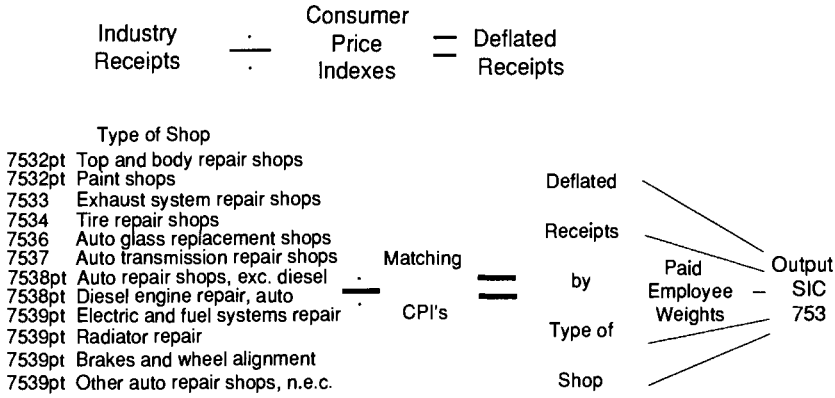

Fig. 2.6 Services: Automotive repair shops (SIC 753)
Note: Individual shop receipts are only from establishments with payrolls. Industry output is further adjusted at the total industry level to reflect the output of all establishments.
Source: Bureau of Labor Statistics

Class of Worker	Employment Source	Average Weekly Hours Source
Nonsupervisory Employees	BLS Establishment Survey	BLS Establishment Survey
Supervisory Employees	BLS Establishment Survey	Census of Population
Partners	IRS Statistics of Income	Current Population Survey
Proprietors	IRS Statistics of Income	Current Population Survey
Unpaid Family Workers	Current Population Survey	Current Population Survey

Fig. 2.7 Employment and hours sources for service industries
Source: Bureau of Labor Statistics.

self-employed and unpaid family workers are derived from current population survey data. The average hours of supervisory workers are constructed from the census of population. These hours are held constant between decennial census years. Average hours and employment by class of worker are multiplied and summed over all classes of workers in the industry. Figure 2.7 shows the construction of labor input for all the service industries described above.

2.5 Results

Tables 2.4, 2.5, and 2.6 show the average growth rates of labor productivity, output, and labor input, respectively, for the published industries in the service sector. Figures 2.8–2.14 show the measures of all the industries. Time periods have been selected according to business cycle peaks except for the

Table 2.4 **Output per Hour for Service Industries, Average Annual Rates of Change (%)**

Industry (SIC)	Annual Growth Rate			Change in Annual Growth Rate	
	1967–73	1973–79	1979–87	1967–73 to 1973–79	1973–79 to 1979–87
Transportation:					
Railroad transport, revenue traffic (SIC 401)	4.9%	1.4%	8.9%	−3.5%	7.5%
Bus carriers, class I (SIC 4111, 413, 414)(part)	−1.3	−1.3	−1.0	0.0	0.3
Intercity trucking (SIC 4213)(part)*	3.6	3.2	2.2	−0.4	−1.0
Intercity trucking, freight (SIC 4213)(part)*	3.4	4.1	2.8	0.7	−1.3
Air transportation (SIC 4511, 4521)(part)*	4.6	4.8	3.3	0.1	−1.5
Petroleum pipelines (SIC 4612, 4613)	7.1	0.7	0.4	−6.4	−0.3
Communications:					
Telephone communications (SIC 4811)	4.6	6.8	5.2	2.2	−1.6
Electric, gas, & sanitary services:					
Gas & electric utilities (SIC 491, 492, 493)	4.5	0.9	−0.5	−3.6	−1.5
Electric utlities (SIC 491, 493)(part)	5.2	1.3	0.7	−4.0	−0.6
Gas utilities (SIC 492, 493)(part)	2.8	−0.2	−4.5	−3.0	−4.3
Trade:					
Scrap & waste materials (SIC 5093)			2.9		
Hardware stores (SIC 5251)		2.6	2.5		0.0
Department stores (SIC 5311)	1.9	3.2	3.6	1.2	0.4
Variety stores (SIC 5331)	1.2	−2.7	−0.6	−3.9	2.0
Retail food stores (SIC 54)	1.2	−0.7	−0.7	−1.8	−0.1
Grocery stores (SIC 5411)		−0.3	−0.7		−0.4
Retail bakeries (SIC 546)		−1.9	−2.7		−0.9
Franchised new car dealers (SIC 5511)	2.9	0.2	1.2	−2.7	0.9
Auto & home supply stores (SIC 5531)		2.3	3.3		1.1
Gasoline service stations (SIC 5541)	5.3	3.7	3.4	−1.6	−0.4
Apparel & accessory stores (SIC 56)	3.4	2.1	2.9	−1.3	0.8
Men's & boys' clothing stores (SIC 5611)	3.6	0.8	2.7	−2.8	1.8
Women's ready-to-wear stores (SIC 5621)	4.8	3.5	4.6	−1.2	1.1
Family clothing stores (SIC 5651)	6.4	−0.1	2.2	−6.6	2.3
Shoe stores (SIC 5661)	0.9	1.9	0.8	1.0	−1.2
Furniture, home furnishing, & equipment stores (SIC 57)	5.2	2.0	4.0	−3.2	1.9
Furniture & home furnishings stores (SIC 571)	5.1	1.4	0.9	−3.7	−0.5
Appliance, radio, TV, & music stores (SIC 572, 573)	5.5	3.0	8.2	−2.5	5.2
Household appliance stores (SIC 5722)		3.4	5.6		2.2
Radio, TV, & music stores (SIC 573)		2.4	9.1		6.8
Eating & drinking places (SIC 58)	1.0	−0.6	−1.2	−1.6	−0.5
Drug & proprietary stores (SIC 5912)	6.4	1.1	0.0	−5.3	−1.1
Liquor stores (SIC 592)		−0.7	−0.7		0.1
Finance, insurance, & real estate:					
Commercial banking (SIC 602)	2.3	0.6	2.0	−1.7	1.4

Table 2.4 (continued)

Industry (SIC)	Annual Growth Rate			Change in Annual Growth Rate	
	1967–73	1973–79	1979–87	1967–73 to 1973–79	1973–79 to 1979–87
Services:					
Hotels, motels, & tourist courts (SIC 7011)	1.8	1.4	−1.6	−0.4	−3.0
Laundry & cleaning services (SIC 721)	0.5	−0.2	−1.9	−0.6	−1.7
Beauty & barber shops (SIC 7231,41)		1.1	−1.0		−2.1
Beauty shops (SIC 723)		0.3	−0.9		−1.2
Automotive repair shops (SIC 753)		−0.7	−0.5		0.1

*Labor input used is number of employees.

beginning and end points of the complete series. The end point, 1987, is the last year for which measures have been completed for all industries. The beginning point, 1967, is the first year for which measures are complete for most of the industries.

During the first time period, 1967–73, of the 24 mutually exclusive industries, only one (bus carriers) experienced negative productivity growth (−1.3 percent). The industry with the highest rate of productivity growth was petroleum pipelines (7.1) percent). Two industries, bus carriers and laundry and cleaning services, had negative output growth during this period. Telephone communications and electric utilities had the fastest output growth rates, 8.3 percent annual rates of increase in both cases.

During the second time period, 1973–79, 10 of the 31 mutually exclusive industries experienced negative productivity growth. It is important to note that 19 of the original 24 industries had slower productivity growth during the slowdown period than in the earlier period. Six industries actually had negative output growth in this period, and 19 had slower output growth rates than during the first period. The industry with the highest productivity growth rate for this period was the telephone communications industry (6.8 percent annually), which also had the best increase in productivity growth from the first period to the next. Radio, television, and music stores had the fastest rate of output growth at 9.2 percent annually. Another strong performer in terms of output growth (6.8 percent) and productivity growth (4.8 percent) for this period was the airlines industry.

For the same time period, 1973–79, variety stores had the worst productivity growth performance (−2.7 percent); family clothing stores experienced the greatest decline in the annual productivity growth rate from the first to the second period (6.6 percentage points). The petroleum pipelines industry also had a large turnaround in its productivity growth rate, dropping 6.4 percentage points from the previous time period. Two other industries showing poor performance during this period were gas utilities and electric utilities. The gas

Table 2.5 Output for Service Industries, Average Annual Rate of Change (%)

Industry (SIC)	Annual Growth Rate			Change in Annual Growth Rate	
	1967–73	1973–79	1979–87	1967–73 to 1973–79	1973–79 to 1979–87
Transportation:					
Railroad transport, revenue traffic (SIC 401)	2.2%	0.1%	0.6%	−2.1%	0.5%
Bus carriers, class I (SIC 4111, 413, 414)(part)	−3.7	−0.9	−7.2	2.8	−6.3
Intercity trucking (SIC 4213)(part)	7.0	2.0	−1.7	−5.1	−3.6
Intercity trucking, freight (SIC 4213)(part)	5.5	1.3	−2.3	−4.2	−3.7
Air transportation (SIC 4511, 4521)(part)	7.4	6.8	7.0	−0.6	0.2
Petroleum pipelines (SIC 4612, 4613)	5.1	4.0	−0.7	−1.1	−4.7
Communications:					
Telephone communications (SIC 4811)	8.3	8.2	5.4	−0.1	−2.8
Electric, gas, & sanitary services:					
Gas & electric utilities (SIC 491, 492, 493)	6.7	2.5	0.9	−4.3	−1.6
Electric utilities (SIC 491, 493)(part)	8.3	3.4	3.1	−4.9	−0.3
Gas utilities (SIC 492, 493)(part)	3.2	−0.1	−5.9	−3.3	−5.7
Trade:					
Scrap & waste materials (SIC 5093)			1.9		
Hardware stores (SIC 5251)		4.3	3.8		−0.5
Department stores (SIC 5311)	5.8	2.9	5.1	−2.9	2.2
Variety stores (SIC 5331)	2.3	−5.2	−3.7	−7.5	1.5
Retail food stores (SIC 54)	2.2	1.1	1.8	−1.0	0.7
Grocery stores (SIC 5411)		1.4	2.0		0.6
Retail bakeries (SIC 546)		0.3	−0.6		−0.9
Franchised new car dealers (SIC 5511)	4.7	0.3	2.7	−4.4	2.4
Auto & home supply stores (SIC 5531)		5.8	6.3		0.5
Gasoline service stations (SIC 5541)	5.1	−1.2	2.0	−6.3	3.2
Apparel & accessory stores (SIC 56)	4.7	4.3	6.0	−0.4	1.7
Men's & boys' clothing stores (SIC 5611)	5.4	0.5	−1.3	−5.0	−1.7
Women's ready-to-wear stores (SIC 5621)	5.9	5.3	7.3	−0.6	2.0
Family clothing stores (SIC 5651)	6.5	4.6	8.8	−1.9	4.1
Shoe stores (SIC 5661)	2.9	4.1	3.0	1.3	−1.1
Furniture, home furnishings, & equipment stores (SIC 57)	7.3	4.4	7.9	−2.9	3.5
Furniture & home furnishings stores (SIC 571)	7.8	3.0	3.7	−4.8	0.7
Appliance, radio, TV, & music stores (SIC 572, 573)	6.5	6.6	13.9	0.1	7.3
Household appliance stores (SIC 5722)		2.1	6.7		4.6
Radio, TV, & music stores (SIC 573)		9.2	16.9		7.7
Eating & drinking places (SIC 58)	3.8	3.2	2.6	−0.5	−0.6
Drug & proprietary stores (SIC 5912)	5.5	1.5	1.5	−4.0	−0.1
Liquor stores (SIC 592)		0.8	−1.7		−2.5
Finance, insurance, & real estate:					
Commercial banking (SIC 602)	8.1	4.6	4.9	−3.5	0.3

Table 2.5 (continued)

Industry (SIC)	Annual Growth Rate			Change in Annual Growth Rate	
	1967–73	1973–79	1979–87	1967–73 to 1973–79	1973–79 to 1979–87
Services:					
Hotels, motels, & tourist courts (SIC 7011)	3.8	4.3	3.4	0.5	−0.9
Laundry & cleaning services (SIC 721)	−4.6	−3.4	−1.0	1.3	2.4
Beauty & barber shops (SIC 7231, 7241)		−0.2	1.8		2.0
Beauty shops (SIC 723)		1.0	3.1		2.1
Automotive repair shops (SIC 753)		4.0	4.4		0.5

utilities productivity rate dropped 3.0 percentage points and electric utilities dropped 4.0 percentage points from the first to the second period.

During the latest time period, 1979–87, 11 of 32 industries experienced average annual rates of decline in productivity. Also, 17 industries had slower rates of growth for this period, compared to the previous time period. Of these 17 industries, 10 had slower productivity growth in the second period than in the first. The service industry with the highest productivity growth rate for this period was again radio, television, and music stores at an impressive 9.1 percent rate. It also had the highest rate of growth in output. The industry with the slowest rate of productivity growth was gas utilities (−4.5 percent annually). This industry also had the largest decline in productivity growth from the second to the third time periods.

2.6 Comparisons

As stated earlier, the BLS develops measures of output and productivity for industries classified mainly at the three- and four-digit SIC levels. The BEA develops measures of output only for industries classified at the one- and two-digit SIC level of classification. In general, it is not possible to compare output measurement results because of the different levels of coverage.

In addition, the output measures developed by BEA are based on value-added or net output; BLS prepares gross output measures. The BEA measures are developed to show the contribution by each industry to GNP (see Mohr, chap. 1, this vol.). The BLS measures are developed for the purpose of measuring productivity changes.[4] However, because of data limitations, the BEA cannot always measure value-added output using a double-deflation procedure

4. There are a number of studies that suggest that gross output measures should be used for productivity measurement at the industry level; at the aggregate level a value-added measure is appropriate. In order for value-added output to be appropriate at the industry level, strong separability must hold for capital and labor inputs with all other inputs.

Table 2.6 Hours for Service Industries, Average Annual Rate of Change (%)

Industry (SIC)	Annual Growth Rate			Change in Annual Growth Rate	
	1967–73	1973–79	1979–87	1967–73 to 1973–79	1973–79 to 1979–87
Transportation:					
Railroad transport, revenue traffic (SIC 401)	−2.6%	−1.3%	−7.5%	1.3%	−6.3%
Bus carriers, class I (SIC 4111, 413, 414)(part)	−2.4	0.4	−4.4	2.8	−4.8
Intercity trucking (SIC 4213)(part)*	3.3	−1.2	−3.4	−4.5	−2.2
Intercity trucking, freight (SIC 4213)(part)*	2.0	−2.6	−4.4	−4.7	−1.8
Air transportation (SIC 4511, 4521)(part)*	2.6	1.9	1.9	−0.7	0.0
Petroleum pipelines (SIC 4612, 4613)	−1.9	3.3	−0.9	5.2	−4.2
Communications:					
Telephone communications (SIC 4811)	3.5	1.3	−1.1	−2.2	−2.3
Electric, gas, & sanitary services:					
Gas & electric utilities (SIC 491, 492, 493)	2.1	1.5	1.2	−0.6	−0.3
Electric utlities (SIC 491, 493)(part)	2.9	2.1	1.6	−0.9	−0.5
Gas utilities (SIC 492, 493)(part)	0.4	0.0	0.1	−0.4	0.0
Trade:					
Scrap & waste materials (SIC 5093)			−2.0		
Hardware stores (SIC 5251)		1.7	0.3		−1.5
Department stores (SIC 5311)	3.8	−0.2	0.2	−4.0	0.4
Variety stores (SIC 5331)	1.1	−2.6	−2.2	−3.7	0.4
Retail food stores (SIC 54)	1.0	1.8	2.1	0.8	0.3
Grocery stores (SIC 5411)		1.7	2.2		0.5
Retail bakeries (SIC 546)		2.2	2.4		0.2
Franchised new car dealers (SIC 5511)	1.7	0.1	0.8	−1.7	0.8
Auto & home supply stores (SIC 5531)		3.4	1.3		−2.1
Gasoline service stations (SIC 5541)	−0.2	−4.7	−1.8	−4.5	3.0
Apparel & accessory stores (SIC 56)	1.2	2.1	1.5	0.9	−0.6
Men's & boys' clothing stores (SIC 5611)	1.7	−0.3	−3.5	−2.1	−3.2
Women's ready-to-wear stores (SIC 5621)	1.1	1.7	0.8	0.6	−0.9
Family clothing stores (SIC 5651)	0.1	4.8	4.2	4.7	−0.6
Shoe stores (SIC 5661)	1.9	2.2	1.5	0.2	−0.7
Furniture, home furnishings, & equipment stores (SIC 57)	1.9	2.3	1.8	0.3	−0.5
Furniture & home furnishings stores (SIC 571)	2.6	1.5	1.8	−1.0	0.3
Appliance, radio, TV, & music stores (SIC 572, 73)	0.9	3.4	1.8	2.5	−1.6
Household appliance stores (SIC 5722)		−1.2	−0.6		0.6
Radio, TV, & music stores (SIC 573)		6.6	3.0		−3.7
Eating & drinking places (SIC 58)	2.8	3.9	3.1	1.1	−0.7
Drug & proprietary stores (SIC 5912)	−0.8	0.4	1.1	1.2	0.7
Liquor stores (SIC 592)		1.6	−0.6		−2.2
Finance, insurance, & real estate:					
Commercial banking (SIC 602)	5.7	4.0	1.6	−1.7	−2.4

Table 2.6 *(continued)*

Industry (SIC)	Annual Growth Rate			Change in Annual Growth Rate	
	1967–73	1973–79	1979–87	1967–73 to 1973–79	1973–79 to 1979–87
Services:					
Hotels, motels, & tourist courts (SIC 7011)	2.0	2.8	4.2	0.8	1.3
Laundry & cleaning services (SIC 721)	−5.1	−3.2	1.1	1.9	4.3
Beauty & barber shops (SIC 7231,41)		−1.2	2.4		3.7
Beauty shops (SIC 723)		0.7	3.3		2.5
Automotive repair shops (SIC 753)		4.7	3.9		−0.8

*Labor input used is number of employees.

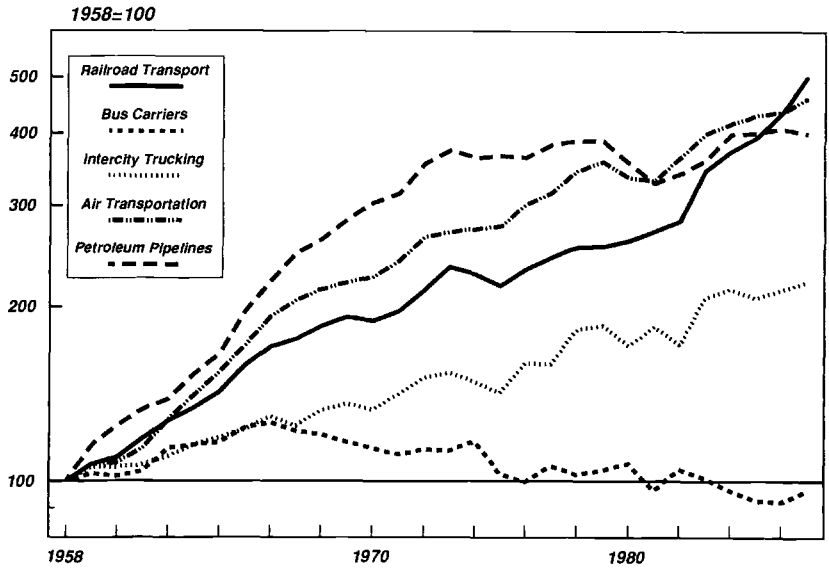

Fig. 2.8 Productivity in transportation industries

and must rely on procedures and data that may approximate gross output changes for certain industries (see Mohr, chap. 1, this volume). For this reason and because many two-digit SIC industries contain only one four-digit industry, some of the BEA and BLS industry output measures may be roughly comparable.

Of the 39 service industries published by the BLS, there are 10 that may be roughly comparable. The industries are (1) railroad transport (SIC 40); (2) bus carriers (SIC 41); (3) intercity trucking (SIC 42); (4) air transportation (SIC

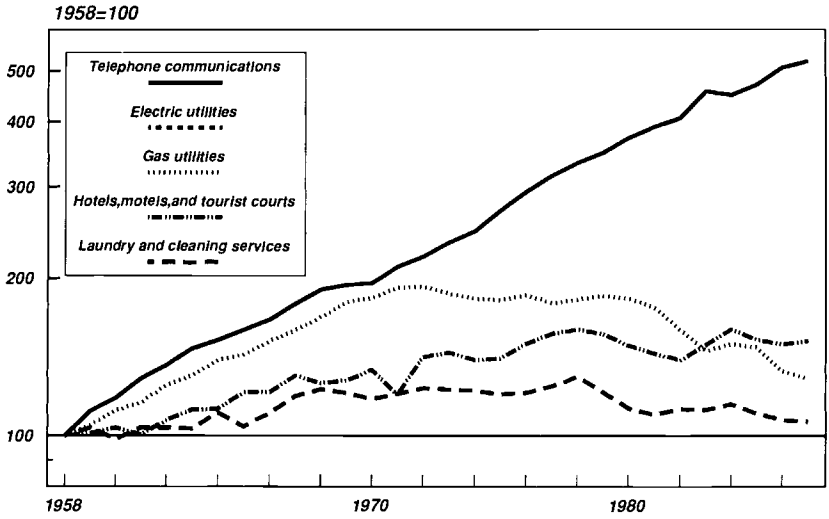

Fig. 2.9 Productivity in telephone communications, utilities, and selected services

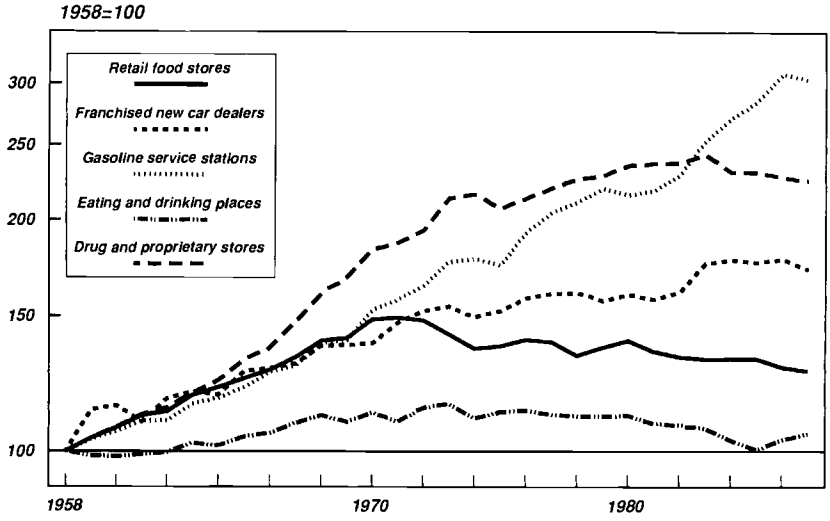

Fig. 2.10 Productivity in retail industries with measures beginning in 1958

45); (5) petroleum pipelines (SIC 46); (6) telephone communications (SIC 48); (7) electric, gas, and sanitary services (SIC 49); (8) commercial banking (SIC 60); (9) hotels, motels, and tourist courts (SIC 70); and (10) automotive repair shops (SIC 75). Table 2.7 shows the average annual growth rates of output for the three periods and the employment coverage of the BLS measure as a percentage of BEA coverage. As is evident from the table, employment

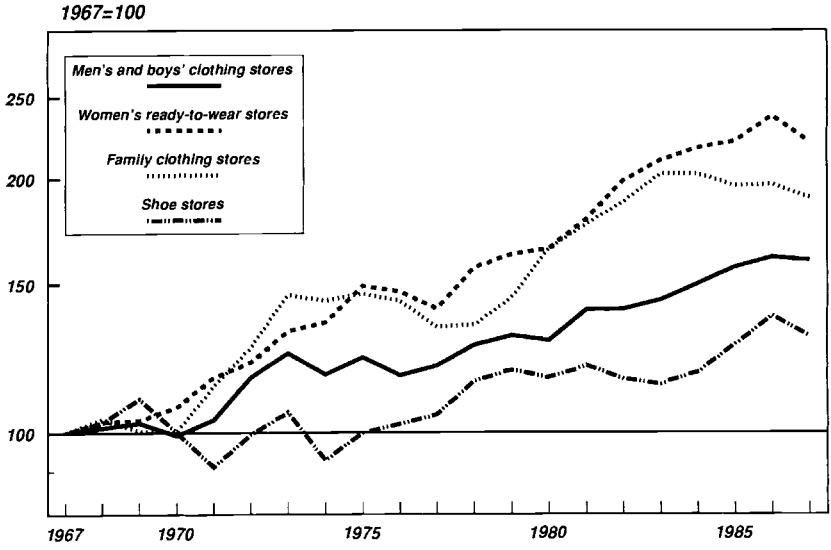

Fig. 2.11 Productivity in four types of apparel and accessory stores

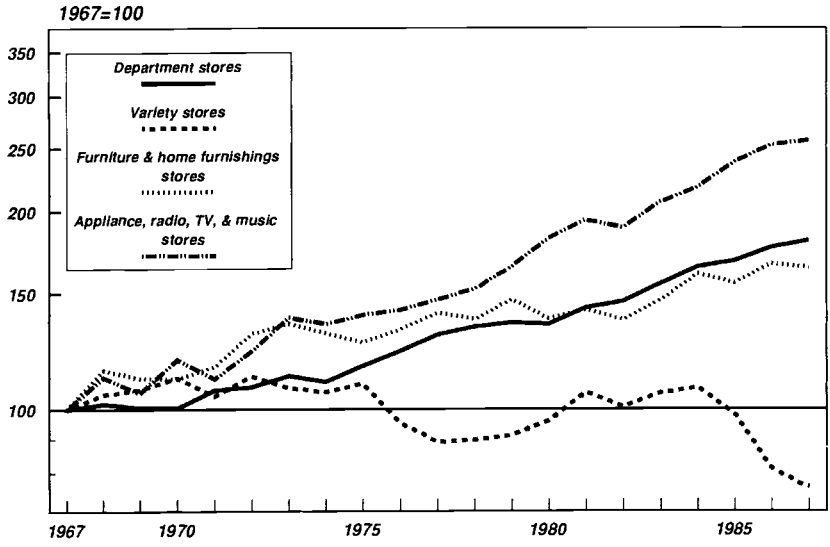

Fig. 2.12 Productivity in retail industries with measures beginning in 1967

coverage is 70 percent or less for the following four industries: bus carriers (6 percent), intercity trucking (27 percent), telephone communications (70 percent), and automotive repair shops (68 percent). For these industries comparison seems tenuous, though they often have similar output growth rates for the time periods shown. The petroleum pipeline industry is the only industry with

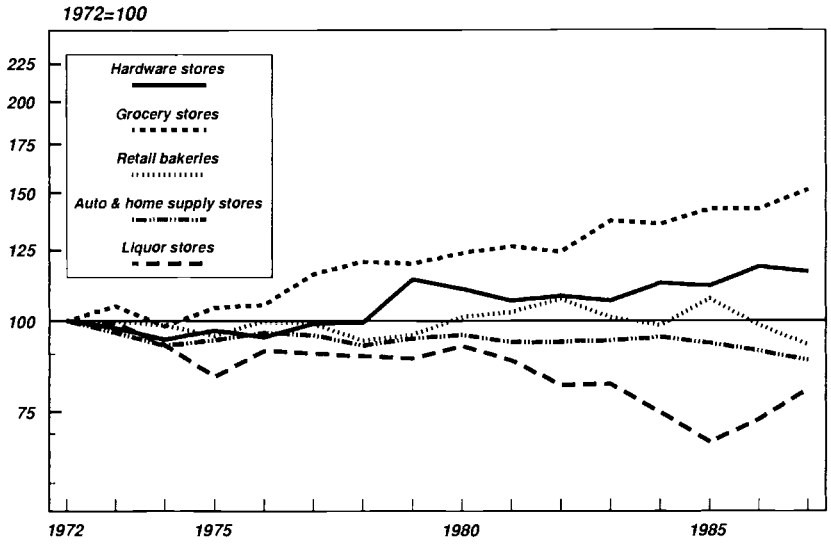

Fig. 2.13 Productivity in retail industries with measures beginning in 1972

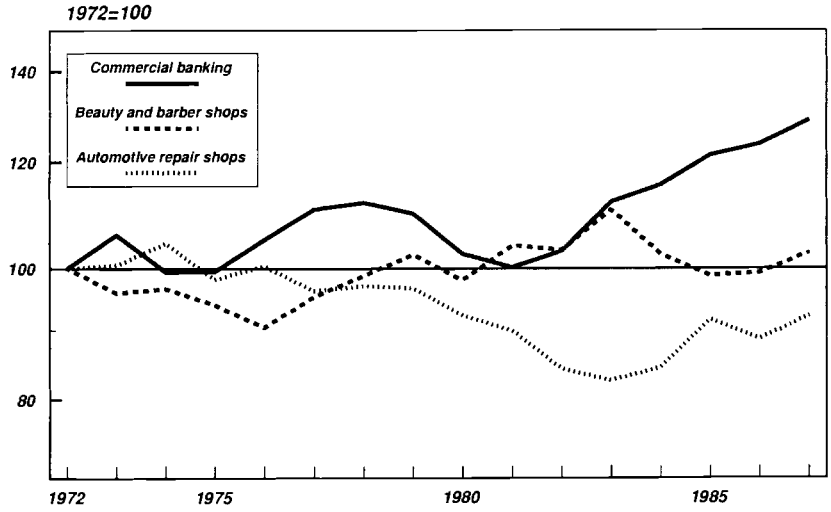

Fig. 2.14 Productivity in commercial banking, beauty, and barber shops, and automotive repair shops

identical BLS and BEA coverage. The output growth rates differ little for the periods shown.

The differences in growth rates in the railroad industry can be attributed to different methodologies of measurement. The BEA measure of output for the railroad industry is a value-added measure calculated using the double-deflation method. The BLS measure for this industry is a gross output mea-

Table 2.7 **Average Annual Rates of Change in Output and Employment Ratios for Selected Industries, BEA versus BLS, 1967–1987**

	BEA (%)	BLS (%)	Employment Ratio (BLS/BEA)
Railroad transport	SIC 40	SIC 401	90.0
1967–73	−1.3	2.2	
1973–79	0.3	0.1	
1979–87	−6.0	0.6	
Bus carriers	SIC 41	SIC 411,31,41	6.0
1967–73	−2.5	−3.7	
1973–79	0.2	−0.9	
1979–87	−1.9	−5.4	
Intercity trucking	SIC 42	SIC 4213 pt.	27.0
1967–73	6.8	7.0	
1973–79	2.5	2.0	
1979–87	0.8	−1.3	
Air transportation	SIC 45	SIC 4511,21	76.0
1967–73	6.0	7.4	
1973–79	6.0	6.8	
1979–87	1.6	5.2	
Petroleum pipelines	SIC 46	SIC 46	100.0
1967–73	5.8	5.1	
1973–79	3.1	4.0	
1979–87	−0.5	−0.5	
Telephone communications	SIC 48	SIC 4811	70.0
1967–73	8.6	8.3	
1973–79	6.1	8.2	
1979–87	5.2	4.1	
Electric, gas, & sanitary services	SIC 49	SIC 491,2,3	89.0
1967–73	6.9	6.7	
1973–79	1.8	2.5	
1979–87	3.0	0.7	
Commercial banking	SIC 602	SIC 60	90.0
1967–73	5.1	8.1	
1973–79	3.9	4.6	
1979–87	1.9	3.6	
Hotels, motels, & tourist courts	SIC 70	SIC 7011	94.0
1967–73	3.2	3.8	
1973–79	3.2	4.3	
1979–87	0.6	2.5	
Automotive repair shops	SIC 75	SIC 753	68.0
1967–73	6.9	n.a.	
1973–79	4.3	4.0	
1979–87	3.5	3.3	

sure based on revenue weighted ton-miles of freight and passenger-miles.[5] The same difference in methods exists for the output measures of the electric, gas, and sanitary services industry, though there is little difference in the growth rates except for the latest period. The BLS measure is gross output

5. See Robert J. Gordon (chap. 10, this vol.) for a detailed comparison of these measures.

based on revenue-weighted physical quantities of kilowatt hours of electricity and total therms of gas produced. The BEA measure is a value-added measure based on deflated receipts and expenses.

For the air transportation industry, much of the difference in the output growth rates can be attributable to differences in the methodology. Up until 1983 BEA measured output based on deflated sales, the BLS on the other hand, has always measured the output as a revenue weighted physical quantity measure of ton-miles and passenger-miles (see Gordon, chap. 10, this vol.). In another productivity study of the airline industry, Caves, Christensen, and Tretheway (1983), arrived at an output growth rate of 5.5 percent from 1970 to 1980. The BLS output index shows the same growth rate for this period.

The differences in the banking industry output measures are again attributable to differences in method, though both the BEA and the BLS methods differ from any discussed above. The BEA measure is an extrapolation of a base-year measure. Employment of persons engaged in production is used as the extrapolator (see Mohr, Chap. 1, this vol.). The BLS measure is based on weighted volume of different type of transactions completed.

For the hotel, motel, and tourist court industry the major difference is in the deflator used to deflate revenue. The BLS uses an aggregate of CPIs; the BEA uses a price index derived by a trade association.

Of the ten industries where it seemed probable that comparisons could be made, BLS employment coverage is 70 percent or less of BEA coverage for four industries, bus carriers, intercity trucking, telephone communications, and automotive repair shops. For four other industries (railroad transport; electric, gas, and sanitary services; air transportation; and banking) the two agencies used different methods of output calculation. Of the remaining two industries, the two agencies' published output series differ considerably for one, hotel, motel, and tourist courts, especially in recent periods; they are similar for the other, petroleum pipelines.

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Comment

W. Erwin Diewert

Edwin R. Dean and Kent Kunze are to be congratulated for presenting a clear exposition and discussion of the BLS's program of productivity measurement.

The focus of my comments will be on the bureau's annual industry productivity measures, which utilize gross output and hours of labor input information for 173 industries. I have four major criticisms of these productivity measures:

My first criticism is that these productivity measures are labor productivity measures and hence that they may be very imperfect indicators of changes in the industry's total factor productivity. Total factor productivity measures are much more useful than labor productivity measures, and I will now attempt to explain why this is so.

Each firm in an industry produces outputs and utilizes many inputs. A rough classification of a firm's outputs and inputs into different broad categories could be made as follows: (1) sales or gross outputs; (2) purchases of materials and goods; (3) purchases of business services; (4) leasing of capital services; (5) labor inputs; (6) capital input: machinery and equipment; (7) capital input: computers; (8) capital input: structures; (9) capital input: inventories; (10) capital input: land and natural resources; (11) capital input: R&D stock and patents; (12) capital input: marketing, trademarks, and advertising; and (13) capital input: human capital and the skills of the firm's workers. Categories 2–4 are intermediate input categories; 5–13 are primary input categories. Categories 6–10 are the traditional physical capital input categories (although the current system of national accounts ignores the contribution of land); 11–13 are the intangible capital input categories. The total factor productivity of a firm (or industry) going from period $t - 1$ to period t can be

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defined as $(Y_t/Y_{t-1})/(X_t/X_{t-1})$ where Y_t is the firm's real value added in period t (an aggregate of the quantities in categories 1–4, above, where intermediate inputs are indexed with a negative sign in the index number formula) and X_t is the firm's quantity of primary input utilized in period t (an aggregate of the inputs in categories 5–13, above). Measuring the total factor productivity of a firm, industry, or economy is a useful exercise because it gives us some indication of how much "free" output per unit of primary input was generated by the firm, industry, or economy going from period t 1 to period t. The gross output divided by labor productivity measures generated by the BLS can be defined (approximately) as $(Q_t/Q_{t-1})/(L_t/L_{t-1})$, where Q_t is the gross output produced by the industry under consideration in period t and L_t is the corresponding period t labor input (measured in unweighted man-hours). Thus the BLS labor productivity measures utilize information on only 2 of the 13 listed above: categories 1–5. Thus the BLS labor productivity measures generally do not closely approximate the total factor productivity measures (which should utilize information on all 13 categories of inputs and outputs).

My second criticism of the BLS labor productivity measures is that they are biased (compared to the labor productivity measures used by other countries) and that they do not aggregate properly over firms and industries. The problem is that the BLS measures use *gross output* instead of *real value added*. In the last two decades, business services (and imports) have been growing faster than gross output. Hence, for the economy as a whole, real value added has grown more slowly than gross output. Thus the BLS labor productivity measures tend to be *biased upward* compared to labor productivity measures calculated in most other industrial countries that use real value added in place of gross output. Because the labor productivity measures calculated in most other industrial countries use real value added in place of gross output, the U.S. labor productivity measures are not comparable with the labor productivity measures calculated by other countries. The use of gross output instead of value added also leads to difficulties in aggregating the BLS labor productivity measures over firms or industries in a consistent manner. These aggregation difficulties are not discussed here: the reader is referred to the papers by Domar, Hulten, and Diewert.[1]

My third criticism of the BLS labor productivity measures is more technical and has to do with the BLS choice of index number formula for measuring gross output. Following Dean and Kunze, define q_{it} as the gross output of product i in year t, define L_{it} as the aggregate number of labor hours spent in producing product i in year t and define $\ell_{it} = L_{it}/q_{it}$ as the unit labor require-

1. W. E. Diewert, Aggregation Problems in the Measurement of Capital, *The Measurement of Capital*, ed. D. Usher, vol. 45, NBER Studies in Income and Wealth (Chicago: Univ. of Chicago Press, 1980); E. D. Domar, On the Measurement of Technological Change, *Economic Journal* 71 (1961): 709–29; C. R. Hulten, Growth Accounting with Intermediate Inputs, *Review of Economic Studies* 45 (1978): 511–18.

ments of product i in year t. Dean and Kunze define their labor productivity measures as the left-hand side of the following equation:

$$\begin{aligned}\sum_i \ell_{i0} q_{it} / \sum_i \ell_{it} q_{it} &= \sum_i (L_{i0}/q_{i0})\, q_{it} / \sum_i (L_{it}/q_{it}) q_{it} \\ &= \sum_i (q_{it}/q_{i0})\, L_{i0} / \sum_i L_{it} \\ &= [\sum_i (q_{it}/q_{i0})(L_{i0}/\sum_j L_{j0})] \,/\, [\sum_i L_{it}/\sum_j L_{j0}].\end{aligned}$$

In the numerator of the right-hand side of the above equation, the ith output growth rate q_{it}/q_{i0} is weighted by the ith labor share for period 0, $L_{i0}/\Sigma_j L_{j0}$. In the denominator, we have the growth rate in unweighted labor hours going from period 0 to period t, $\Sigma_i L_{it}/\Sigma_j L_{j0}$. I am unaware of any discussion in the theoretical index number literature that justifies the use of such a strange output index. Even Irving Fisher did not consider such an odd index number formula.[2] Thus my third major criticism of the BLS labor productivity measure is that the choice of index number formula used to calculate the gross output growth rate is totally unconventional and leads to the U.S. gross output, labor productivity measures being noncomparable with the labor productivity measures computed by other countries. A related criticism of the choice of index number formula by the BLS is that it is usually very difficult to compute exactly how many hours of labor L_{it} were required in period to produce the corresponding amount of the ith output in period t.

My final criticism of the BLS labor productivity measures concerns the way the data are collected from different sources. Often, the data or sales are collected from one source of survey, the data for price deflators from another source, and the data or man-hours from a third source. The end result is that the output data do not actually correspond to the labor input data. Thus the resulting labor productivities could be seriously biased, depending on sample sizes and the intersection of the survey frames. The cure for this problem is easy to state (but probably difficult to implement): instead of having 13 separate business surveys to collect data for each of the 13 major categories listed above, there should be a *single* business survey that collects price and quantity information on all 13 categories of outputs and inputs. The statistical unit to be samples should be the firm (or establishment), and comprehensive economic data should be collected for *all* of the inputs and outputs that the firm produces and utilizes.

My conclusion is that the various U.S. statistical agencies (BLS, BEA, and the Census Bureau) should cooperate in the construction of comprehensive total factor productivity measures. It is simply too wasteful to have independent and unrelated measures of productivity. In fact, I think that the time is ripe for the creation of a comprehensive U.S. statistical agency. "Statistics USA" has a nice ring to it.

2. I. Fisher, *The Making of Index Numbers* (Boston: Houghton Mifflin, 1922).

Reply

Edwin R. Dean and Kent Kunze

W. Erwin Diewert's comments on our paper and the BLS's productivity-measurement program suggest that the bureau's labor productivity measures suffer from important shortcomings. As we had expected, Diewert's comments proved stimulating and provocative. We have responses to each of his four major criticisms:

First, he states that the BLS labor productivity measures are very imperfect indicators of changes in an industry's multifactor productivity because they use only 2 of 13 possible inputs and outputs. Although he rightly points out the advantages of multifactor productivity measures relative to labor productivity measures, he underestimates the value and usefulness of these measures.

As stated in our paper, the industry labor productivity measures form only one part of the bureau's productivity measurement program. Although the bureau continues to increase the number of industry labor productivity measures, since the late 1970s the main focus has in fact been on developing multifactor measures both for industries and for the economy as a whole. The bureau has developed annual measures of multifactor productivity for all the two-digit SIC industries within manufacturing, five three-digit industries in manufacturing, and one four-digit industry in services (railway transportation). The first two of these measures were introduced in 1984, and all provide annual data from 1958 (or earlier) forward. The measures include all but the last three inputs on Diewert's list of input and output data, though some of the measures also include energy, a component of production he did not mention. In addition, the bureau has developed measures of the effects of R&D expenditures and changes in labor skills on productivity growth for the economy. And it continues to publish major-sector multifactor productivity measures, first published in 1983, on a value-added basis. Between 1983 and the very recent past, the bureau was the only government statistical agency in the world with an ongoing program of multifactor productivity measurement. (Statistics Canada has recently joined us with some preliminary results.)

The bureau's emphasis on multifactor measures does not mean that labor productivity measures have no merit. In fact, as the bureau increases its multifactor coverage, we find that the trends and changes in the industry labor productivity measures often reflect the trends and changes in the industry multifactor productivity measures. Further, the labor productivity measures provide useful information in their own right and can be prepared with fewer resources and less developmental time.

Second, Diewert states that the BLS labor productivity measures are biased and do not aggregate properly over firms and industries. It appears that the bias Diewert has in mind relates mainly to a comparison that might be made between the bureau's gross output measures and value-added measures produced by other countries. Certainly gross output measures should not be com-

pared to value-added measures. But, just as certainly, the bureau should not be choosing an output measure based mainly on the criterion of comparability with foreign countries. We should be concerned mainly with the appropriateness of gross output for our purposes. Finally, the issue of comparability with other countries is not a weighty one. We know of only two other countries that regularly produce industry productivity measures at a three-or four-digit level and in both cases the output measure is not a pure value-added measure.

The bureau never intended for the detailed industry productivity measures to be aggregated. Although a common methodology is applied, each industry measure is tailor-made: each is produced using the best data available for that particular industry and the specific measurement techniques appropriate for that data. It would, therefore, be inappropriate to aggregate these measures.

Suppose, on the other hand, that someone were to wish to aggregate these measures. As Diewert correctly points out, there are difficulties in aggregating industry productivity measures, but his statement that the use of gross output rather than value added is the source of the difficulties is questionable. *If* one were to aggregate industry *multifactor* productivity measures, there are reasons to prefer gross-output-based measures. Domar showed how gross-output-based multifactor productivity measures can be aggregated.[1] Domar also stated that industry productivity measures should be developed using gross as opposed to net output. Domar's conclusions have been strengthened by Hulten, who showed how major-sector multifactor productivity measures can be aggregated from gross-output-based industry productivity measures in the context of a flexible production formula, and by Gollop, who set forth the case that industry multifactor productivity measures should be based on gross output.[2]

We would be the first to agree that the conclusions regarding the preferability of gross output industry multifactor measures may not carry over to labor productivity measurement, which is one of the reasons why BLS has generally published measures only for those industries that have not experienced strong changes in the ratio of value added to gross output.

The bureau does produce value-added-based measures of productivity at the more aggregate levels. The results do not support Diewert's statement that gross output labor productivity measures, compared to value-added measures, tend to be biased upward: from 1979 to 1988, the value-added measure of output increased faster than the gross output measure for the total U.S. manufacturing sector (a 3.1 percent annual rate for value added compared to a 2.1 percent annual rate for gross output).

Third, Diewert states that the index number formula used by BLS for out-

1. E. D. Domar, On the Measurement of Technical Change, *Economic Journal* 71 (1961): 710–29.

2. Charles R. Hulten, Growth Accounting with Intermediate Inputs, *Review of Economic Studies* 45 (1978): 511–18; Frank M. Gollop, Growth Accounting in an Open Economy, *Working Papers in Economics* (Boston: Boston College, 1981).

put measurement has not been discussed in the theoretical index number literature and is unconventional. However, Irving Siegel discussed this formula in several papers, including one paper published in an Income and Wealth Conference volume, cited in our paper.

Finally, Diewert states that the data for the bureau's industry labor productivity measures are collected from different sources and that therefore the output and input data do not correspond to one another. However, the fact that the bureau usually uses data collected from different surveys is not the hindrance to accuracy that Diewert suggests it might be. First, it is not the case that there are 13 separate business surveys to collect data for each of the 13 major categories listed by Diewert. Second, as long as the surveys use the same universe for constructing the sample frames and appropriate weights are used for each sampled unit, consistent estimates can be made. The sample unit for the bureau's surveys of employment and producer prices, as well as the Census Bureau's survey of output and employment, is the establishment. The great majority of the BLS industry productivity measures are constructed mainly with these data sources. There is no evidence that the labor productivity numbers are seriously biased because of sample sizes and intersection of sample frames as Diewert's statements suggest.

Comment

Robert E. Lipsey

Several measurement issues that are passed over very lightly in Edwin R. Dean and Kent Kunze's paper, by their simply describing the methods the BLS prefers, deserve more extensive consideration.

The first of these is the preference for the use of physical quantities in preference to deflated values in the construction of quantity indexes. Because neither prices nor physical quantities are obtainable for all the products of most industries, any choice between them involves some assumption that omitted products behave in the same way as do covered products. If the sample of quantity changes is used, the assumption is that quantity changes for uncovered items move identically, on average, with those of covered items. If a sample of price changes is used, the same assumption is made for uncovered prices. If the degree of coverage were identical and the precision of product specifications were identical for price and quantity information, the choice would rest on the variance of price changes as compared with that of quantity changes. I would guess that the variance of price changes is smaller in most cases, and the preference of the BLS for quantity data needs some justifica-

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tion. Users of the data would probably like to see a comparison of the results of the two methods.

Another decision that is not discussed is that no attempt is made to adjust for changes in the quality of labor inputs. Changes in the composition of the labor force must be important, for example, in retailing, where inexperienced and part-time workers have come to represent a much larger part of employment. The composition of the labor force in banking also may have changed with the increased use of computers.

The use of employment weights may be appropriate when the emphasis is on measuring labor productivity, particularly if the main purpose of the measurement is to analyze changes in the demand for labor. Once the focus is on efficiency, as with multifactor productivity measures, that weighting no longer appears to be an obvious choice. For example, it must give very little weight to highly computer-intensive operations that may be the major growth areas in some service industries, such as banks. At least some discussion of the justification for this particular weighting scheme is needed.