The Productivity Growth Slowdown: Diverging Trends in the Manufacturing and Service Sectors

By Sharon Kozicki

Continuing gains in labor productivity are essential to keep real wages and the U.S. standard of living from stagnating. After a period of strong gains in the 1960s, the average growth rate of productivity slowed substantially in the early 1970s. In the following years, productivity continued to grow slowly despite rapid technological advances in such areas as computers and digital communications. Analysts have proposed differing explanations for the productivity slowdown and for the failure of productivity growth to rebound in recent years. Most explanations focus on aggregate factors, such as overall saving and investment rates or the quality of the labor force.

This article approaches the productivity growth slowdown from a different perspective. In particular, it decomposes the slowdown into contributions by broad sectors of the economy, focusing on the two largest sectors—manufacturing and services. Doing this reveals that the main factor accounting for the productivity slowdown has been stagnating productivity in the service sector. An accompanying and reinforcing factor has been the strong employment growth in services relative to manufacturing.

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The first section of the article documents the key sectoral shifts in productivity growth and employment shares since 1960. The second section identifies underlying factors that may explain these key sectoral shifts. The third section explores the outlook for sectoral productivity and employment shares to assess the prospects for a rebound in productivity growth.

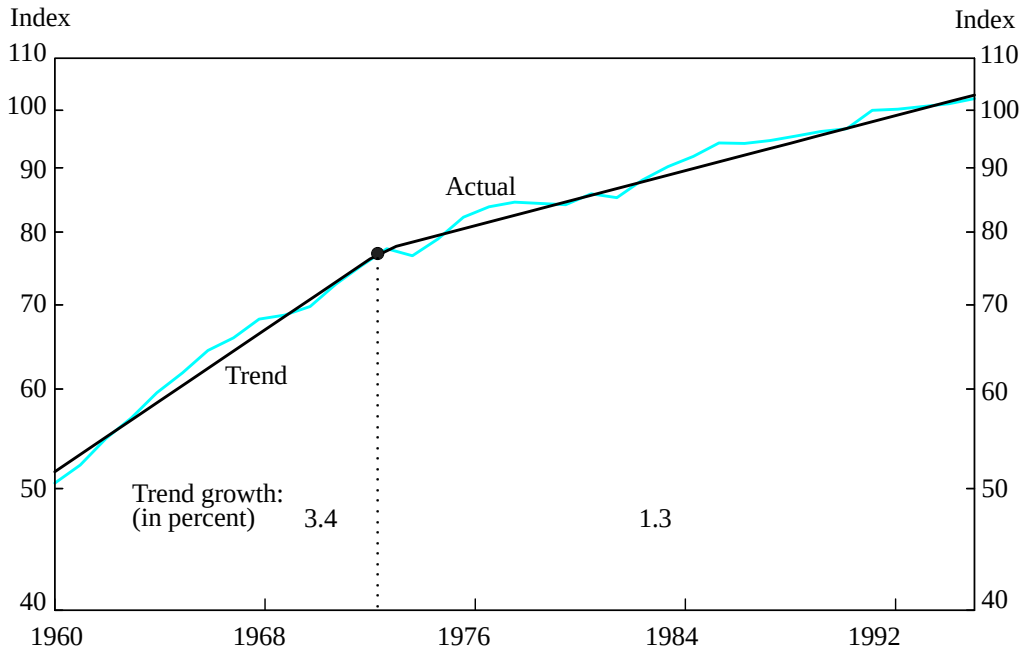
I. THE DECLINE: A SECTORAL EXPLANATION

Sectoral explanations of the productivity slowdown complement the more familiar aggregate explanations rather than competing with them. Broad factors, such as saving and investment rates, help determine aggregate productivity and output and implicitly underlie the sectoral developments discussed in this article. But an explicit sectoral analysis provides a different perspective on the productivity slowdown, highlighting some important factors that often are lost in aggregate analysis. This section documents the decline in aggregate productivity growth and shows how shifts in relative sector sizes and productivity growth rates contributed to the decline.

The aggregate productivity slowdown

The trend growth rate of U.S. aggregate productivity slowed in the early 1970s. Chart 1 shows actual productivity and an estimate of

Chart 1
PRIVATE PRODUCTIVITY, 1960-96

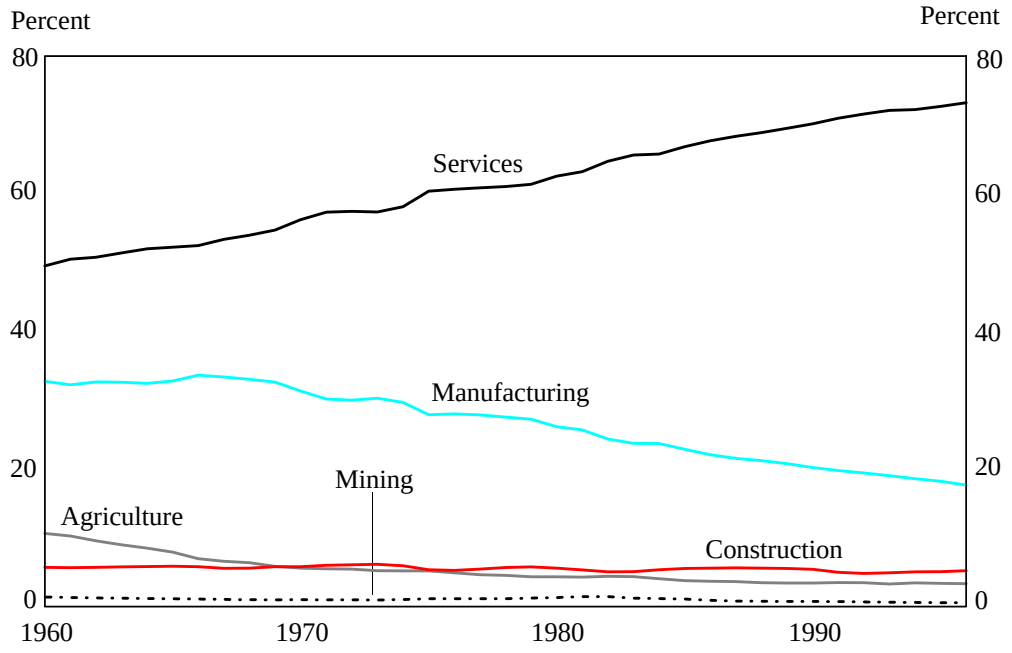


Note: Trend line is fitted to annual data through 1995. The 1996 value is the average of the first three quarters of 1996. Scale of vertical axis is logarithmic.
Source: Bureau of Labor Statistics, author's calculations.

trend productivity for the private, or nongovernment, sector since 1960. The government sector was excluded because of measurement difficulties encountered by the Bureau of Economic Analysis (BEA) and the Bureau of Labor Statistics (BLS) when constructing real government output and productivity estimates.[1] The slope of the trend productivity line represents an estimate of the trend growth rate of private productivity. Since 1972, when the trend growth rate is estimated to have fallen, private productivity growth has averaged only 1.3 percent per year (Filardo). This rate is down substantially from the 3.4 percent productivity growth rate recorded from 1960 until 1972.

Why has the estimated trend growth rate fallen 2.1 percentage points since 1972? Moreover, can productivity growth rebound in the future? To answer these questions, it is useful to examine the behavior of sectoral factors that contribute to aggregate productivity growth. Aggregate productivity growth roughly equals a weighted average of sector productivity growth rates. The weight on a given sector's productivity growth rate reflects the sector's employment share, or the fraction of the nation's work force employed in that sector.[2] Thus, shifts in relative size and productivity growth rates of the various sectors should explain the 1972 productivity slowdown.

Chart 2
PRIVATE EMPLOYMENT BY SECTOR, 1960-96



Source: Bureau of Labor Statistics; payroll survey (services, manufacturing, construction, mining), household survey (agriculture).

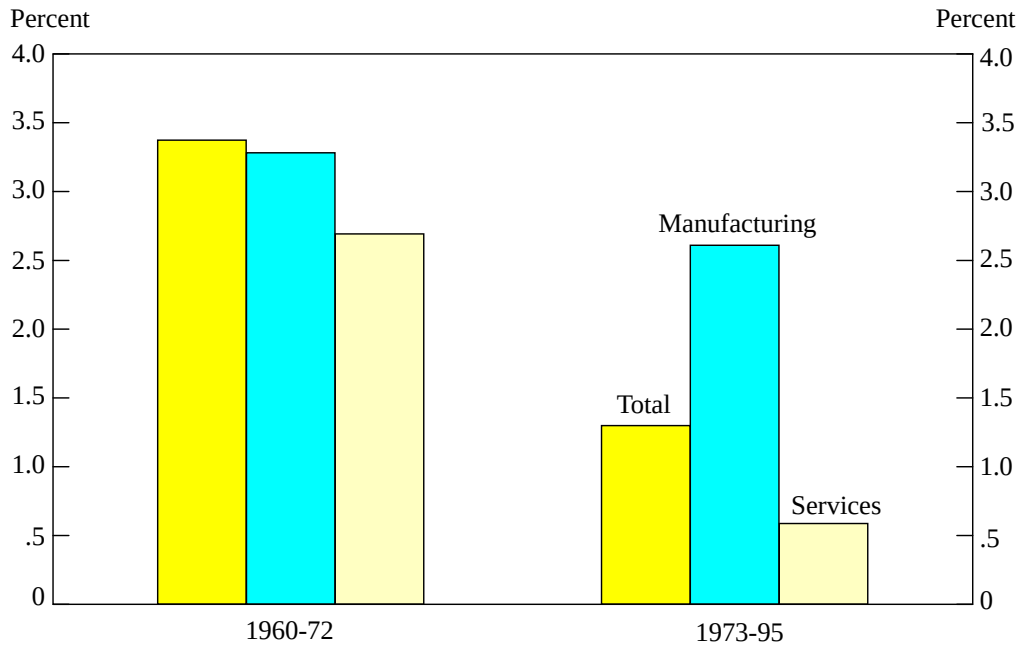
Sectoral shifts in services and manufacturing

Because manufacturing and services account for such a large share of private employment, most of the productivity slowdown can be explained by focusing on these two sectors. The service sector is the largest in terms of employment and real output (Chart 2). This sector includes a wide variety of industries classified by the BEA under transportation, communications, utilities, finance, insurance and real estate, trade, and other services. The other services category includes such industries as personal services, business services, health care, legal services, and education. Manufacturing is the second-largest employer of the private work force. Together, manufacturing and services account for over 90 percent of today's nongovernment employment.

Sectoral shifts in services and manufacturing have reduced aggregate productivity growth in two ways. First, average productivity growth in both manufacturing and services fell in 1972. Second, reinforcing this fall was the shift of employment from manufacturing, with relatively high productivity growth, to services, with relatively low productivity growth.

Productivity growth in services has slowed

Chart 3
GROWTH OF PRIVATE PRODUCTIVITY

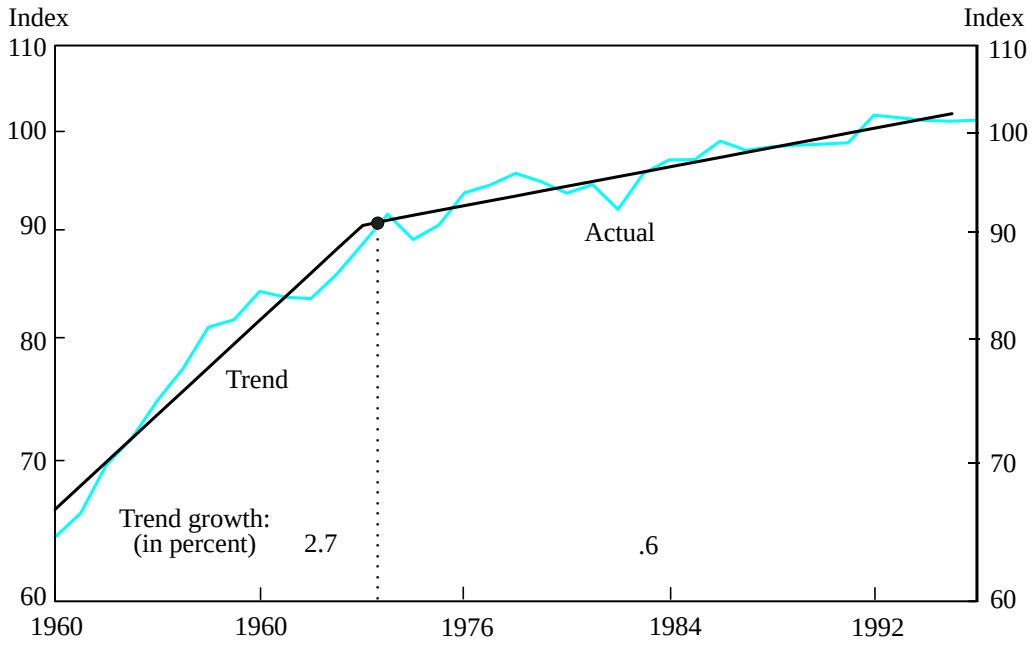


Note: Services productivity growth is represented by nonfarm nonmanufacturing productivity growth.
Source: Bureau of Labor Statistics, author's calculations.

dramatically relative to manufacturing since 1972. Chart 3 shows growth rates of private productivity, manufacturing productivity, and services productivity for 1960-72 and 1973-95.[3] Because service sector productivity growth is available for only part of the 1960-95 period, private nonfarm nonmanufacturing productivity growth is used as a proxy for service sector productivity growth.[4] Both manufacturing and services experienced strong productivity growth from 1960 to 1972, with manufacturing productivity growth averaging about 3.3 percent per year and services about 2.7 percent per year. However, productivity growth of services has declined substantially since 1972, growing only 0.6 percent per year (Chart 4).[5] By contrast, manufacturing productivity growth has continued to register strong gains, averaging 2.6 percent per year since 1972 (Chart 5). The larger decline experienced by the service sector resulted in a widening of the gap between the productivity growth rates of manufacturing and services.

The changes in the employment shares of manufacturing and services also contributed to the aggregate productivity slowdown. In addition to being larger than the manufacturing sector, the service sector employment share has continued to grow, while the manufacturing employment share has shrunk (Chart 2). The private

Chart 4
SERVICES PRODUCTIVITY, 1960-96



Note: Trend line is fitted to annual data through 1995. The 1996 value is the average of the first three quarters of 1996. Scale of vertical axis is logarithmic.
Source: Bureau of Labor Statistics, author's calculations.

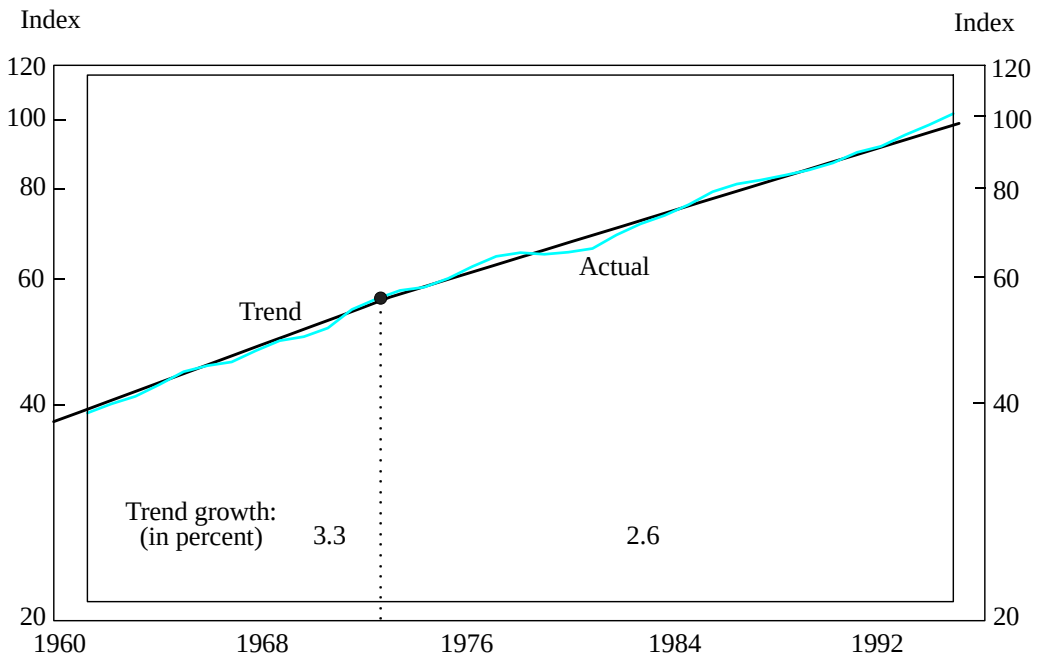
employment share of the service sector increased from 43 percent in 1960 to 73 percent in 1995. Over the same period, the employment share of manufacturing fell from 36 percent to 18 percent. Because productivity growth was lower in the service sector, shifting employment shares gradually put more weight on services, with slower productivity growth, and less weight on manufacturing, with faster productivity growth.

With both sectors experiencing large shifts in employment shares and productivity growth rates, it is natural to wonder which sector is more responsible for the aggregate productivity slowdown. This question can be answered by tracing changes in sectoral contributions to aggregate productivity.

A sectoral accounting of the productivity slowdown

The degree to which each sector is responsible for the aggregate productivity slowdown can be determined by tracking sectoral contributions to aggregate productivity growth over time. Recall that aggregate productivity roughly equals the sum of sector contributions, where the contribution of each sector is the product of the sector's employment share and its productivity growth rate. If a sector's contribution is lower over 1973-95 than

Chart 5
MANUFACTURING PRODUCTIVITY, 1960-96



Note: Trend line is fitted to annual data through 1995. The 1996 value is the average of the first three quarters of 1996. Scale of vertical axis is logarithmic.
Source: Bureau of Labor Statistics, author's calculations.

over 1960-72, then that sector is partly responsible for the aggregate productivity slowdown.

This analysis shows that the service sector makes the largest contribution to the 2.1-percentage-point slowdown in aggregate productivity growth after 1972. The contribution of the service sector to private productivity growth fell from 1.4 percentage points over 1960-72 to 0.4 percentage point since 1972, reflecting both the slowdown in service sector productivity growth and the large increase in the service sector employment share.[6] This 1.0-percentage-point decrease in the service sector contribution accounts for about half of the aggregate productivity slowdown.

While manufacturing productivity registered strong gains after 1972, manufacturing was also partly responsible for the reduction in aggregate productivity growth. The contribution of manufacturing to aggregate productivity growth fell from 1.1 percentage points over 1960-72 to 0.6 percentage point since 1972. The small reduction in manufacturing productivity growth, combined with the decrease in the manufacturing employment share, reduced the manufacturing contribution by 0.5 percentage point. This reduction accounted for about one-fourth of the aggregate productivity slowdown.

Together, the contributions of services and

manufacturing explain about 1.5 percentage points of the 2.1-percentage-point decline in private productivity growth. The remaining 0.6-percentage-point slowdown in private productivity growth can be attributed to three smaller sectors: agriculture, mining, and construction.[7] Thus, the interaction of the widening manufacturing-services productivity growth gap with shifts in employment shares of manufacturing and services accounted for most of the productivity growth slowdown.

II. WHAT EXPLAINS THE STRUCTURAL SHIFTS IN PRODUCTIVITY AND EMPLOYMENT?

Knowing that structural shifts in sector productivity growth rates and employment shares account for the slowdown in aggregate productivity, it is natural to ask what factors lie behind these structural shifts. This section discusses why the productivity gap between manufacturing and services has widened and why employment opportunities have shifted from manufacturing to services.

What explains the manufacturing-services productivity growth gap?

The widening gap between manufacturing and services productivity growth may be related to four main factors: outsourcing, measurement issues, lagging computerization of service industries, and differences in competitive pressures. Two of these factors, outsourcing and measurement issues, suggest the actual productivity growth differential between the two sectors may be smaller than reported. The other two factors attempt to explain why productivity growth has been lower in services than manufacturing.

Outsourcing has been offered as one explanation for the widening productivity gap. In this view, manufacturing productivity growth may be overreported at the expense of underreported growth in the service sector. The BLS practice of classifying employees by the industry of the employing firm rather than by the tasks performed, combined with difficulties in assessing the real output of many service jobs, may cause the efficiency gains from service outsourcing to be assigned improperly to the manufacturing stage of production. For example, a clerk in a manufacturing firm is considered a manufacturing employee. By contrast, a clerk in a business services firm is considered a service sector employee. When a clerk in a manufacturing firm is fired and the clerical tasks are outsourced to a business services firm, manufacturing employment declines and business services employment increases, even though the same task is performed. Thus, the increased outsourcing of services by manufacturing firms may partially explain the downward trend in the manufacturing employment share and the upward trend in the service sector employment share. Both the BLS procedures and the difficulties in determining the value added by service inputs raise the possibility that manufacturing labor productivity is overstated and service productivity is understated.

While the outsourcing theory may help explain the productivity gap between manufacturing and services, it does not help explain the aggregate productivity slowdown. The outsourcing argument merely suggests the real value added by service workers is not being credited appropriately to the service sector. Although the decomposition of productivity by stage of production may be in error, aggregate measures of labor productivity that include all stages of production are correct (Baily and Gordon).

Measurement issues provide a second explanation of the widening productivity growth gap. Service sector output is generally harder to define

and measure than manufacturing output, and the measurement difficulties tend to result in underreporting the level of real service sector output and productivity. Evidence that the measurement problems are important can be found by comparing two estimates of productivity growth for a given industry obtained from different data sources. For instance, the BLS estimates that productivity growth in banking averaged 2.8 percent per year from 1977 to 1993. Over the same period, the BEA estimates banking productivity growth averaged only 0.1 percent per year. The differences can be attributed largely to differences in the way real output is measured (Dean and Kunze 1992).

Two complications arise when measuring real output (Sherwood). The first complication, identifying the unit of output, is more of a problem in service industries than in manufacturing. Examples of manufacturing output are thousands of automobiles and cartons of cigarettes. While some services—such as a haircut—may seem easy to measure, others are not. For example, two competing approaches to measuring medical care give very different pictures of the costs and production of the medical sector (Cutler, McClellan, Newhouse, and Remler). One approach is to value units of medical services, such as a day in the hospital or an hour in an operating room. The second is to value the expected health consequences of an encounter with the medical sector. This approach, which tracks costs of treating particular ailments, finds that real output and productivity of the medical sector have been much higher than reported.

The second complication, adjusting for quality improvements, arises after the output has been identified and a dollar value for total expenditures on the product is obtained. Real output is typically constructed by adjusting the expenditures on industry output for price inflation, but the price indexes used to correct for inflation should be adjusted for quality improvements.[8] Assessing quality change tends to be more difficult for service output than manufacturing output. For example, convenience is a quality characteristic that is common in service industries but difficult to value. In retailing, an increase in the hours a store is open provides greater convenience for customers. Yet although customers may recognize the value in increased convenience, assigning a particular dollar value to this improvement in service quality is almost impossible.[9]

Without adequate adjustment for quality improvements, price indexes tend to overstate price increases and result in understated real output and labor productivity. Returning to the medical care example, adjustments to the current medical care CPI for technological change and increasing price discounts reduce medical care inflation about three percentage points per year (Cutler, McClellan, Newhouse, and Remler).[10] Using such an adjusted price index would result in higher estimates of real output and productivity for the medical sector. Such adjustments are controversial, however, because the rapid increase in prices of medical services has also been used as evidence that productivity in the medical sector has stagnated relative to other sectors (Baumol 1992).

The slowdown in aggregate productivity growth since 1972 may be exaggerated because of such measurement problems. The U.S. economy has become increasingly service-oriented, and the real output of service industries is frequently hard to measure. A possible explanation of the slowdown in aggregate productivity growth is that "the fraction of output in hard-to-measure sectors [was] increasing" (Griliches 1994). Thus, although estimates of the trend growth rate of productivity have decreased, it is not clear that the estimates provide unbiased pictures of reality.

Automation and computerization provide a third explanation for the widening productivity growth gap. The service sector has been slower than manufacturing to realize gains from automation and computerization. Computer-aided manufacturing first appeared around 1969, and by the early 1980s, computerized systems for materials requirements planning were rapidly expanding (Gerwin; Anderson and Schroeder). Yet even by the early 1990s, the service sector still seemed unable to exploit the potential of new technologies, and information technology had not improved the productivity of the white-collar workers who used it (Roach). While factory investment in technology has typically made workers more efficient and caused unit labor costs to fall, service industry investment in computer technology has tended not to reduce labor costs.

Differences in competitive pressures faced by manufacturers and service providers are a fourth explanation for the productivity growth gap. Competition between domestic and foreign manufacturers for U.S. market share has forced domestic manufacturers to be constantly on the lookout for ways to enhance labor productivity. Until recently, however, the service sector was largely insulated from foreign competition. Because services are typically consumed as they are produced, the need for geographic proximity between service producers and consumers has favored domestic firms. In addition to such natural barriers to competition, government regulation may have protected some service industries, such as telecommunications, banking, and utilities, from competitive pressures to improve labor productivity (Roach).

Why has employment shifted from manufacturing to services?

There are four leading explanations for why manufacturing and service sector employment shares have diverged over the years. Three of these explanations attribute the increased employment in service industries to various aspects of the demand for services. The remaining explanation suggests that employment shifts have been exaggerated due to increased outsourcing of service inputs by manufacturing firms.

Increased demand for services is the most obvious explanation for the increase in service sector employment. Some analysts believe that as a country grows richer, the preferences of its residents tend to shift toward services. In this view, U.S. demand for services increases naturally as the economy grows richer, causing service sector employment to rise accordingly. International evidence provides some support for this explanation. In most industrialized countries, the service sector accounts for more than half of employment, and the employment share of services has been rising (Klein).

In addition to greater demand for services, changing consumer tastes in favor of *customized products* may have prompted the bundling of more services with goods (Harker). Similar products may be differentiated not only on the basis of physical characteristics, but also on the basis of related service components included in the purchase price. For example, computer software packages often come with toll-free telephone numbers or electronic mail addresses that can link customers with service personnel to answer customers' product-related questions. Likewise, automobile dealerships often sell extended warranty coverage or prepaid maintenance contracts with vehicles.

A contrasting explanation is that past increases in service sector employment may have been necessary to meet a *constant relative demand for stagnant services* (Baumol 1967). Stagnant services refer to service output of industries that have experienced little improvement in productivity

compared with other industries. To meet a constant relative demand for stagnant services, the share of employment allocated to production in these industries must grow over time. Three forms of evidence support this explanation (Baumol, Blackman, and Wolff). First, the steep trends evident in the employment shares of manufacturing and services are absent from the real output shares of manufacturing and services.[11] Second, the relative prices of services and the services share of total nominal expenditures have increased with time.[12] Third, the increase in service sector employment has been absorbed increasingly by low-productivity growth industries in the service sector.

Outsourcing is the final explanation for the increasing service employment share. Outsourcing refers to the increasingly common practice of firms hiring subcontractors for some stages of the production process. Although such subcontracting originated with the farming out of parts manufacturing, firms more recently have been outsourcing service inputs to the manufacturing process, such as transportation, computer support, secretarial assistance, and even personnel department responsibilities.

The trend toward increased outsourcing of services is reflected in the rising fraction of service workers employed in business services industries (Chart 6). Examples of business services are advertising, credit reporting, photocopying, data processing, and temporary help. However, business services do not include services such as accounting, research, management, and transportation that may also be outsourced by manufacturers. Nevertheless, the rising trend shown in Chart 6 is indicative of increased outsourcing of service activities.

Increased outsourcing of service inputs by manufacturing firms is likely to have exaggerated employment growth in business services relative to manufacturing. The overstatement has probably occurred because the BLS classifies employees according to the industry of their employer rather than the tasks performed by the employee.

III. OUTLOOK

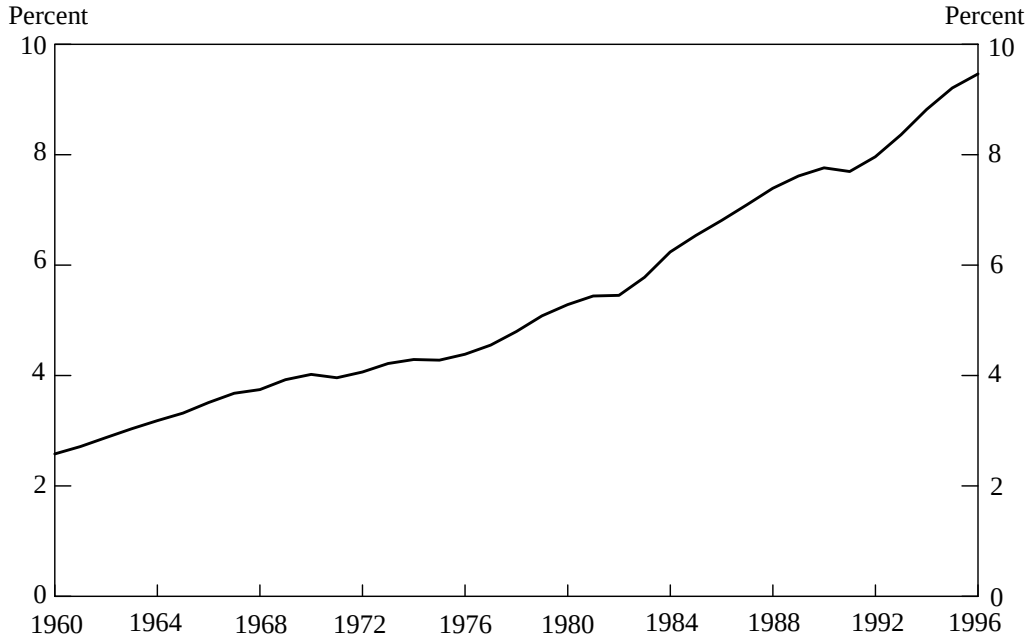
The previous sections examined changing behavior in the sectoral factors that contributed to the 1972 productivity growth slowdown. The same exercise can be followed to assess the outlook for productivity. Examining the likelihood and implications of future shifts in sector employment shares and productivity growth rates will provide insight into future productivity growth.

Prospects for sectoral employment shares

Future shifts in sector employment shares are likely to have a relatively minor influence on aggregate productivity. The service sector employment share rose 30 percentage points from 1960, reaching 73 percent in 1995. Although the upward trend may continue, future increases in the service sector employment share will necessarily be much smaller in percentage terms, and thus the implications for aggregate productivity growth will be small. Manufacturing's employment share, equal to 18 percent of the private work force in 1995, could continue to see proportionally large decreases. However, because manufacturing's employment share is small relative to services, even large proportional shifts would have small effects on aggregate productivity growth.

Because shifting employment shares will have little influence on future changes in the trend growth rate of productivity, the outlook for trend productivity growth will depend on growth rates in sector productivity. Manufacturing is expected to continue to post relatively strong productivity growth. Thus, an improved outlook for aggregate productivity growth hinges primarily on

Chart 6
BUSINESS SERVICES EMPLOYMENT AS A SHARE OF TOTAL SERVICES EMPLOYMENT, 1960-96



Source: Bureau of Labor Statistics.

whether productivity growth in the service sector will rise.

Prospects for service sector productivity growth

The same issues that helped explain the widening of the manufacturing-services productivity growth gap may offer insight into the outlook for productivity growth in services. Computerization, increased competition in the service sector, and improvements in measurement techniques may increase the reported growth rate of service sector productivity. Other factors that may affect productivity growth include work force education and training and the discovery rate of new productive ideas.

Computerization may be starting to have a larger effect on productivity growth in the service sector. For example, computers may now be facilitating a major improvement in retailing efficiency. Advances in digital communication technologies have helped retailers and manufacturers develop cooperative partnerships to streamline their distribution channels (Buzzell and Ortmeyer). Direct computer links between retailers and manufacturers have resulted in significantly higher rates of inventory turnover. Bar-coding and scanning technologies now allow retailers to transmit information on the sale of a product directly to the manufacturer, whose computers can arrange for a replacement to be sent immediately. Retailers benefit from reduced probability of losing sales because popu-

lar items are out of stock. Manufacturers also benefit from access to consumer surveys and sales data that aid in the development of new styles and products.

Another example of how computerization might enhance service sector productivity is financial electronic data interchange (EDI). Financial EDI refers to transactions made through the combination of electronic transfer of funds with electronic remittance data. For example, General Motors Corporation uses financial EDI to collect payments from its dealers. General Motors sends electronic payment instructions with information identifying the vehicles for which payment is being requested to one of its banks. At settlement, General Motors' bank credits its account as the dealer's bank debits the dealer's account. Such electronic payments allow businesses to replace the labor-intensive activities associated with issuing, mailing, and collecting checks with a fully automatic payments process (Knudson, Walton, and Young). Although not yet widely used, financial EDI holds the promise of productivity gains in the future.

Estimates of the contribution of computing services to future productivity growth vary widely. Some analysts believe that because computers are only a relatively small part of the total capital stock, they are unlikely to be a major source of growth and their contribution to growth is unlikely to increase (Oliner and Sichel). Other estimates suggest increases of as much as 0.6 percentage point per year may be on the horizon. These higher estimates are justified by arguments suggesting that the growth effects of radically new technologies may be slow to evolve (David).

Increased *competitive pressures* in the service industries also may result in faster rates of service sector productivity growth in the future. As more service industries are deregulated, productivitygrowth in the service sector should increase because competition forces profit-maximizing firms to allocate resources more efficiently. It is too early to determine the ultimate effects of recent deregulation on the banking and telecommunications industries. As rules prohibiting interstate banking have been relaxed, however, bank mergers and acquisitions have increased. If well-managed institutions acquire and improve the efficiency of high-cost institutions, then future productivity gains are likely (Yellen).

Increased international competition in many service industries may also promote faster service sector productivity growth in the future. With advances in communications and information technologies, it has become more common for back-office services in industries such as insurance, publishing, market research, and financial services to be produced offshore (Wilson). Offshore activities often involve the collection, management, and processing of data and tend to be labor intensive. Examples include processing insurance claims and computer software development. Deregulation also tends to open domestic markets to foreign competition (Quinn and Gagnon). Still another factor that is increasing competitive pressures from international firms is greater foreign direct investment in the U.S. service sector (Roach).

Improvements in measurement techniques that reduce the understatement of service sector productivity may result in an increase in reported productivity growth in the sector. Of course, such improvements in measurement techniques would imply an increase in reported productivity, not an increase in actual productivity. Thus, the reported data would more closely reflect actual economic experience.

Unfortunately, the future also holds downside risks for productivity growth. *Work force*

training and education are vitally important in a rapidly changing economy. The major structural shifts evident in the employment structure of the work force raise the possibility that work force education and training may not match the requirements of new employment opportunities. It may take quite a while before the work force learns the skills necessary to best take advantage of the extraordinary technological advances (Greenspan). Moreover, current education and training systems may not be optimally suited to a rapidly changing world.

Continuing growth in productivity will require a constant influx of *new ideas* (Gordon 1996). Although continued expenditures on research and development will probably lead to further technological advances in many industries, some industries may have reached their technological limits. Gordon argues that technological depletion, or "running out of ideas," explains the productivity slowdown in service industries such as electric utilities and air transportation. This argument seems a less plausible explanation for the aggregate productivity slowdown because technological depletion in some industries may be offset by rapid technological advances in others. Also, the idea that existing technology cannot be improved has been wrong many times in the past.

IV. CONCLUSIONS

Aggregate productivity growth slowed dramatically in the U.S. economy after 1972. A sectoral analysis of productivity growth reveals that the major factor accounting for the slowdown was the sharp decline in service sector productivity growth. Productivity growth also slowed in the manufacturing sector after 1972, but to a much smaller extent. An accompanying and reinforcing factor was the shift in employment shares toward services and away from manufacturing.

Prospects for a future increase in productivity growth largely depend on the likelihood of a pickup in service sector productivity growth. Increased competition should raise the incentive for service firms to improve efficiency and invest in productivity-enhancing technologies. Although some productivity gains have been reported from computerization of service industries, it will likely take a long time to fully realize the potential gains from the extraordinary technological advances of the past couple of decades. Because the U.S. work force is still learning how to use the new technologies, education and training programs will be necessary to prepare the work force for new employment demands. And, of course, continued research and development efforts will be required to open the door to new opportunities.

ENDNOTES

[1] The issues discussed in this article are not sensitive to including or excluding the government sector. To better understand why the government sector is excluded, note that real output and productivity series are constructed by adjusting data on nominal expenditures for increases in inflation. Because government services are not priced in a competitive market, nominal expenditures are adjusted for inflation using a price index that reflects increases in input costs, not output prices. This procedure generates flat government sector productivity.

[2] Slifman and Corrado perform a different sectoral decomposition of productivity. They decompose the private nonfarm business sector into nonfarm corporate business, financial corporations, nonfarm nonfinancial corporations, manufacturing corporations, nonmanufacturing corporations (excluding farm and financial corporations), and nonfarm noncorporations. They attribute the 1970s slowdown in productivity growth to a sustained reduction in productivity growth in the nonfarm noncorporate sector. As nearly half of the income in the nonfarm noncorporate sector is generated by businesses in the service sector, the analysis of this paper complements that of Slifman and Corrado. Corrado and Slifman also report an industry decomposition of productivity that is similar to the one in this paper, but their analysis is limited to the 1977-94 period.

[3] Estimates of private nonfarm nonmanufacturing productivity (π_{NFNM}) were constructed from private nonfarm productivity (π_{NF}), manufacturing productivity (π_M), and the fraction of the private nonfarm work force employed by manufacturing (ι_M) using the relationship

$$\pi_{NF} = (1 - \iota_M)\, \pi_{NFNM} + \iota_M \pi_M \, .$$

However, because productivity data are reported as an index, levels of different productivity data series are not directly comparable. In particular, although BLS reports that both the index of private nonfarm productivity and the index of manufacturing productivity are equal to 100 in 1992, it would be wrong to conclude that in 1992 the actual level of real output per manufacturing worker was equal to the actual level of real output per worker in the private nonfarm sector. This complicates the estimation of private nonfarm nonmanufacturing productivity because it is inappropriate simply to substitute available data into the above expression and solve for π_{NFNM}.

Two series for private nonfarm nonmanufacturing productivity growth were constructed. One was based on the assumption that the level of manufacturing productivity was equal to the level of private nonfarm productivity in 1960. The second was based on the assumption that the level of manufacturing productivity was equal to the level of private nonfarm productivity in 1995. Average productivity growth rates of the two constructed series are, respectively, 2.9 and 2.7 percent per year over 1960-72 and 0.7 and 0.6 percent per year since 1973. Results in the article are based on the assumption of equal productivity levels in 1995. However, the results would not have been qualitatively different had the other series been used.

The two constructed series present a set of bounds on an index for private nonfarm nonmanufacturing productivity scaled to be comparable to the index for private nonfarm productivity, provided the level of manufacturing productivity has been equal to private nonfarm productivity at some point in time between 1960 and 1995. While it is possible that the true index of private nonfarm nonmanufacturing productivity lies outside these bounds, it is unlikely that implied productivity growth rates of this series would generate qualitatively different results to those in the article.

[4] Private nonfarm nonmanufacturing productivity growth is a good stand-in for service sector productivity growth because service sector productivity growth is the main determinant of private nonfarm nonmanufacturing productivity growth. Over 1977-94, an estimate of service sector productivity growth was constructed using data released by the BEA. Services output was estimated by summing chained 1992 dollar estimates of output in transportation and public utilities, wholesale trade, retail trade, finance, insurance, and real estate, and services taken from the BEA release of real GDP by industry group. Services hours were estimated by summing BEA estimates of total hours worked by full-time and part-time employees in the same industries. Services productivity was constructed by dividing estimated services output by estimated services hours. This measure of service sector productivity grew 0.4 percent per year on average over the 1980s, very close to average productivity growth of 0.5 percent per year for the constructed series for private nonfarm nonmanufacturing productivity . On average over 1977-94, services productivity grew 0.5 percent per year, and private nonfarm nonmanufacturing productivity grew 0.4 percent per year.

[5] Just as the sectoral productivity experiences differ, so do the experiences of different industries within a given sector. For example, the BLS reports that productivity growth in radio, television, and computer stores averaged 7.2 percent

per year over 1972-94, but that productivity growth in automotive repair shops averaged only 0.1 percent per year over the same period.

[6] These contributions were calculated by multiplying the average service sector employment share of private employment by average productivity growth of the service proxy, with both averages taken over the same time period.

[7] Comparing 1960-72 with 1973-95, private nonfarm productivity growth slowed by only 1.9 percentage points. Thus, the agriculture sector appears to account for an additional 0.2 percentage point of the falloff in private productivity growth. The remaining unexplained 0.4 percentage point of the productivity slowdown is likely due to structural shifts in mining and construction.

[8] For example, suppose the sticker price of a new car stays the same in two successive years, but the new model-year cars are of higher quality than cars produced in the previous year. Although sticker prices are unchanged, it would be inappropriate to leave the price index for new cars unchanged because, with the quality improvements, the same dollar expenditure on a new car can now buy more. The price index for new cars should be adjusted downward in the second year to reflect that, if still available, the sticker price of a car without the quality improvements would likely have fallen relative to the sticker price of a new model-year car. A higher estimate of auto industry real output will be obtained by using the quality-adjusted price index to convert dollar expenditures on cars to real output, than by using an unadjusted index based only on sticker prices.

[9] Construction of industry price indexes is further complicated in service industries regulated by the government. In regulated industries such as transportation, communications, and electric, gas, and sanitary services, output prices may not reflect competitive market conditions, causing adverse effects on output measures (Dean and Kunze 1995).

[10] Improvements in the calculation of the price of hospital and related services were introduced by the BLS in January 1997. This change is being implemented in response to criticism that medical care price indexes should reflect changes in the cost of achieving a benefit from hospital services (that is, the cost of treating a given ailment) rather than changes in the costs of inputs to the service, such as a day in the hospital.

[11] From 1977 to 1994, although the manufacturing share of private employment fell from 28 percent to 19 percent, the manufacturing share of real private GDP fell only slightly from 22 percent to 20 percent. Over the same period, while the services share of private employment rose from 61 percent to 72 percent, the services share of real private GDP rose by less, from 66 percent to 71 percent.

[12] Slifman and Corrado show that the same relative price behavior holds in their decomposition. In particular, since 1976, the implicit deflator for the nonfarm noncorporate sector (the relatively low productivity growth sector) has been rising much faster than the deflator for the nonfarm corporate sector (the relatively high productivity growth sector).

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