



Faster Productivity Growth: Who Benefits?

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Summary

Productivity growth is generally understood to be a good thing. An increase in the production of goods and services that does not require more work raises incomes and is the source of rising living standards. Productivity growth may vary over time, but improving productivity is widely taken for granted as a normal characteristic of the U.S. economy. For the nation, faster productivity growth would be hard to characterize as anything but good. But, while *average* labor productivity and average incomes have been rising more rapidly since 1995 than during the previous 20 years, that may not mean that everyone is reaping benefits from faster productivity growth. Like current income, productivity gains may also be unequally distributed. If income gains from productivity are less equally distributed than is current income, productivity growth could exacerbate inequality.

In theory, increases in labor productivity make it profitable for firms to hire more workers, as long as they have a market for increases in their production. Other things being equal, this increase in the demand for labor tends to push wages up. If conditions are such that labor demand does not increase, say in a shrinking market, then the productivity gains will either accrue to consumers in the form of lower prices or to the owners of the firm in the form of higher profits.

The rate of growth in real compensation rises and falls with the rate of productivity growth, but growth in real compensation lags productivity, and the gap between the two increased after 1973. In part, the difference may be because the available measure of *average* labor productivity is not the one theory tells us determines the wage rate. The increase in the gap between productivity growth and real compensation growth may also be because of labor's declining bargaining power.

But even given that gap, the rate of increase in real compensation rose significantly along with productivity growth after 1995. Between 1995 and 2003, the average annual growth rates of both average labor productivity and real compensation rose by 1.6 percentage points over their rates of increase between 1973 and 1995. Given that, it would be hard to argue that labor has not benefitted from the post-1995 acceleration in productivity growth.

However, several studies have shown that labor's gains from faster productivity growth have not been equally distributed. In fact, most of the gains in labor income due to faster productivity growth have gone to those in the upper half of the earnings distribution. One study concluded that the top 0.1% of the income distribution accounted for as much of the gain in real income between 1997 and 2001 as the bottom 50%. Numerous studies have investigated this phenomenon, which is referred to in the literature as "skill-biased technical change." As an example, those workers who have more education and training are more likely to benefit from the productivity gains made possible by increased investment in computers and IT equipment.

This report will not be updated.

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Introduction

Productivity growth is generally understood to be a good thing. An increase in the production of goods and services that does not require more work raises incomes and is the source of rising living standards. Productivity growth may vary over time, but improving productivity is widely taken for granted as a normal characteristic of the U.S. economy.

Overall, economic growth, usually measured as change in gross domestic product (GDP), is ultimately determined by growth in the labor force and growth in the productivity of labor. Since 1995, as has become widely recognized, productivity has increased at an accelerated rate compared with the previous 20 years, which means that the economy can now grow more rapidly than before without risking a faster rate of inflation.

For the nation, faster productivity growth would be hard to characterize as anything but good. After all, incomes are rising faster and that presents consumers with greater choices. Higher incomes also have consequences for the federal budget. They, along with progressive income tax rates, will yield higher tax revenues and reduce the budget deficit.

Although *average* labor productivity and average incomes are rising more rapidly, it may not mean that everyone is reaping benefits from faster productivity growth. Like current income, productivity gains may also be unequally distributed. If income gains from productivity are less equally distributed than is current income, productivity growth will exacerbate inequality. This report examines the acceleration in productivity that began in the mid-1990s, and who has reaped its benefits.

What is Productivity?

Productivity is a ratio. It is a measure of the quantity of output (goods and services) produced relative to the amount of work required to produce it. It is expressed as the ratio of inflation-adjusted output, based on real GDP, to the number of labor hours required to produce that output. Mathematically, it is expressed this way:

$$productivity = \frac{\text{output} / \text{prices}}{\text{hours}}$$

Measured productivity will rise any time inflation-adjusted output increases more rapidly than hours. Even with constant output a decline in hours worked would indicate an increase in productivity, which would reflect an increase in leisure time.

The production of all the goods and services accounted for by GDP yields income to each of the factors involved, namely labor and capital.¹ Since total income of all factors of production must equal the value of that production, income can be substituted for output in the previous equation:

¹ This discussion ignores land for purposes of simplicity.

$$\text{productivity} = \frac{(\text{labor income} + \text{capital income}) / \text{prices}}{\text{hours}}$$

This equation shows that, since equality must be maintained, an increase in productivity must result in an increase in either labor or capital income, a decline in the price level, or a decline in hours worked (an increase in leisure). In theory, any income gains will accrue to the factor responsible for the productivity gains. If prices fall, then the gains will accrue to consumers of those goods and services that have become cheaper. Whether income gains accrue to labor or capital can have an effect on the distribution of income as well. Because wealth is much less equally distributed than labor income, an increase in the share of income accruing to capital would be likely to increase the overall inequality in the distribution of income. The following section discusses the theoretical connection between productivity and labor income.

The Link Between Productivity and Wages

To understand how productivity growth affects labor income, consider the behavior of an individual firm. A single firm in a competitive market has little influence and sells its goods at prevailing prices and hires workers at prevailing wages. Most economic models also make the assumption that each additional worker hired is less productive than those hired before. In the jargon of economics, this is referred to as “diminishing marginal productivity.” There are at least two justifications for that assumption. One, it is in the best interest of a firm to hire the most able workers first, meaning that each additional worker is less productive; and two, without additional investment each addition to the labor force reduces the amount of capital per worker.

As long as the contribution to output produced by the last worker hired (i.e., the price of the good multiplied by the quantity produced per hour) exceeds the cost of his labor (i.e., the hourly compensation rate), a profit-maximizing firm will continue to hire more workers. As the productivity of each successive hire declines, the value of the additional production also falls. Eventually, the value of the goods produced by the last worker hired will be just equal to the cost of the additional labor. At that point, the profit-maximizing firm will stop hiring more workers.

Now suppose a technological innovation raises the productivity of all the workers at a firm. If each worker is now able to produce more than before, that will raise the total value of the output each worker can produce. Now, the value of the production of that last worker hired exceeds the cost of his labor.

Assuming the firm will continue hiring as long as the value produced by each additional worker is greater than the additional labor cost, the increase in productivity will increase the firm’s demand for labor. Hiring more labor is again profitable to the firm. Other things being equal, an increase in the demand for labor will tend to push up the wage rate. In this way, increases in labor productivity increase labor income. Once the firm again reaches the point where the cost of additional labor is more than the value of goods one more worker can produce, it will stop hiring.

There are circumstances where an increase in productivity might not necessarily lead to an increase in employment. Suppose, for example, that worker productivity rises faster than does demand for the good those workers produce. Because the supply of the good rises relative to the demand for it, the price of the good will tend to fall. The fall in the price of the good will offset the effect of higher productivity on the value of goods produced by workers. If the drop in price

exactly offsets the increase in productivity, there will be no change in the value of each worker's production to the firm and there will be no increase in the firm's demand for labor. In that case, the firm will neither hire more workers nor will wages increase.

In this case, the benefits of higher productivity will accrue to consumers. Because consumers can now buy the same quantity of the good with less of their income, they have more to spend on all of the other goods (and services) they want. That increase in demand will tend to push up the price of those other goods. When those prices rise, the demand for labor at firms producing those goods will increase. That will tend to push up both employment and wages at those firms.

There is also the possibility that an increase in productivity will simply increase the profits of the firm. If there is no possibility for the firm to increase sales, and if wages are inflexible, the firm may reduce the number of workers it employs and thus reduce its overall labor costs. In that case, higher productivity will increase the profitability of the firm.

In the short run, prices and wages may be somewhat "sticky" or inflexible. For example, wages may be slow to respond to changing market conditions because of long-term labor contracts. The rapidity with which prices and wages respond to changes in productivity will determine, in part, who gets the benefits. To the extent that prices fall, consumers will benefit. To the extent that wages rise, workers will benefit. To the extent that neither changes, profits will rise and the benefits will go to the stockholders. Over the long run, history has shown that prices and wages tend to respond to changes in supply and demand and that the benefits will be shared.

Capital also contributes to the production of goods and services and earns income for its owners. The demand for capital is determined in the same way that demand for labor is. Firms will add capital as long as each new investment yields more in revenue than it costs the firm to use.

Suppose there is an innovation that raises the productivity of a firm's capital equipment. Just as in the case of an improvement in the productivity of workers, the value produced by that equipment rises and so it becomes profitable for the firm to invest in more equipment.

The income of both factors of production is based on the value of their contribution to the total value of the goods and services produced. But they are interdependent. An increase in the amount of capital available to each worker is likely to increase his or her productivity, which would tend to increase the firm's demand for labor and push up wages.

Measuring Labor Income

Most accounts in the popular press regarding labor income refer to wages specifically. But wages account for only a portion of labor income, and focusing exclusively on wages can be misleading.² Compensation is a more comprehensive measure of labor income. Compensation includes wages and salaries, employer contributions for social insurance, pensions and insurance, profit sharing, and unemployment compensation.³

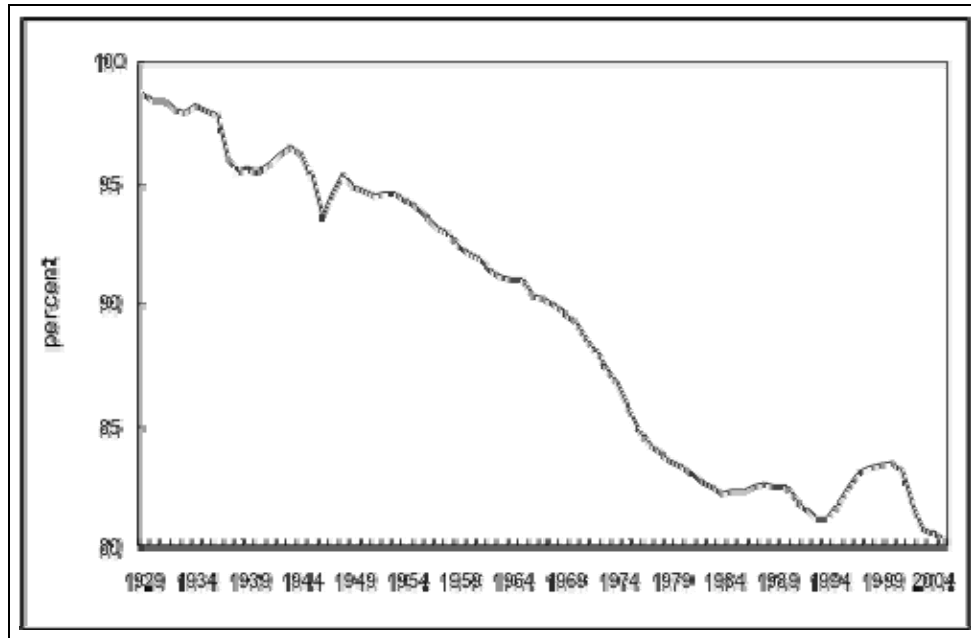
² Wages and salaries in the national income and product accounts published by the Commerce Department refers to the monetary remuneration of employees including commissions, tips, bonuses, and voluntary employee contributions to certain deferred compensation plans (such as 401(k) plans).

³ This measure of labor income may be more expansive than what some have in mind when they think of "labor."
(continued...)

Over the long run, wages and salaries have been declining as a share of total compensation. Even in the short run, variations in wages may not be indicative of variations in compensation because wages are an incomplete measure of labor income. **Figure 1** shows wage and salary income as a percentage of total compensation since 1929.

As the data make clear, using wages alone as a measure of labor income would be misleading. A decline in wages is not necessarily indicative of trends in labor income, but may just be part of the long-term shift in how labor is paid for its services.

Figure 1. Wages and Salaries as a Percentage of Compensation



Source: Department of Commerce, Bureau of Economic Analysis.

Labor's Share of National Income

Most discussions of income distribution address what is known as the *size* distribution of income. The size distribution of income describes how the incomes of individuals or families are distributed. The *functional* distribution of income refers to how income is shared among the different factors of production, mainly labor and capital. The income for both factors of production is determined by the quantity employed and the price for their use. Relative income shares may vary either because of changes in the relative quantities employed or in their prices.

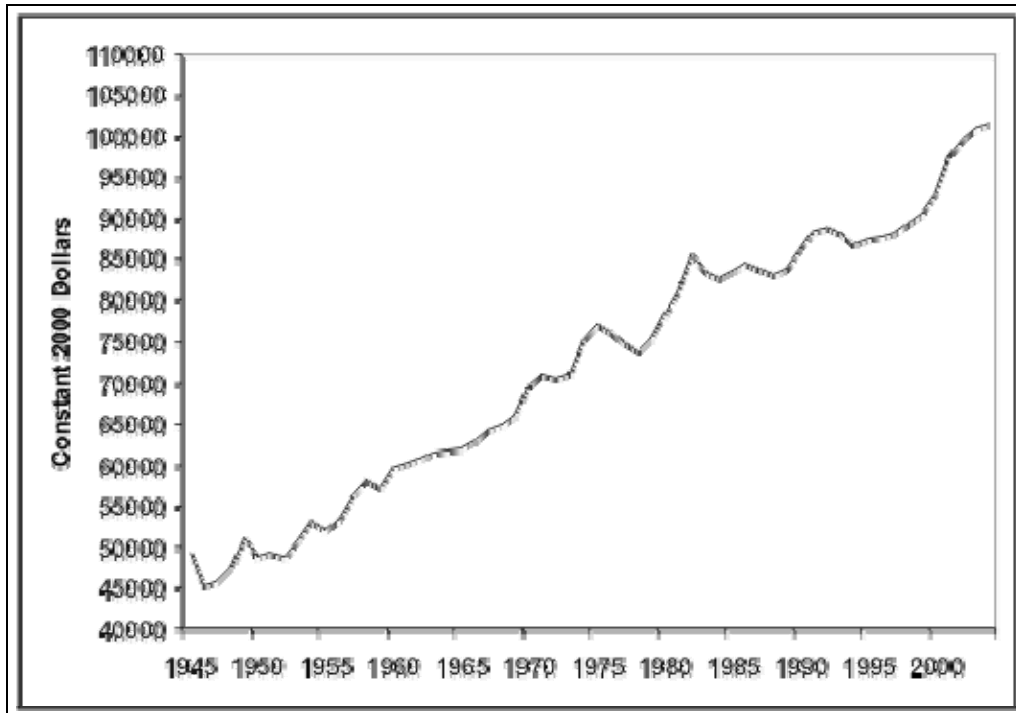
Over the long run, the trend has been for the quantity of capital employed to rise faster than the quantity of labor. In other words, the capital-labor ratio tends to rise. To understand why, consider

(...continued)

Compensation here includes the pay of corporate CEOs getting million dollar plus salaries. To the extent that is an issue, it is one of the size distribution of income and not one of the distribution of income among the different factors of production.

that output growth is determined by growth in productivity and the labor force. If investment is a fairly stable share of total output, then the capital stock will grow at the same rate as the economy. Because the economy is growing faster than the labor force (because of rising labor productivity), the capital stock will grow more rapidly than the labor force and so the capital-labor ratio will rise. **Figure 2** shows the rise in the capital-labor ratio since 1945.

Figure 2. Fixed Capital per Employee, Private Sector



Sources: Department of Commerce, Bureau of Economic Analysis; Department of Labor, Bureau of Labor Statistics.

Because the capital stock has increased relative to labor, it may be presumed that capital's share of income has also been increasing. Unfortunately, measuring shares of income accruing to labor and capital is somewhat complicated.

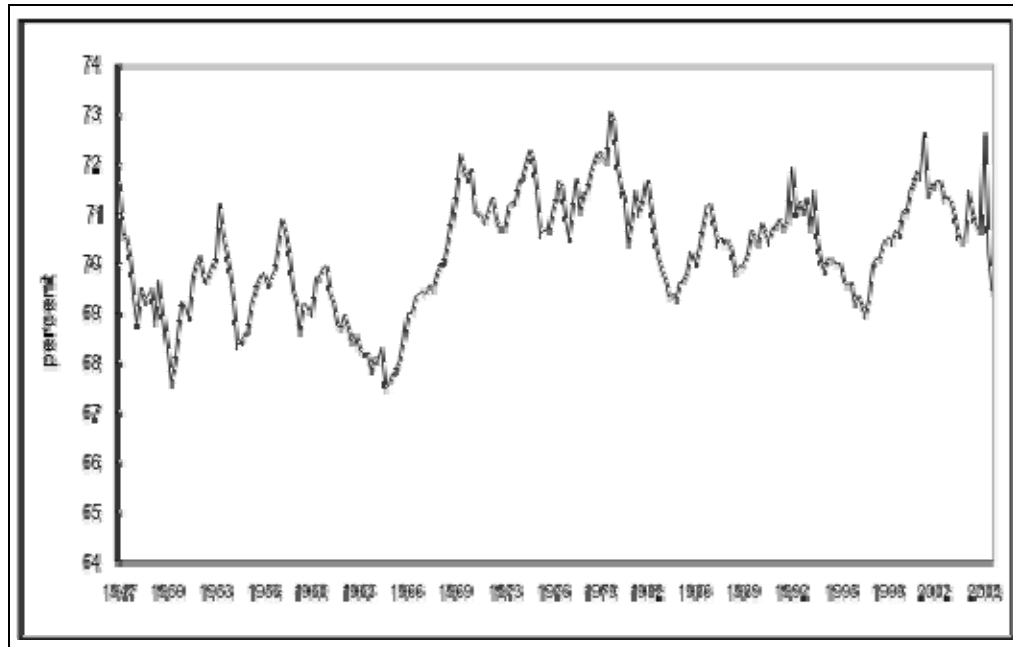
Published measures of compensation are broadly defined and some may not consider all of the forms of compensation that are included to be part of their definition of what constitutes "labor income." Most of compensation comes from wages and salaries, but it also includes fringe benefits such as employer contributions for insurance and also the realized value of stock options. All earnings are included in compensation, from those working for the minimum wage to those at the top of large corporations.

It would seem easy enough to calculate labor's share of income by simply dividing labor compensation by total national income. But in the national income accounts, there is a separate accounting for the income of proprietors, mostly small business owners. That income is attributable to both labor and capital. It is important to account for the labor share of proprietor income because proprietor income has been falling as a share of national income and leaving it out would lead to an increasing upward bias in the estimated labor share. There is no clear cut

way to identify the labor share of proprietor income, but many studies make the simple assumption that it is about two-thirds in order to minimize the bias.⁴

Figure 3 shows estimates of the labor share of income since 1947, using the simplifying assumption that two-thirds of proprietor income is attributable to labor. This estimate is based on national income data published by the Bureau of Economic Analysis (BEA) of the Department of Commerce.

Figure 3. Labor Share of National Income, BEA



Source: Department of Commerce, Bureau of Economic Analysis.

If there is a discernable trend in these data, it is one of modest increase from the late 1940s to the early 1970s, but since then the ratio has fluctuated without any clearly discernible trend up or down. That may seem counterintuitive given the increase in the capital-labor ratio. One reason this may have occurred is that, as was assumed in the case of labor, there generally are also diminishing returns to each addition to the capital stock. That would tend to reduce the value of the output produced by each increment to the capital stock and so push down its share of income.

Another reason why labor's share might not fall over time is that the characteristics of the labor force are changing. Education, training, and other labor skills, what economists refer to as "human capital," are continually improving.⁵ If this human capital per worker rises more rapidly than the physical capital per worker, that could explain an increase in the labor share of income.⁶ As long as wages keep pace with the productivity of labor, and the return to capital keeps pace

⁴ See, for example, Daniel S. Hamermesh and Albert Rees, *The Economics of Work and Pay*, (New York: Harper & Row Publishers, 1984), pp. 354-359.

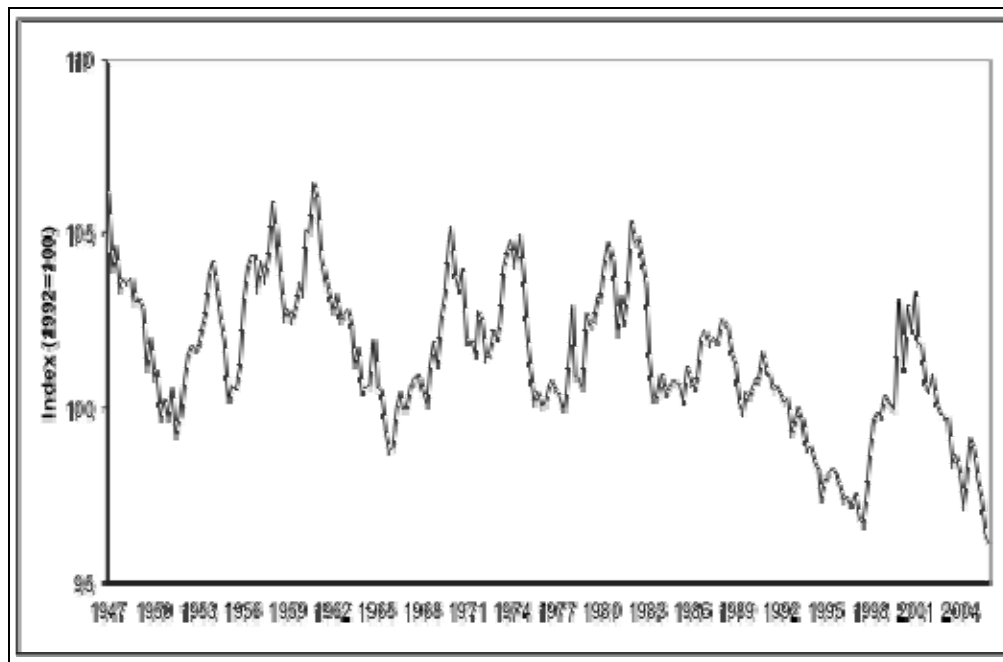
⁵ Daniel Aaronson, "Growth in Worker Quality," *Chicago Fed Letter*, Feb. 2002, 4 pp.

⁶ Daniel S. Hamermesh and Albert Rees, *The Economics of Work and Pay*, 3rd edition, Harper and Row, 1984, pp. 356-360.

with the productivity of capital, the relative income shares of labor and capital will depend on changes in the relative growth in labor and capital productivity. If labor productivity rises at the same rate as capital productivity, then the labor share of income will tend to be fairly stable.

There is another measure of labor's share of income, published by the Bureau of Labor Statistics of the Department of Labor (BLS), and it indicates that the labor share of income for the non-farm business sector has been falling. **Figure 4** presents this series (an index with 1992 set equal to 100). These data suggest that the labor share has been *falling* steadily since at least the early 1980s, and is now at its lowest point over the entire history of the series.

Figure 4. Labor Share of Income, BLS



Source: Department of Commerce, Bureau of Economic Analysis.

Which of these two measures is correct? Economists Gomme and Rupert, in a study published by the Federal Reserve Bank of Cleveland, point out that the BLS series is the only one of the three measures of labor's income share they examine to show a decline.⁷ The other two persist around their historical averages. They also argue that if the share has declined recently it may be due to the fact that labor's share is countercyclical. In other words, the labor share of income tends to fall during economic expansions and rise during contractions. If that is what has happened, then any decline in the labor share below historical levels is likely to be temporary.

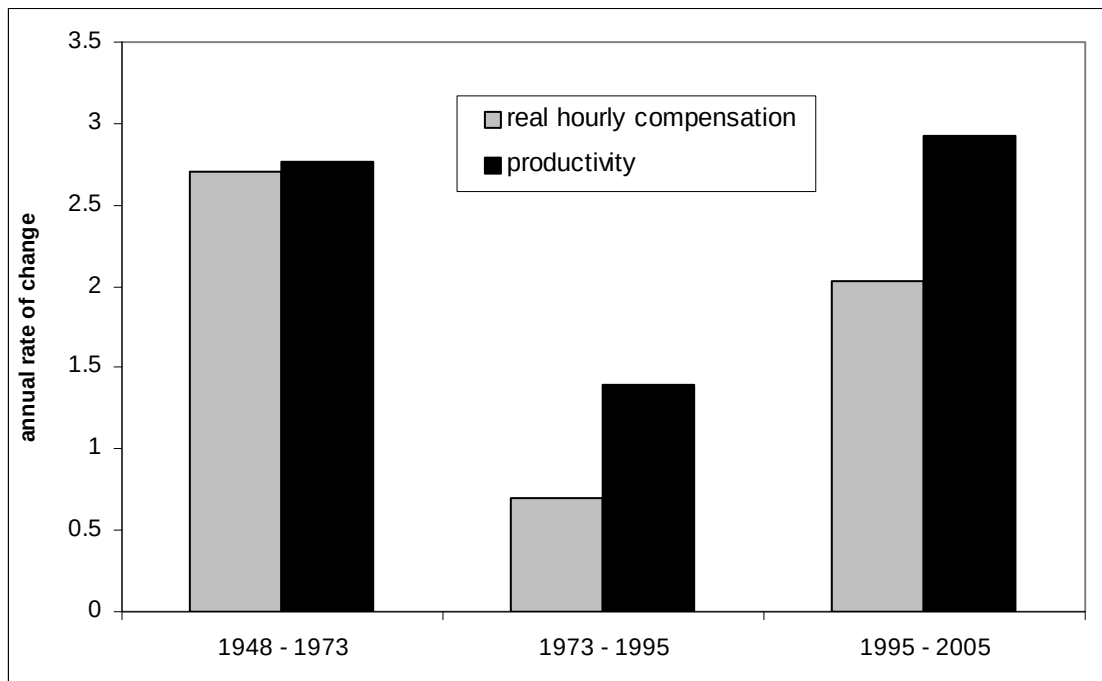
The decline in the BLS measure seems unlikely to be sufficient cause for most economists to abandon one of the so-called "stylized facts" of economic growth. Economist Nicholas Kaldor, in a 1958 lecture, presented a list of givens that any economist would have to take into account in any economic theory. Among them was the observation that the labor share of income had been

⁷ Paul Gomme and Peter Rupert, "Measuring Labor's Share of Income," Federal Reserve Bank of Cleveland, Policy Discussion Paper, no. 7, Nov. 2004, 10 pp.

relatively constant over time, and not just for the United States but for other countries as well.⁸ A constant labor share of income is a key assumption of many current macroeconomic models. That the BLS time series shows it declining may be due to peculiarities of that particular measure or may be the result of temporary factors.

Another way to approach the question is to compare growth rates in productivity and labor compensation. **Figure 5** shows annual rates of growth for three periods defined by distinctly different trend rates of growth in productivity. Two things are apparent. First is that after 1973 growth in compensation fell behind growth in labor productivity. Second is that after 1995, both growth rates increased by the same amount.

Figure 5. Growth Rates of Compensation and Production



Sources: Department of Commerce, Bureau of Economic Analysis; Department of Labor, Bureau of Labor Statistics.

One reason why compensation seems to lag productivity growth may be the result of changes in labor's "terms of trade." In this context, labor's terms of trade refers to the difference between the rate of change in the prices of those things workers buy, and the rate of change in the prices of the things workers make. In other words, worker pay is based on the prices of the goods they produce, not on the prices of the goods they consume. The compensation growth rates shown in **Figure 5** are adjusted for inflation using a price index for consumer goods and services. The measure of real output used to calculate productivity is adjusted for inflation using a more comprehensive price index which reflects not only consumer goods and services but also the goods and services purchased by government, as well as business investment. If the prices of the goods workers produce rise more slowly than the prices of the goods they consume, then it is unlikely that labor income, in real terms, will keep pace with rising productivity.

⁸ See Charles I. Jones, *Introduction to Economic Growth* (New York: W.W. Norton & Company, 1998), pp. 12-13.

Economists Bosworth and Perry suggest that this effect is enough to account for both the difference between compensation and productivity growth and the increase in the gap between the two.⁹ They constructed a measure of real compensation based on the same price index used to calculate productivity and found that measure to follow productivity much more closely.

The Distribution of Labor's Gains From Faster Productivity Growth

Since productivity growth and labor income have accelerated, there remains a question of how those gains have been distributed. How has faster productivity growth affected the size distribution of income? There are indications that some have benefitted more than others.

A study published by the Federal Reserve Bank of Minneapolis examined the changing distribution of earnings since 1961.¹⁰ Economists Eckstein and Nagypál found that, for men, there was a substantial increase in the inequality of the earnings distribution beginning in the mid 1970s. Between 1973 and 1995, the real earnings of men in the bottom 25% of the earnings distribution fell. Over that same period, the real earnings of men in the top 25% of the distribution made significant gains. They also found that beginning in 1995, the year productivity growth picked up, the real earnings of men in the bottom 25% of the distribution began to rise along with earnings all across the distribution. However the earnings of men at the top of the distribution grew more rapidly. While the distribution continued to grow more unequal after 1995, the rate of increase in that inequality slowed. Women's earnings exhibited similar although less pronounced changes in inequality.

Economists Dew-Becker and Gordon examined the relationship between labor income and productivity and concluded that the benefits of productivity growth have been even more unequally distributed than the Eckstein and Nagypál study.¹¹ Dew-Becker and Gordon looked at Internal Revenue Service (IRS) income data from 1966 to 2001. They concluded that over that entire period only the top 10% of the distribution experienced income gains equal to or greater than the overall rate of productivity growth. Further, they found that the top 1% of the distribution accounted for 21.6% of the income gains for that period and for 21.3% of the gains between 1997 and 2001, after productivity growth had accelerated. Finally, they found that the top 0.1% of the distribution received as much of the real rise in earnings as the bottom 50% between 1997 and 2001.¹²

What explains this increased inequality in the distribution of labor income in a period of faster productivity growth? Among the candidates that have been suggested are the declining real value of the minimum wage, increasing globalization, and the decline in unionization of the labor force.

⁹ Barry Bosworth and George L. Perry, "Productivity and Real Wages: Is There a Puzzle?," *Brookings Papers on Economic Activity*, 1994/1, pp. 317-335.

¹⁰ Zvi Eckstein and Éva Nagypál, "The Evolution of U.S. Earnings Inequality: 1961-2002," *Federal Reserve Bank of Minneapolis Quarterly Review*, Dec. 2004, pp. 10-29.

¹¹ Ian Dew-Becker and Robert J. Gordon, *Where Did the Productivity Growth Go? Inflation Dynamics and the Distribution of Income*, National Bureau of Economic Research, Working Paper 11842, Dec. 2005, pp. 86.

¹² Aside from the direct effects of productivity on earnings Dew-Becker and Gordon found that the acceleration in productivity resulted in a 1.2% slower rate of inflation between 1995 and 2005. That meant an increase in the purchasing power of all workers.

But the one factor that most economists consider to be important is the role of technological change.¹³

Much of the acceleration in productivity growth that began in 1995 has been attributed to investment in computers and other information technology (IT) equipment.¹⁴ But even before 1995, investment in computers may have been affecting the distribution of labor income.

Economists Autor, Levy, and Murnane argue that the introduction of computers affected different jobs in different ways.¹⁵ In the case of jobs involving routine and repetitive tasks computers served as *substitutes* for labor and reducing the demand for it and putting downward pressure of wages. The authors suggest as examples clerks, cashiers, bank tellers, and bookkeepers. In the case of jobs involving non-routine problem solving, computers serve as *complements* to labor. The authors suggest as examples of non-routine problem solving, tasks such as medical diagnoses, legal research, management, and sales. In the case of these jobs, where computers are a complement to labor, increased investment in computers increases the demand for labor and tends to push up wages. Increased use of computers, as both substitutes for and complements to labor, has tended to increase push wages up at the upper end of the distribution and hold wages down at the lower end, thus increasing the inequality in the distribution of wages.

Numerous studies have investigated this phenomenon, which is referred to in the literature as “skill-biased technical change.” Those workers who have more education and training are more likely to benefit from the productivity gains made possible by increased investment in computers and IT equipment.

Conclusion

Since 1995, the United States seems to have experienced an acceleration in the trend rate of growth of productivity. While productivity growth is widely understood to be the means by which living standards improve, those standards may not be improving at the same rate for everyone. Some have argued that labor has not been reaping the rewards of faster productivity growth and that instead those gains have gone to the owners of capital. However, if labor’s share of income is down, it seems likely to be a short-term phenomenon and not part of any permanent shift in income shares.

Whether labor’s income share has fallen, however, may be moot insofar as changes in the income distribution are concerned. Evidence shows that labor’s gains from faster productivity growth have been concentrated in the upper half of the earnings distribution. For workers at the bottom of the earnings distribution, whether labor’s overall share of income has fallen is of little consequence. Their earnings have not kept up with those at the top of the distribution, neither would they stand to gain much from any increase in the share accruing to the owners of capital.

¹³ Aaron Steelman and John A. Weinberg, “What’s Driving Wage Inequality?,” Federal Reserve Bank of Richmond *Economic Quarterly*, summer 2005, pp. 1-17.

¹⁴ CRS Report RL32456, *Productivity: Will the Faster Growth Rate Continue?*, by Brian W. Cashell.

¹⁵ David H. Autor, Frank Levy, and Richard J. Murnane, *The Skill Content of Recent Technological Change: An Empirical Exploration*, NBER Working Paper 8837, June 2001, 61 pp.

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