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# Productivity and Wages

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*Congressional Research Service*

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# Productivity and Wages

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## Productivity and Wages

**August 30, 2004**

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# Productivity and Wages

## Summary

Productivity growth is widely understood to be the means to raising living standards. Higher productivity means that the quantity of goods and services produced and consumed can rise without having to work more. Beginning in 1995, productivity growth accelerated, suggesting that living standards could be expected to rise more rapidly than had been the case since the early 1970s.

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 demand for labor tends to push wages up. If conditions are such that labor demand does not increase, in a shrinking market or because of technological advances, 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.

Most accounts in the popular press regarding labor income refer to wages specifically. But wages only account for a portion of labor income, and focusing exclusively on wages can be misleading. Compensation is a more comprehensive measure of labor income. Compensation includes wages and salaries, employer contributions for insurance and pensions, profit sharing, and unemployment compensation. Over the long run, wages and salaries have been declining as a share of total compensation.

The rate of growth in real compensation rises and falls with the rate 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 that 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 as the unionization rate declines.

But even given that gap, the rate of increase in real compensation increased significantly along with productivity growth after 1995. Between 1995 and 2003, the 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.

This report will not be updated.

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# Productivity and Wages

Productivity growth is widely understood to be the means to raising living standards. Higher productivity means that the quantity of goods and services produced and consumed can rise without having to work more. Beginning in 1995, productivity growth accelerated, suggesting that living standards could be expected to rise more rapidly than had been the case since the early 1970s.

At the same time, concern has been widely expressed about the relatively slow growth in employment during the current economic expansion. Moreover, while productivity growth has accelerated, many have argued that wages are not keeping pace and that workers are being squeezed in an effort to boost profits. That seems to have inspired some doubts regarding the benefits of rising productivity. Public policy is, of course, concerned both with the rate of economic growth and how the gains are distributed.

This report explains what economic theory tells us about the relationship between wages and productivity. The report discusses why wages may be a misleading measure of labor income, and changes in labor's share of national income. Finally, possible reasons for changes in the relationship between growth in labor income and productivity are examined.

## Productivity and Wages: The Theory

It seems simple and intuitive that wages would rise with productivity. But as is the case for many such intuitions, there are exceptions and qualifications, so it may be helpful to understand the theoretical connection between growth in wages and productivity.

In order to understand how productivity growth affects wages, consider the behavior of an individual firm. A single firm in a competitive economy has little influence on market conditions 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 reasons behind 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 new hire 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 times the quantity produced) exceeds the cost of his labor (i.e., the wage rate times hours worked), a profit-maximizing firm will continue to add to its labor force. If the productivity of each successive hire declines, then the value of the

additional production also falls. At some point the value of the output of the last worker hired will equal the cost of the additional labor. At that point, the profit-maximizing firm will stop adding to its labor force.

Now suppose that some event, a technological innovation for example, raises the productivity of all the workers at the 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. In that case the last worker hired, instead of producing just enough to cover the cost of his labor is now producing more than that.

If the firm is willing to continue hiring as long as the value produced by each additional worker is greater than the additional labor cost, the increase in productivity also 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. When 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 goods those workers produce. Because the supply of the good being produced 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, all of 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. More so in some markets than in others, but to the extent that they are, one group may benefit more from increases in productivity than others. 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. Over the long run, however, prices and wages do tend to respond to changes in supply and demand and the benefits will be shared. How the benefits are distributed is an empirical question.

Thus far, this discussion has considered only the contribution of labor to the production of goods and services. Two other factors of production also contribute to the production of goods and services and they also share in the income yielded by sales of the goods and services.

Demand for both land and capital are determined in the same way that demand for labor is. Firms will continue to add capital as long as each new investment yields more in revenue than it costs the firm to use. The same holds for land.

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 each of the three 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 equipment available to the existing workforce is likely to increase their productivity as well. That would tend to increase the firm's demand for labor and push up wages.

## Measuring Labor Income

Thus far, the terms "labor income" and "wages" have been used interchangeably, and 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.<sup>1</sup>

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.<sup>2</sup>

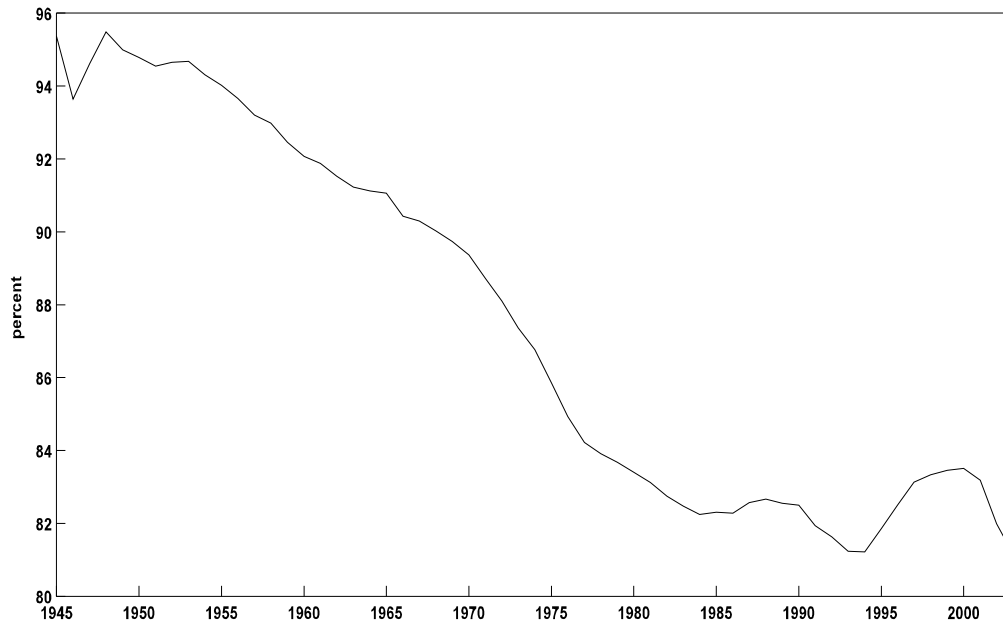
Over the long run, wages and salaries have been declining as a share of total compensation. Even in the short run, variations in wages may not be indicative of variations in compensation, because wages are an incomplete measure of labor income. **Figure 1** shows wage and salary income as a percentage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

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<sup>1</sup> 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).

<sup>2</sup> This measure of labor income may be more expansive than what some have in mind when they think of "labor." 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.



**Figure 1. Wages and Salaries as a Percentage of Compensation**

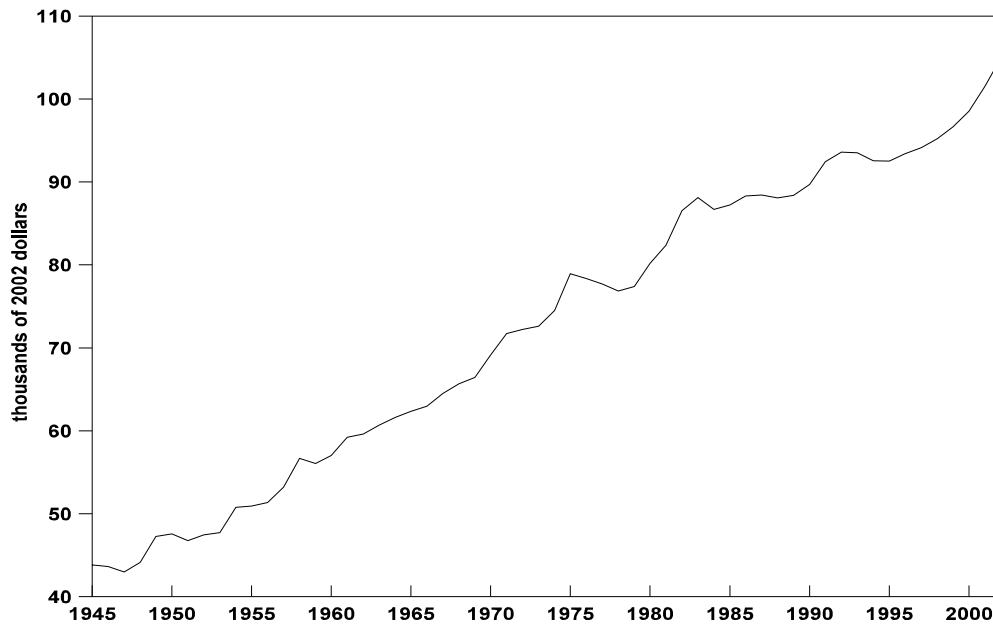
Source: Department of Commerce, Bureau of Economic Analysis.

## The Labor Share of 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” describes how income is shared among the different factors of production: labor, capital, and land. If the argument that companies are increasing profits at the expense of labor is correct, then that should be reflected in the way income is distributed among these factors of production.

The income for each of these 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 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. Since 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 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.

That the capital stock has increased relative to labor might lead one to presume that capital's share of income has also been increasing. In the national income accounts published by the Bureau of Economic Analysis, income is accounted for as shown in **Table 1**.

**Table 1. National Income, 2003**

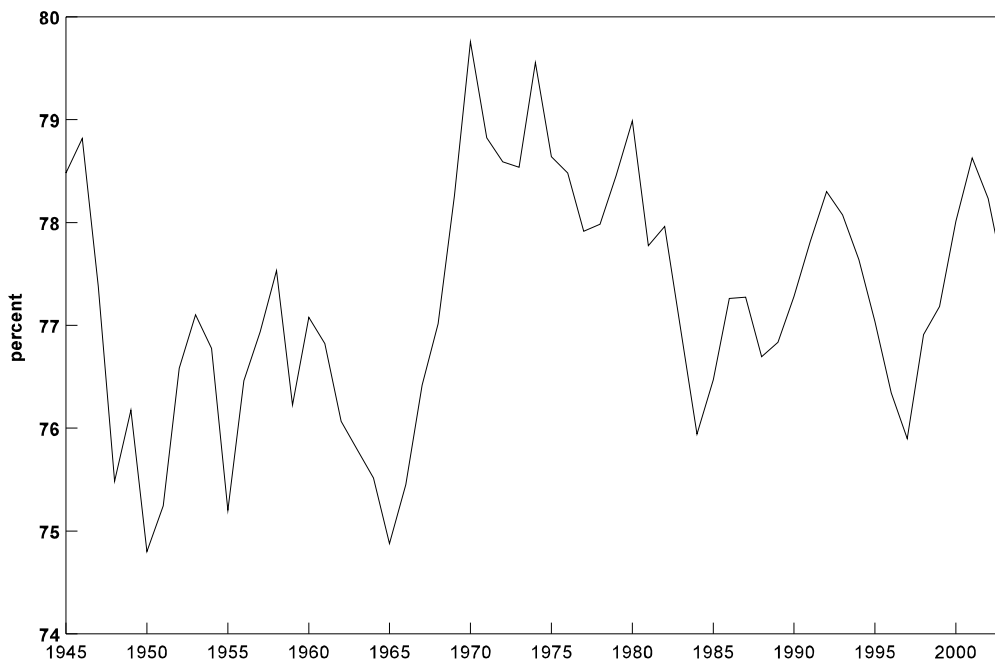
	billions of dollars	percent of total
Total	8,841.0	100.0
Compensation of employees	6,289.0	71.1
Proprietor's income	834.1	9.4
Rental income of persons	153.8	1.7
Corporate profits	1,021.1	11.5
Net interest	543.0	6.1

**Source:** Department of Commerce, Bureau of Economic Analysis.

The amounts in **Table 1** account for all of the payments to the three factors of production: labor, capital, and land. Labor income is measured as compensation. Profits, rent, and interest measure payments for the use of capital and land. Proprietor's income reflects payments to all three factors. **Figure 3** shows estimates

of the labor share of income since 1945. This measure assumes that two-thirds of proprietor income is attributable to labor. Income attributable to proprietorships has declined relative to total national income over the long run. Because of that, neglecting to consider the labor income of proprietors would give an upward bias to the trend in labor's income share.

**Figure 3. Labor Share of National Income**



**Source:** Department of Commerce, Bureau of Economic Analysis.

If there is a discernable trend in these data, it is one of modest increase since the late 1940s, although there has been substantial variation and the share has declined from relatively high levels in the mid-1970s. 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.

A second reason why labor's share might be rising 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.<sup>3</sup> If this human capital per worker rises more rapidly than the physical capital per worker,

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<sup>3</sup> Daniel Aaronson, "Growth in Worker Quality," *Chicago Fed Letter*, Feb. 2002, 4 pp.

that could explain an increase in the labor share of income.<sup>4</sup> As long as wages keep pace with the productivity of labor, and the return to capital keeps pace 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 faster than capital productivity, then the labor share of income will tend to rise, other things being equal.

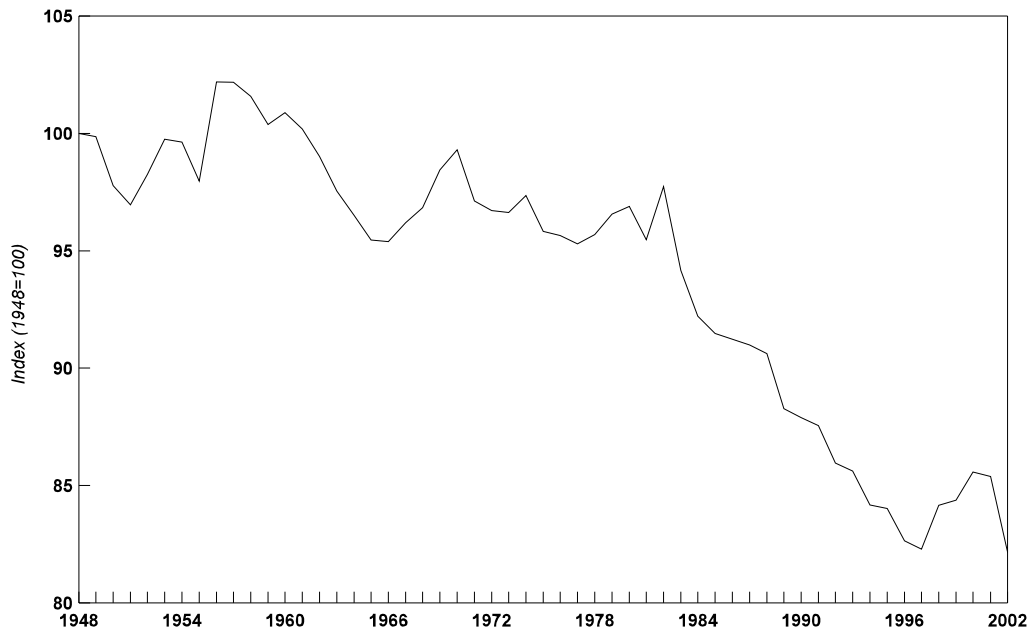
**Unit labor costs.** Another way to assess whether or not labor is reaping the benefits of increasing productivity is to examine unit labor costs. Unit labor cost measures the cost of labor required to produce a “unit” of output. It can be expressed mathematically as:

$$ULC = \frac{W \times L}{y} = \frac{W}{\frac{y}{L}}$$

This equation says that unit labor cost is simply the rate of compensation (W) times the quantity of labor (L, measured in hours) divided by total output (y). Dividing both the top and bottom of the ratio by the quantity of labor shows that the per unit labor cost is also equal to the rate of compensation divided by productivity. That being the case, as long as compensation increases at the same rate as productivity, unit labor costs, as well as the labor share of income, should remain constant. **Figure 4** shows unit labor costs adjusted for inflation since 1948.

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<sup>4</sup>Daniel S. Hamermesh and Albert Rees, *The Economics of Work and Pay*, 3<sup>rd</sup> edition, Harper and Row, 1984, pp. 356-360.

**Figure 4. Real Unit Labor Costs**

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

As the figure shows, real unit labor costs have fallen significantly since the mid-1970s. That corresponds with the period of decline in labor's share of income, and shows that labor income has not been keeping pace with productivity growth over that period.

## Labor Income and Productivity Growth

Productivity growth varies considerably over short periods of time, and in more or less predictable ways over the course of the business cycle, but more important are changes in its long run trends. Economists have identified two shifts in the long-term trend rate of growth in productivity. In 1973, productivity growth slowed significantly, and in 1995, it appears to have accelerated somewhat. The 1973 slowdown is still poorly understood, while the post-1995 improvement has been attributed, at least in part, to investments in computers and other information technology.<sup>5</sup>

Compensation growth trends reflect those shifts in productivity growth. **Figure 5** compares annual rates of change in inflation-adjusted hourly compensation with annual rates of growth in productivity for the intervals identified above.

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<sup>5</sup> For a discussion of productivity growth see, CRS Report RL32456, *Productivity: Will the Faster Growth Continue?*, by Brian W. Cashell.

**Figure 5. Real Compensation and Productivity Growth**

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

The figure shows that productivity growth fell by more than half after 1973 and that it accelerated after 1995 approaching its pre-1973 rate of growth. It also shows that growth in real compensation, perhaps not surprisingly, followed the same pattern. The chart also indicates that compensation did not grow as rapidly as productivity in any of the periods shown and, further, that the gap between compensation growth and productivity growth increased after 1973. The gap remained the same in both post-1973 intervals shown. The increase in the growth rate of real compensation after 1995 was the same as for productivity.

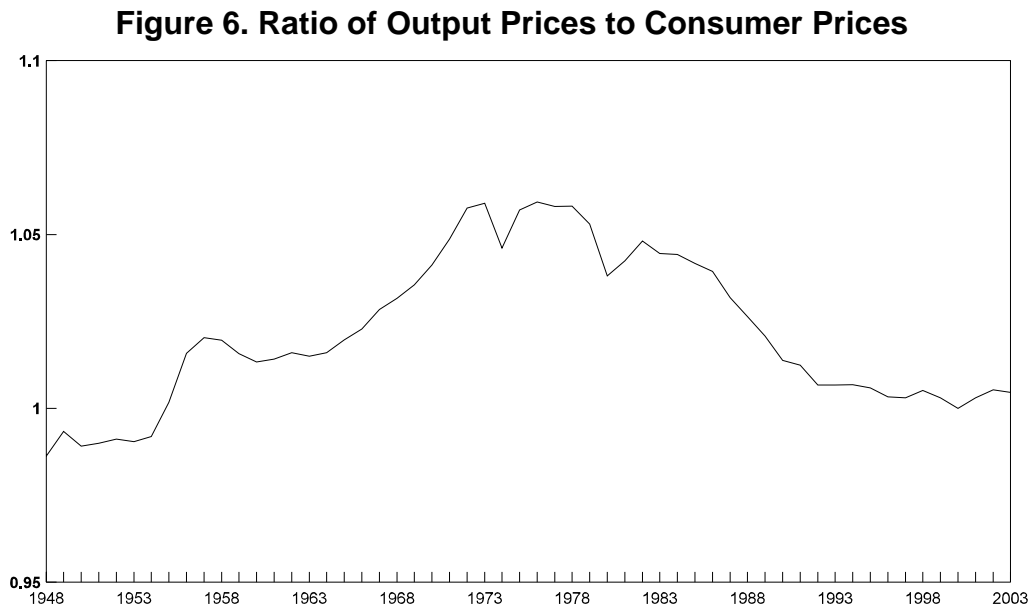
One reason for the gap between productivity and compensation growth might be that, in theory at least, the rate of compensation is based on the contribution to productivity of the last worker added to the labor force. The data in **Figure 5** are based on average labor productivity. It may be that the average productivity growth is not representative of growth in marginal productivity. But that does not make for a very satisfactory explanation, and economists often presume that the two measures behave similarly.

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 here 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.

Bosworth and Perry suggest that is enough to account for both the difference between compensation and productivity growth and the increase in the gap between the two.<sup>6</sup> 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.

**Figure 6** presents the ratio of the chain-weighted price indexes for total gross domestic product and for personal consumption expenditures. It is clear that between 1948 and the mid-1970s prices for all goods and services rose relative to those for just consumption goods and services. As a result, workers' terms of trade improved, and labor's share of income rose over that period.



**Source:** Department of Commerce, Bureau of Economic Analysis.

After the mid-1970s, consumer prices rose relative to overall prices. One reason the more comprehensive measure of prices fell relative to the consumption price index is that since the early 1980s computer prices have fallen significantly. Computers account for a very small portion of consumer spending. As a result of the

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<sup>6</sup> Barry Bosworth and George L. Perry, "Productivity and Real Wages: Is There a Puzzle?," *Brookings Papers on Economic Activity*, 1994/1, pp. 317-335.

relative price change, real labor income did not rise as much as total labor productivity.

The gap between productivity and compensation growth might also be affected by changes in how competitive the labor market is. For example, if something alters the relative bargaining power of either employers or employees, that could affect the rate of compensation.

A study published by the Federal Reserve Bank of Atlanta investigated the connection between unionization and the gap between compensation growth and the rate of productivity growth.<sup>7</sup> The study found that industries with relatively high rates of unionization had relatively small gaps between compensation and productivity growth. The study also found weak evidence that industries experiencing relatively larger declines in unionization experienced relatively larger increases in the gap between compensation and productivity growth.

## Conclusion

There is no doubt that productivity growth is the source of rising living standards. From a nationwide perspective that is certain. But how the gains from rising productivity are distributed may be an issue. The benefits of productivity growth may accrue to workers whose pay increases, to consumers in the form of lower prices, or to the owners of capital.

The labor share of income has fallen since the mid-1970s, but is actually above what it was in the 1950s and 1960s, in spite of the fact that the capital stock has grown more rapidly than the labor force.

It is clear that the rate of growth in real compensation rises and falls with the rate 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 that 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 as the unionization rate declines.

But even given that gap, the rate of increase in real compensation increased significantly along with productivity growth after 1995. Between 1995 and 2003, the 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

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<sup>7</sup> Madeline Zavodny, "Unions and the Wage-Productivity Gap," Federal Reserve Bank of Atlanta *Economic Review*, Second Quarter 1999, pp. 44-53.