For Release on Delivery
1:10 p.m. EDT
June 13, 2000

Remarks by

Alan Greenspan

Chairman

Board of Governors of the Federal Reserve System

before the

New York Association for Business Economics

New York, New York

June 13, 2000

This afternoon, bearing my old business economist credentials, I would like to discuss productivity. In particular, I will emphasize the potential to improve our understanding of the performance of productivity from delving into the microeconomic details of our current business environment. I believe the gains from this approach are likely to be greater than those from efforts to squeeze additional insight out of a limited number of macroeconomic statistics.

Until recently, much of the professional debate on the performance of productivity centered on whether there had been any meaningful acceleration of nonfarm business sector output per hour--a standard measure of aggregate productivity. That there has been some underlying improvement in the growth of aggregate productivity is now generally conceded by all but the most skeptical. The discussion has shifted to the extent and nature of that acceleration. A great deal of the evidence offered by the participants in this debate focuses on examinations of very aggregative measures of productivity. However, while the application of sophisticated filtering techniques, cyclical adjustment procedures, and other statistical tools to the analysis of aggregate productivity may improve our understanding in some respects, these approaches ultimately have significant limitations.

Only when data are disaggregated can we reasonably hope to tie productivity performance directly to business practices in our offices, on our plant floors, and through our distribution channels. Evidence developed at this level, recalibrated to an economywide scale, is, for reasons that I will discuss, more persuasive than that offered by the aggregate figures. Both the extent of the acceleration we are experiencing and the forces that underlie this improvement can be brought into sharper focus using a disaggregated approach.

To make any headway toward understanding productivity trends, one must first understand the data. In that regard, disaggregation often uncovers troubling implications of the

underlying data that are not immediately obvious. For example, separating nonfarm business sector output per hour into nonfinancial corporate, financial corporate, and noncorporate sectors has revealed disquieting problems with the measurement of productivity, especially in the noncorporate sector.[1] The Commerce Department will soon release data on output by industry, or "gross product originating," which will allow this decomposition to be updated to more fully reflect the benchmark revision to the national income and product accounts (NIPA) published last fall. Taken at face value, the prerevision data suggested that the level of noncorporate output per hour was no higher in the late 1990s than it had been in 1985. Indeed, the data pointed to falling levels of productivity for many years in such industries as construction and medical, legal, and business services--areas that are important in the noncorporate sector. These statistics,

---

[1]The initial work in this area by the Board's staff appeared in 1996 in Lawrence Slifman and Carol Corrado, "Decomposition of Productivity and Unit Costs," available at *www.federalreserve.gov/pubs/oss*. An updated version of the paper was published as Carol Corrado and Lawrence Slifman, "Decomposition of Productivity and Unit Costs," *American Economic Review*, vol. 89 (May 1999), pp.328-332.

however, are wholly at variance with our casual day-by-day experiences. Perhaps this the re-benchmarked GPO data will paint a significantly different picture. But, their doing so would only reinforce the argument for downweighting from our analyses sectoral data that are subject to such large revisions.

Putting aside the issue of data revisions, some analysts argue that such disaggregation of national productivity measures is inappropriate. They point out that inaccurate estimates of intermediate inputs and prices can shift measured value added from one sector of the economy to another without affecting the total. The implication is that aggregate productivity is measured more accurately than sectoral productivity. This concern clearly would be relevant if one sector were all, or predominantly, an input into the other. But in the case at hand, many of the types of firms that are important in the noncorporate sector--such as self-employed construction contractors, small retail stores, individual insurance agents, and doctors' offices--typically do not supply their output to the corporate sector. Consequently, the hypothesis that the currently estimated flat productivity of the noncorporate sector in recent years largely results from output misattributed to the corporate sector seems improbable.

The sources of the productivity measurement problems in the noncorporate sector are not entirely clear. Interestingly, value added per hour in nominal terms has risen at about the same pace in both the noncorporate and the corporate sector since 1992. Although it is conceivable that the problem could be mismeasurement of nominal incomes, difficulties with price measurement likely are the more important factor. The 1996 Boskin Commission documented widespread upward bias in estimated price change. If the biases are greater in the price indexes that implicitly are employed to deflate nominal noncorporate incomes, as I suspect, the output

and productivity growth of this sector would be understated. Whatever the source of the measurement error, it simply is not credible that for many years the noncorporate sector has experienced no productivity growth.

None of the available measures of productivity are without drawbacks. But I prefer to focus greater attention on the productivity measure for the nonfinancial corporate sector, which accounts for some 70 percent of total nonfarm business product. These figures eliminate the clearly mismeasured productivity of the noncorporate sector and avoid the thorny conceptual issues surrounding measurement of the financial sector. The remainder, while far from perfect, may provide a better representation of productivity developments in the economy. Moreover, in the national accounts, the gross product of the nonfinancial corporate business sector is measured from the income side. In my judgment, this income-side framework has the advantage that it is better suited to identifying the forces of cost containment that have been so critical in engendering productivity growth at the company level.

Conceptually, of course, there is no distinction between gross domestic product and gross domestic income. In practice, their difference in measurement is reflected in the NIPA statistical discrepancy. In the past, the year-to-year changes in the discrepancy generally have fluctuated around zero. Hence, over most of the past half-century the average growth rates of output and productivity measured from the product and the income side usually have not differed by much. Data for the most recent years, however, trace a different story. The statistical discrepancy has swung sharply since late 1992, reflecting an annual growth rate in real gross domestic income that has been 0.4 percentage point higher than the growth rate of real gross domestic product. This seven-year change is the largest in the statistical discrepancy, viewed in real terms, in the

postwar period. This difference is reflected directly in faster growth of productivity measured on the income side than that measured on the product side of the accounts.

Faced with a formidable data collection challenge, the Bureau of Economic Analysis (BEA) does a commendable job in limiting the discrepancy to so low a level; despite the recent widening, the discrepancy is little more than 1 percent of the total nominal annual GDP of nearly $10 trillion. But that said, the differences in productivity growth measured on the product and the income sides of the accounts are large enough to be economically meaningful. And in my view, insufficient attention is paid to the economic signal provided by the income-side measures.

To be sure, for some purposes, the product-side estimates of necessity play the central role. For example, most of our structural econometric models seek to explain the dynamics of spending behavior utilizing the structure of the product side of the accounts.

But for understanding the behavior of prices, costs, and productivity, using the consolidated and internally consistent income-side accounts, unencumbered by a changing statistical discrepancy, has advantages. To illustrate with recent developments in the nonfinancial corporate sector, for about four years price inflation has remained subdued--with prices rising on average about ½ percent per year. During that period, growth in hourly compensation has stepped up, and profitability has been strong. How are these observations reconciled? In the framework of this income-side system, the answer is an acceleration of labor productivity; indeed, for the nonfinancial corporate sector, output per hour has accelerated from around a 1-1/2 percent pace in the first half of the 1990s to more than a 4 percent pace over the past couple of years. Of course, this is precisely the story told repeatedly by businesspeople in recent years, and that also is apparent from a microeconomic examination of firm performance.

Indeed, one need not have adverted to the national income and product accounts at all to surmise the early emergence of productivity acceleration. Domestic operating profit margins, rising as they did from 1995 into 1997 in an environment of falling inflation, necessarily implied falling rates of total unit cost increases--most credibly the consequence of rising productivity growth.

Substantial increases in U.S. capital investment, and the accompanying faster growth of our capital stock relative to labor input--so-called capital deepening--explain a large part of the pickup in underlying growth in output per hour over the past five years, irrespective of how measured. But there has also been a marked step-up in the growth of so-called multifactor productivity (MFP). MFP is, of course, that portion of labor productivity that cannot be explained by other identifiable inputs into the production process. To a significant extent, MFP captures technological and managerial advance. These influences are very difficult to quantify, and we can only indirectly check that the resulting performance of other economic measures conform with our judgments about underlying efficiency gains in the production of specific goods and services.

There is considerable evidence at the microeconomic level that companies have continued to reap ample returns on capital outlays. In that regard, the rate of return on capital has been well maintained in recent years, despite the huge expansion of the capital stock. This conclusion runs counter to our usual expectation that increased supply brings down the marginal product of capital and is certainly consistent with some continuing improvement in multifactor productivity.

Indications that something unusual was afoot surfaced as early as 1993 when, a full two years after the 1991 recession, a significant rise in new orders for high-tech equipment unexpectedly emerged. Plant managers must have been inferring large increases in projected

rates of return on these capital outlays, a judgment supported by subsequent increases in MFP and a high-tech order flow that is still increasing at an elevated double-digit annual rate.

In retrospect, it is evident that we were in the early phases of a major expansion and diffusion of new technologies. These developments allowed firms to boost earnings in the face of intense competitive pressures through a reduction in the growth of unit costs. Moreover, despite a huge increase in the supply of high-tech capital assets, there is little evidence of a noticeable reduction in prospective rates of return on the newer technologies. What differentiates this period from other periods in our history is the extraordinary role played by information and communication technologies. The effect of these technologies could rival and arguably even surpass the impact the telegraph had prior to, and just after, the Civil War.

The important contribution of these new technologies is quite evident from another interesting disaggregation of the macroeconomic data, carried out by Stephen Oliner and Dan Sichel at the Federal Reserve Board in some recent research.[2] Their paper shows that much of the jump in productivity growth since the mid-1990s can be explained by two factors related to new information technologies. Most important, businesses throughout the economy have installed a great deal of information technology capital in recent years, which has boosted productivity growth through the associated capital deepening. In addition, the companies that produce computers and the embedded semiconductors appear to have achieved major efficiencies in their own operations, which have boosted MFP growth for the economy as a whole. Taking

---

[2]See Stephen D. Oliner and Daniel E. Sichel, "The Resurgence of Growth in the Late 1990s: Is Information Technology the Story?", available at www.federalreserve.gov/pubs/feds/2000/index.html.

these two effects together, the authors estimate that since 1995 information technologies have contributed about one-half of the acceleration of productivity measured on the income side and about two-thirds of the acceleration of productivity when measured on the product side. Much, if not all the remainder, reflects improvements beyond information technology narrowly defined and presumably reflects the managerial synergies that have resulted from an innovation-driven reorientation of business practice.

The results of the Oliner-Sichel analysis confirm what we could already sense from observation of company performance--that information and communication capabilities are currently expanding at an awesome rate.

Ever more sophisticated laser, computer, and satellite technologies, together with innovations in fiber optics, have significantly altered the way goods and services are produced and have improved the associated effectiveness with which we are able to allocate and utilize scarce labor and capital resources.

At the most basic level, the major contribution of information innovation is to reduce the number of worker hours required to produce a given level of the nation's output. Yet, in the vibrant economic conditions that have accompanied this period of rapid gains in productivity, labor resources freed up by technical advance have found ready opportunities elsewhere. Indeed, many more jobs have been created than have been lost, and our unemployment rate has fallen notably as technology has blossomed.

The more-rapid pace of IT and other high-tech innovation also has been accompanied by a visible acceleration of the process of "creative destruction," a shifting of capital from failing technologies into those technologies at the cutting edge as differential rates of return among

prospective investments widened. The resulting process of capital reallocation across the economy has been assisted by a significant unbundling of risks in capital markets made possible by the development of innovative financial products, many of which themselves owe their viability to improvements in IT.

Before this revolution in information availability, most twentieth-century business decisionmaking had been hampered by wide uncertainty. Owing to the paucity of timely knowledge of customers' needs and of the location of inventories and materials flowing throughout complex production systems, businesses, as many of you well remember, required substantial programmed redundancies to function effectively.

Doubling up on materials and people was essential as backup to the inevitable misjudgments of the real-time state of play in a company. Decisions were made from information that was hours, days, or even weeks old. Accordingly, production planning required costly inventory safety stocks and backup teams of people to respond to the unanticipated and the misjudged.

Large remnants of information void, of course, still persist, and forecasts of future events on which all business decisions ultimately depend are still unavoidably uncertain. But the remarkable surge in the availability of more timely information in recent years has enabled business management to remove large swaths of inventory safety stocks and worker redundancies.

Information access in real time--resulting, for example, from processes such as electronic data interface between the retail checkout counter and the factory floor or the satellite location of

trucks--has fostered marked reductions in delivery lead times and the related workhours required for the production and delivery of all sorts of goods, from books to capital equipment.

The dramatic decline in the lead times for the delivery of capital equipment has made a particularly significant contribution to the favorable economic environment of the past decade. When lead times for capital goods are long, the equipment must have multiple capabilities to deal with the plausible range of business needs likely to occur after these capital goods are delivered and installed.

With lead times foreshortened, many of the redundancies built into capital equipment to ensure that it could meet most plausible alternatives of a defined distant future could be sharply reduced. That means fewer goods and worker hours are caught up in activities that, while perceived as necessary insurance to sustain valued output, in the end produce nothing of value.

Those intermediate production and distribution activities, so essential when information and quality control were poor, are being reduced in scale and, in some cases, eliminated. These trends may well gather speed and force as the Internet continues to alter relationships of businesses to their suppliers and their customers.

The process of innovation goes beyond the factory floor or distribution channels. Design times and costs have fallen dramatically as computer modeling has eliminated the need, for example, for the large staff of architectural specification-drafters previously required for building projects. Medical diagnoses are more thorough, more accurate, and far faster, with access to heretofore unavailable information. Treatment is accordingly hastened, and hours of procedures eliminated.

Indeed, these developments emphasize the essence of information technology--the expansion of knowledge and its obverse, the reduction of uncertainty. As a consequence, risk premiums that were associated with many forms of business activity have declined.

Because the future is never entirely predictable, risk in any business action committed to the future--that is, virtually all business actions--can be reduced but never eliminated. Information technologies, by improving our real-time understanding of production processes and of the vagaries of consumer demand, are reducing the degree of uncertainty and, hence, risk.

In short, information technology raises output per hour in the total economy principally by reducing hours worked on activities needed to guard productive processes against the unknown and the unanticipated. Narrowing the uncertainties reduces the number of hours required to maintain any given level of production readiness.

In economic terms, we are reducing risk premiums and variances throughout the economic decision tree that drives the production of our goods and services. This has meant that employment of scarce resources to deal with heightened risk premiums has been reduced.

The expanding opportunities for e-commerce are already changing the relationship between businesses and consumers. The networking forces unleashed by the Internet are almost surely to be even more potent within and among businesses, where uncertainties are being reduced by improving the quantity, the reliability, and the timeliness of information. This is the case in many recent initiatives, especially among our more seasoned companies, to consolidate and rationalize their supply chains using the Internet.

Not all technologies, information or otherwise, however, increase productivity--that is, output per hour--by reducing the inputs necessary to produce existing products. Some

technologies bring about new goods and services with above-average value added per workhour. The dramatic advances in biotechnology, for example, are significantly increasing a broad range of productivity-expanding efforts in areas from agriculture to medicine.

In summary then, most of the gains in the level and the growth rate of productivity in the United States since 1995 appear to have been structural, largely driven by irreversible advances in technology and its application--irreversible in the sense that knowledge once gained is almost never lost. Having learned to employ bar code and satellite technologies, for example, we are not about to lose our capability in applying them.

To be sure, some of the increase in output per hour may well reflect cyclical rather than structural changes. Output can be stretched beyond sustainable capacity for a time, raising measured output per hour. And, on the other side, a cyclical slowing in demand is not usually matched by a prompt scaling back of employment, resulting in a temporary decline in output per hour or, at best, a significant slowing in its growth rate.

But cutting through the inevitable cyclical fluctuation of measured output per hour, the evidence of a decided improvement in the growth rate of structural productivity from the macro data has continued to strengthen. And, an examination of the micro level evidence is even more compelling. Disaggregative probings of the productivity data, as well as direct observation of the performance of U.S. businesses lend considerable credibility to the notion that our economy is benefiting from structural gains in productivity that have been driven by a remarkable wave of technological innovation.