Mr Greenspan discusses technology and the US economy

Remarks by Mr Alan Greenspan, Chairman of the Board of Governors of the US Federal Reserve System, before the Economic Club of New York, New York, on 13 January 2000.

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We are within weeks of establishing a record for the longest economic expansion in this nation's history. The 106-month expansion of the 1960s, which was elongated by the Vietnam War, will be surpassed in February. Nonetheless, there remain few evident signs of geriatric strain that typically presage an imminent economic downturn.

Four or five years into this expansion, in the middle of the 1990s, it was unclear whether, going forward, this cycle would differ significantly from the many others that have characterized post-World War II America. More recently, however, it has become increasingly difficult to deny that something profoundly different from the typical postwar business cycle has emerged. Not only is the expansion reaching record length, but it is doing so with far stronger-than-expected economic growth. Most remarkably, inflation has remained subdued in the face of labor markets tighter than any we have experienced in a generation. Analysts are struggling to create a credible conceptual framework to fit a pattern of interrelationships that has defied conventional wisdom based on our economy's history of the past half century.

When we look back at the 1990s, from the perspective of say 2010, the nature of the forces currently in train will have presumably become clearer. We may conceivably conclude from that vantage point that, at the turn of the millennium, the American economy was experiencing a once-in-a-century acceleration of innovation, which propelled forward productivity, output, corporate profits, and stock prices at a pace not seen in generations, if ever.

Alternatively, that 2010 retrospective might well conclude that a good deal of what we are currently experiencing was just one of the many euphoric speculative bubbles that have dotted human history. And, of course, we cannot rule out that we may look back and conclude that elements from both scenarios have been in play in recent years.

On the one hand, the evidence of dramatic innovations - veritable shifts in the tectonic plates of technology - has moved far beyond mere conjecture. On the other, these extraordinary achievements continue to be bedeviled by concerns that the so-called New Economy is spurring imbalances that at some point will abruptly adjust, bringing the economic expansion, its euphoria, and wealth creation to a debilitating halt. This evening I should like to address some of the evidence and issues that pertain to these seemingly alternative scenarios.

What should be indisputable is that a number of new technologies that evolved largely from the cumulative innovations of the past half century have now begun to bring about awesome changes in the way goods and services are produced and, especially, in the way they are distributed to final users. Those innovations, particularly the Internet's rapid emergence from infancy, have spawned a ubiquity of startup firms, many of which claim to offer the chance to revolutionize and dominate large shares of the nation's production and distribution system. Capital markets, not comfortable dealing with discontinuous shifts in economic structure, are groping for sensible evaluations of these firms. The exceptional stock price volatility of most of the newer firms and, in the view of some, their outsized valuations, are indicative of the difficulties of divining from the many, the particular few of the newer technologies and operational models that will prevail in the decades ahead.

How did we arrive at such a fascinating and, to some, unsettling point in history? The process of innovation, of course, is never-ending. Yet the development of the transistor after World War II appears in retrospect to have initiated an especial wave of innovative synergies. It brought us the microprocessor, the computer, satellites, and the joining of laser and fiber-optic technologies. These, in turn, fostered by the 1990s an enormous new capacity to disseminate information. To be sure,

innovation is not confined to information technologies. Impressive technical advances can be found in many corners of the economy.

But it is information technology that defines this special period. The reason is that information innovation lies at the root of productivity and economic growth. Its major contribution is to reduce the number of worker hours required to produce the nation's output. Yet, in the vibrant economic conditions that have accompanied this period of technical innovation, many more job opportunities have been created than have been lost. Indeed, our unemployment rate has fallen notably as technology has blossomed.

One result of the more-rapid pace of IT innovation has been a visible acceleration of the process of "creative destruction," a shifting of capital from failing technologies into those technologies at the cutting edge. The 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 advances 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 such processes 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 equipment 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 all 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 alters 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, of the large staff of architectural specification-drafters previously required for building projects. Medical diagnoses are more thorough, 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 in uncertainty. As a consequence, risk premiums that were associated with all forms of business activities 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 relationship between businesses and consumers already is being changed by the expanding opportunities for e-commerce. The 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 new 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.

Indeed, in our dynamic labor markets, the resources made redundant by better information, as I indicated earlier, are being drawn to the newer activities and newer products, many never before contemplated or available. The personal computer, with ever-widening applications in homes and businesses, is one. So are the fax and the cell phone. The newer biotech innovations are most especially of this type, particularly the remarkable breadth of medical and pharmacological product development.

At the end of the day, however, the newer technologies obviously can increase outputs or reduce inputs and, hence, increase productivity only if they are embodied in capital investment. Capital investment here is defined in the broadest sense as any outlay that enhances future productive capabilities and, consequently, capital asset values.

But for capital investments to be made, the prospective rate of return on their implementation must exceed the cost of capital. Gains in productivity and capacity per real dollar invested clearly rose materially in the 1990s, while the increase in equity values, reflecting that higher earnings potential, reduced the cost of capital.

In particular, technological synergies appear to be engendering an ever-widening array of prospective new capital investments that offer profitable cost displacement. In a consolidated sense, reduced cost generally means reduced labor cost or, in productivity terms, fewer hours worked per unit of output. These increased real rates of return on investment and consequent improved productivity are clearly most evident among the relatively small segment of our economy that produces high-tech equipment. But the newer technologies are spreading to firms not conventionally thought of as high tech.[1]

It would be an exaggeration to imply that whenever a cost increase emerges on the horizon, there is a capital investment that is available to quell it. Yet the veritable explosion of high-tech equipment and software spending that has raised the growth of the capital stock dramatically over the past five years could hardly have occurred without a large increase in the pool of profitable projects becoming available to business planners. As rising productivity growth in the high-tech sector since 1995 has

[1] Since the early 1990s, the annual growth rate in output per hour of non-financial corporate businesses outside high tech has risen by a full percentage point.

resulted in an acceleration of price declines for equipment embodying the newer technologies, investment in this equipment by firms in a wide variety of industries has expanded sharply.

Had high prospective returns on these capital projects not materialized, the current capital equipment investment boom - there is no better word - would have petered out long ago. In the event, overall equipment and capitalized software outlays as a percentage of GDP in nominal dollars have reached their highest level in post-World War II history.

To be sure, there is also a virtuous capital investment cycle at play here. A whole new set of profitable investments raises productivity, which for a time raises profits - spurring further investment and consumption. At the same time, faster productivity growth keeps a lid on unit costs and prices. Firms hesitate to raise prices for fear that their competitors will be able, with lower costs from new investments, to wrest market share from them.

Indeed, the increasing availability of labor-displacing equipment and software, at declining prices and improving delivery lead times, is arguably at the root of the loss of business pricing power in recent years. To be sure, other inflation-suppressing forces have been at work as well. Marked increases in available global capacity were engendered as a number of countries that were previously members of the autarchic Soviet bloc opened to the West, and as many emerging-market economies blossomed. Reductions in Cold War spending in the United States and around the world also released resources to more productive private purposes. In addition, deregulation that removed bottlenecks and hence increased supply response in many economies, especially ours, has been a formidable force suppressing price increases as well. Finally, the global economic crisis of 1997 and 1998 reduced the prices of energy and other key inputs into production and consumption, helping to hold down inflation for several years.

Of course, Europe and Japan have participated in this recent wave of invention and innovation and have full access to the newer technologies. However, they arguably have been slower to apply them. The relatively inflexible and, hence, more costly labor markets of these economies appear to be an important factor. The high rates of return offered by the newer technologies are largely the result of labor cost displacement, and because it is more costly to dismiss workers in Europe and Japan, the rate of return on the same equipment is correspondingly less there than in the United States. Here, labor displacement is more readily countenanced both by law and by culture, facilitating the adoption of technology that raises standards of living over time.

There, of course, has been a substantial amount of labor-displacing investment in Europe to obviate expensive increased employment as their economies grow. But it is not clear to what extent such investment has been directed at reducing existing levels of employment. It should always be remembered that in economies where dismissing a worker is expensive, hiring one will also be perceived to be expensive.

An ability to reorganize production and distribution processes is essential to take advantage of newer technologies. Indeed, the combination of a marked surge in mergers and acquisitions, and especially the vast increase in strategic alliances, including across borders, is dramatically altering business structures to conform to the imperatives of the newer technologies.[2]

We are seeing the gradual breaking down of competition-inhibiting institutions from the keiretsu and chaebol of East Asia, to the dirigisme of some of continental Europe. The increasingly evident advantages of applying the newer technologies is undermining much of the old political wisdom of protected stability. The clash between unfettered competitive technological advance and protectionism, both domestic and international, will doubtless engage our attention for many years into this new century. The turmoil in Seattle last month may be a harbinger of an intensified debate.

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[2] For example, the emergence of many alternate technologies in areas where only one or two will set the standard and survive has created high-risk, high-reward outcomes for their creators. The desire to spread risk (and the willingness to forgo the winner-take-all return) has fostered a substantial number of technology-sharing alliances.

However one views the causes of our low inflation and strong growth, there can be little argument that the American economy as it stands at the beginning of a new century has never exhibited so remarkable a prosperity for at least the majority of Americans.

Nonetheless, this seemingly beneficial state of affairs is not without its own set of potential challenges. Productivity-driven supply growth has, by raising long-term profit expectations, engendered a huge gain in equity prices. Through the so-called "wealth effect," these gains have tended to foster increases in aggregate demand beyond the increases in supply. It is this imbalance between growth of supply and growth of demand that contains the potential seeds of rising inflationary and financial pressures that could undermine the current expansion.

Higher productivity growth must show up as increases in real incomes of employees, as profit, or more generally as both. Unless the propensity to spend out of real income falls, private consumption and investment growth will rise, as indeed it must, since over time demand and supply must balance. (I leave the effect of fiscal policy for later.) If this was all that happened, accelerating productivity would be wholly benign and beneficial.

But in recent years, largely as a result of the appreciating values of ownership claims on the capital stock, themselves a consequence, at least in part, of accelerating productivity, the net worth of households has expanded dramatically, relative to income. This has spurred private consumption to rise even faster than the incomes engendered by the productivity-driven rise in output growth. Moreover, the fall in the cost of equity capital corresponding to higher share prices, coupled with enhanced potential rates of return, has spurred private capital investment. There is a wide range of estimates of how much added growth the rise in equity prices has engendered, but they center around 1 percentage point of the somewhat more than 4 percentage point annual growth rate of GDP since late 1996.

Such overall extra domestic demand can be met only with increased imports (net of exports) or with new domestic output produced by employing additional workers. The latter can come only from drawing down the pool of those seeking work or from increasing net immigration.

Thus, the impetus to spending from the wealth effect by its very nature clearly cannot persist indefinitely. In part, it adds to the demand for goods and services before the corresponding increase in output fully materializes. It is, in effect, increased purchasing from future income, financed currently by greater borrowing or reduced accumulation of assets.

If capital gains had no evident effect on consumption or investment, their existence would have no influence on output or employment either. Increased equity claims would merely match the increased market value of productive assets, affecting only balance sheets, not flows of goods and services, not supply or demand, and not labor markets.

But this is patently not the case. Increasing perceptions of wealth have clearly added to consumption and driven down the amount of saving out of current income and spurred capital investment.

To meet this extra demand, our economy has drawn on all sources of added supply. Our net imports and current account deficits have risen appreciably in recent years. This has been financed by foreign acquisition of dollar assets fostered by the same sharp increases in real rates of return on American capital that set off the wealth effect and domestic capital goods boom in the first place. Were it otherwise, the dollar's foreign exchange value would have been under marked downward pressure in recent years. We have also relied on net immigration to augment domestic output. And finally, we have drawn down the pool of available workers.

The bottom line, however, is that, while immigration and imports can significantly cushion the consequences of the wealth effect and its draining of the pool of unemployed workers for a while, there are limits. Immigration is constrained by law and its enforcement; imports, by the willingness of global investors to accumulate dollar assets; and the draw down of the pool of workers by the potential emergence of inflationary imbalances in labor markets. Admittedly, we are groping to infer where those limits may be. But that there are limits cannot be open to question.

However one views the operational relevance of a Phillips curve or the associated NAIRU (the nonaccelerating inflation rate of unemployment) - and I am personally decidedly doubtful about it - there has to be a limit to how far the pool of available labor can be drawn down without pressing wage levels beyond productivity. The existence or nonexistence of an empirically identifiable NAIRU has no bearing on the existence of the venerable law of supply and demand.

To be sure, increases in wages in excess of productivity growth may not be inflationary, and destructive of economic growth, if offset by decreases in other costs or declining profit margins. A protracted decline in margins, however, is a recipe for recession. Thus, if our objective of maximum sustainable economic growth is to be achieved, the pool of available workers cannot shrink indefinitely.

As my late friend and eminent economist Herb Stein often suggested: if a trend cannot continue, it will stop. What will stop the wealth-induced excess of demand over productivity-expanded supply is largely developments in financial markets.

That process is already well advanced. For the equity wealth effect to be contained, either expected future earnings must decline, or the discount factor applied to those earnings must rise. There is little evidence of the former. Indeed, security analysts, reflecting detailed information on and from the companies they cover, have continued to revise upward long-term earnings projections. However, real rates of interest on long-term BBB corporate debt, a good proxy for the average of all corporate debt, have already risen well over a full percentage point since late 1997, suggesting increased pressure on discount factors.[3] This should not be a surprise because an excess of demand over supply ultimately comes down to planned investment exceeding saving that would be available at the economy's full potential. In the end, balance is achieved through higher borrowing rates. Thus, the rise in real rates should be viewed as a quite natural consequence of the pressures of heavier demands for investment capital, driven by higher perceived returns associated with technological breakthroughs and supported by a central bank intent on defusing the imbalances that would undermine the expansion.

We cannot predict with any assurance how long a growing wealth effect - more formally, a rise in the ratio of household net worth to income - will persist, nor do we suspect can anyone else. A diminution of the wealth effect, I should add, does not mean that prices of assets cannot keep rising, only that they rise no more than income.

A critical factor in how the rising wealth effect and its ultimate limitation will play out in the market place and the economy is the state of government, especially federal, finances.

The sharp rise in revenues (at a nearly 8% annual rate since 1995) has been significantly driven by increased receipts owing to realized capital gains and increases in compensation directly and indirectly related to the huge rise in stock prices. Both the Administration and the Congress have chosen wisely to allow unified budget surpluses to build and have usefully focused on eliminating the historically chronic borrowing from social security trust funds to finance current outlays.

The growing unified budget surpluses have absorbed a good part of the excess of potential private demand over potential supply. A continued expansion of the surplus would surely aid in sustaining the productive investment that has been key to leveraging the opportunities provided by new technology, while holding down a further reliance on imports and absorption of the pool of available workers.

I trust that the recent flurry of increased federal government outlays, seemingly made easier by the emerging surpluses, is an aberration. In today's environment of rapid innovation, growing unified budget surpluses can obviate at least part of the rebalancing pressures evident in marked increases in real long-term interest rates.

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[3] The inflation expectations employed in this calculation are those implicit in the gap between the interest rates on ten-year Treasury inflation-indexed notes and those on a nominal security derived from Treasury STRIPS constructed to have comparable duration. The latter are used because they have the same relatively limited liquidity as inflation-indexed notes.

As I noted at the beginning of my remarks, it may be many years before we fully understand the nature of the rapid changes currently confronting our economy. We are unlikely to fully comprehend the process and its interactions with asset prices until we have been through a complete business cycle.

Regrettably, we at the Federal Reserve do not have the luxury of awaiting a better set of insights into this process. Indeed, our goal, in responding to the complexity of current economic forces, is to extend the expansion by containing its imbalances and avoiding the very recession that would complete a business cycle.

If we knew for sure that economic growth would soon be driven wholly by gains in productivity and growth of the working age population, including immigration, we would not need to be as concerned about the potential for inflationary distortions. Clearly, we cannot know for sure, because we are dealing with world economic forces which are new and untested.

While we endeavor to find the proper configuration of monetary and fiscal policies to sustain the remarkable performance of our economy, there should be no ambiguity on the policies required to support enterprise and competition.

I believe that we as a people are very fortunate: when confronted with the choice between rapid growth with its inevitable insecurities and a stable, but stagnant economy, given time, Americans have chosen growth. But as we seek to manage what is now this increasingly palpable historic change in the way businesses and workers create value, our nation needs to address the associated dislocations that emerge, especially among workers who see the security of their jobs and their lives threatened. Societies cannot thrive when significant segments perceive its functioning as unjust.

It is the degree of unbridled fierce competition within and among our economies today - not free trade or globalization as such - that is the source of the unease that has manifested itself, and was on display in Seattle a month ago. Trade and globalization are merely the vehicles that foster competition, whose application and benefits currently are nowhere more evident than here, today, in the United States.

Confronted face-on, no one likes competition; certainly, I did not when I was a private consultant vying with other consulting firms. But the competitive challenge galvanized me and my colleagues to improve our performance so that at the end of the day we and, indeed, our competitors, and especially our clients, were more productive.

There are many ways to address the all too real human problems that are the inevitable consequences of accelerating change. Restraining competition, domestic or international, to suppress competitive turmoil is not one of them. That would be profoundly counterproductive to rising standards of living.

We are in a period of dramatic gains in innovation and technical change that challenge all of us, as owners of capital, as suppliers of labor, as voters and policymakers. How well policy can be fashioned to allow the private sector to maximize the benefits of innovations that we currently enjoy, and to contain the imbalances they create, will shape the economic configuration of the first part of the new century.